

Asphalt Technology News

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Research Findings Attract Record-Setting Attendance at NCAT's Test Track Conference



Buzz Powell leads a walking tour of pavement preservation research on Lee Road 159.

The National Center for Asphalt Technology (NCAT) hosted its fifth Pavement Test Track Conference on March 3-5, 2015 at the Hotel at Auburn University and Dixon Conference Center in Auburn, Alabama. Over 260 attendees participated in the sessions, tours, and social functions. That's a 60-plus percent increase over the previous conference.

Held every three years, the conference is a forum to present research findings from the previous cycle of accelerated pavement testing. During the two and a half day program, participants learned about advancements in asphalt pavement design, construction, technologies, and maintenance that are more cost effective and improve performance. The conference also provided a valuable networking opportunity and set the stage for further cooperation among federal, state, and local agencies as well as the private sector.

The overall focus of NCAT's fifth and most recent research phase was to minimize the life-cycle cost of asphalt pavements by using innovative materials during construction and selecting the best preservation alternatives. This cycle of pavement testing included the most complex range of experiments to date, including the incorporation of pavement preservation research on Lee County Road 159, open graded friction courses (OGFCs), cold central plant recycling (CCPR), and the optimization of recycled materials in asphalt pavement.

The opening session set forth the purpose of the conference, importance of NCAT as a national proving ground for pavement research, and provided additional historical background of accelerated pavement testing. Opening speakers included Christopher Roberts, dean of the Samuel Ginn College of Engineering at Auburn University; John

Cooper, director of the Alabama Department of Transportation; Ray Bonaquist, CEO of Advanced Asphalt Technologies; and Buzz Powell, assistant director and Pavement Test Track manager at NCAT.

Tuesday's sustainable pavements session focused on the Group Experiment and Green Group Experiment followed by transportation to the Pavement Test Track for a 90-minute guided tour. At the track, attendees were able to get an up close look at trenches in numerous test sections, high friction surfaces, track instrumentation, falling weight deflectometer (FWD) testing, and other forensic equipment including NCAT's mobile testing lab. Events later resumed at the conference center where the day's final session on innovative pavement materials contained findings from cold central plant recycling (CCPR) and high-polymer sections.

Research was presented on bond and tack coats, open graded friction courses, and high friction surface treatments in Wednesday morning's session followed by an introduction to NCAT's pavement preservation research on Lee Road 159. Afterward, group tours to the site provided participants an unprecedented opportunity to appreciate first hand the life extending and condition improving benefits of a large number of pavement preservation treatments. After returning to the conference center, additional presentations on pavement preservation, state implementation, and the next research cycle were given.

The conference concluded on Thursday and featured presentations by representatives from sponsoring agencies who demonstrated how the benefits of implementing test track research has helped further their transportation dollars.



Nam Tran discusses the interlayer bond and points out cracks that can be seen in the trench.



Mike Heitzman explains how NCAT uses an albedometer to measure the reflectivity of a pavement surface.



The event achieved its highest attendance to date with over 260 attendees, a 60-plus percent increase over the previous conference.

Other highlights of the conference were social events such as meals, receptions, and a well-received speech by Dick Burluson. In addition to his engineering and military careers, Burluson was a football official in the Southeastern Conference for 25 years. His engaging presentation covered issues such as how to manage change and be an effective leader while sharing humorous insights from one of the nation's most premier college football conferences.

NCAT thanks the conference attendees, test track sponsors, exhibitors, and reception sponsors, whose enthusiasm and dedication were essential to the success of this symposium. Our next Pavement Test Track Conference will examine the research of our upcoming sixth cycle of accelerated pavement testing and is scheduled for March 6-8, 2018. A complete report of the fifth research cycle's findings will be published later this year.



Dick Burluson entertains attendees with valuable lessons and a humorous look at SEC football during Thursday's dinner.



Visit our Facebook page for more conference photos and videos at:
www.facebook.com/NCATAuburn



Auburn's Samuel Ginn College of Engineering Dean Chris Roberts addresses the audience at Tuesday morning's opening session.



Mary Robbins offers insights into pavement preservation research during a group tour of Lee Road 159.

An Innovative Partnership: NCAT & MnROAD Collaborate to Improve Our Nation's Roadways

In a groundbreaking step to play a larger role in pavement research, a newly formed partnership with MnROAD is a centerpiece of NCAT's upcoming research cycle. By sharing resources and expertise, this collaboration will expand the scope of NCAT's research to include implementable solutions for cold weather climates while addressing national pavement research needs in the areas of pavement preservation and the validation of reliable tests to assess the cracking resistance of asphalt mixes.

NCAT and MnROAD are the world's two largest full-scale pavement testing facilities. Using real construction methods and live trafficking under actual climate conditions provides an authentic environment for researchers to study and evaluate the performance of materials used in roadway construction. The combination of traffic loading types and the range in climate conditions will provide unique opportunities for this partnership to address nationwide needs such as pavement preservation and performance issues.

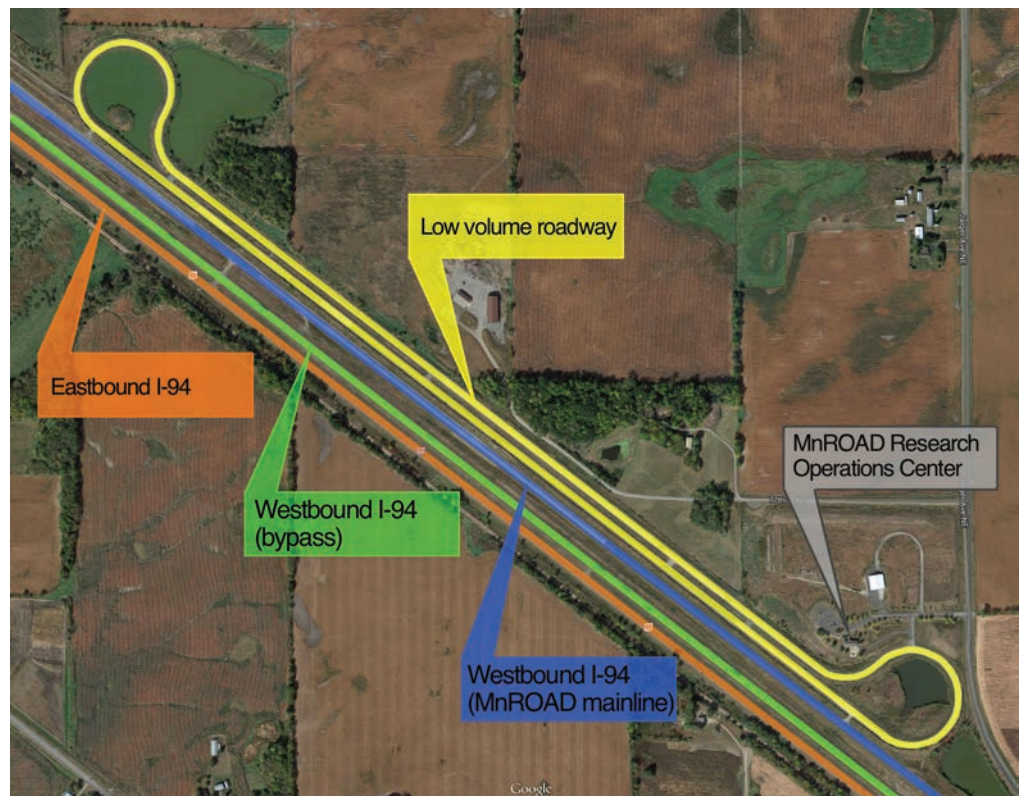
Owned and operated by the Minnesota Department of Transportation, MnROAD is a real-world accelerated pavement testing facility located approximately 40 miles northwest of Minneapolis. Constructed in 1994, this unique proving ground is composed of a 3.5-mile interstate (I-94), a 3.5-mile bypass for diverting interstate traffic when needed, and a controlled access 2.5-mile low-volume roadway. MnROAD is committed to providing safer, smarter, and sustainable pavements through innovative research.

NCAT's Pavement Test Track is located 15 miles from the Auburn University campus where research is conducted on a 1.7-mile oval track comprised of 46 test sections. Sponsored on three-year cycles, the track recently completed its fifth cycle of accelerated pavement testing, which included the incorporation of pavement preservation research on Lee County Road 159. NCAT's sixth research cycle will expand to include a section of the westbound lane of U.S. 280 near the test track. Working with state highway agencies, the Federal Highway Administration, and the highway

construction industry, NCAT evaluates new products as well as design technologies and construction methods that lead to pavement improvements.

The two primary experiments in the MnROAD-NCAT partnership will focus on pavement preservation and validation of cracking tests. Many of the same pavement preservation treatments installed on Lee Road 159 will also be investigated at MnROAD to provide a far-reaching impact in advancing pavement research. This parallel study is aimed at producing findings that can be directly implemented by a larger base of state departments of transportation who may have had previous concerns that findings from NCAT were not directly applicable to their climate or pavement surface type.

MnROAD and NCAT will also work with sponsors to develop experiments to validate cracking tests. A critical need at this point in time is a reliable cracking test (or tests) that can be used during mix design and quality assurance during mix production to eliminate mixes that are not durable. There are several lab tests being used or proposed by researchers that claim to relate to one or more modes of cracking. However, most of these tests lack robust validation outside of the state where the method



MnROAD was originally constructed in 1994 and consists of a 3.5-mile portion of mainline interstate, 3.5-mile bypass roadway, and a 2.5-mile closed loop low-volume roadway.



An 80,000 pound five-axle tractor-trailer operates on MnROAD's closed loop adjacent to Interstate 94 (I-94).

was developed. The experiments at MnROAD and NCAT will help validate the correlation between lab results and field performance and provide much needed data on where to set criteria for specifications.

“Both facilities and organizations have a great track record of completing applied research that gets implemented and pays off,” said Dr. Randy West, director of NCAT. “These are the only pavement testing facilities in the world that use realistic climates, axle loads, and speeds. Developing experiments to answer needs about pavement preservation options and validating asphalt mix cracking tests will help us more effectively utilize asphalt pavements, especially those containing innovative and recycled components.”

View the webinar and download informational slides online at <http://ncat.us>

Auburn's Online Master of Civil Engineering Degree Now Includes Pavement Engineering

Interested in pursuing an online master's degree with an emphasis in pavement engineering? That option is now available through Auburn University, whose program was ranked 17th in U.S. News and World Report's 2015 "Best Online Graduate Engineering Programs."

Auburn's Samuel Ginn College of Engineering will offer its first online graduate course in pavements and materials this summer. NCAT Director Dr. Randy West will be teaching the 3-credit hour course, Design and Production of Asphalt Paving Mixtures. Students will be able to access the lectures online at their convenience via streaming video. Future online course offerings are planned, including Advanced Pavement Design, Sustainable Pavements, Pavement Management and Rehabilitation, and Advanced Characterization of Pavement Materials. A few courses may require a week-long lab during the semester at NCAT.

The Master of Civil Engineering (MCE) degree available through distance learning does not require a thesis. Students have up to six years to complete 30 semester hours of online graduate-level classes which may include a 3-credit hour civil engineering project. The program requires an advisory committee of three faculty members to approve the plan of study. Tuition is reasonably priced at \$795 per semester credit hour for both residents and non-residents of Alabama.

Applicants must have a bachelor's degree in civil engineering (or a similar field) from an accredited institution and must have taken the GRE prior to entering the graduate online program. The online application should be completed at grad.auburn.edu at least 60 days before the semester starts. Additional submissions are required, including a statement of purpose, three letters of recommendation, GRE scores, and college transcripts.



10 Advantages of our Online Master's Degree

- 1 Experienced Faculty**
Students attending courses online receive the same professors as their on-campus peers.
- 2 Cost-Effective**
Online courses can cut transportation and other expenses incurred by attending traditional classes.
- 3 Work/School Balance**
Thanks to the flexibility online education offers, it's easier for students to maintain a job during business hours.
- 4 Supportive Environment**
Students can get feedback and advice from other students and interact with instructors one-on-one.
- 5 Career Advancement**
Earning a master's degree demonstrates to employers that you are prepared for new challenges.
- 6 Life/School Balance**
With online delivery, you won't have to relocate your family if you live out of state.
- 7 Technological Skills**
Online students gain skills that translate to the workplace, such as sharing documents and completing training online.
- 8 Future Stability**
Having a post-secondary degree typically leads to better job security.
- 9 Networking Opportunities**
You'll connect with other students no matter where they're located- something traditional programs can't offer.
- 10 Quality and Reputation**
Auburn's online graduate engineering program is nationally recognized for its excellence.

Don't Forget the Impact of Basic Principles on Asphalt Mix Durability

In a number of states, there has been increasing concern that many asphalt mixes are not as durable as they should be. Some cases of overlays deteriorating within a few years have been reported. The problems have been attributed to a range of causes such as the use of RAS, low asphalt contents, low in-place density, poor quality underlying layers, and freeze-thaw cycles of recent harsh winters. Typically, for any particular case there are a number of factors that play a part in durability problems. The root causes can often be traced back to failing to follow basic principles of mix design and quality assurance. The aim of this article is to refresh our attention to those basic principles.

Asphalt Content

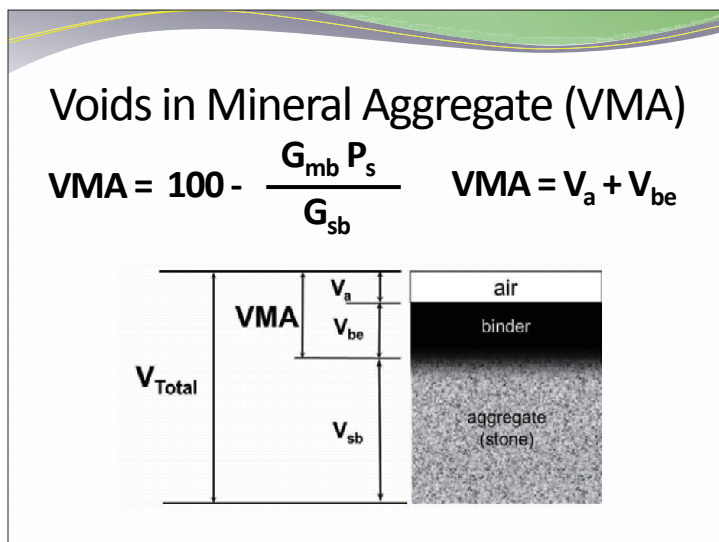
In the past few years, many highway agencies have implemented specification changes to increase asphalt contents of mix designs. Some have reduced the target air void content or increased VMA limits in mix design. In general, reducing the target air void content by 0.5% or increasing the minimum VMA by 0.5% will add about 0.2% more asphalt to mixes. Increasing asphalt contents will generally improve durability and also make the mixes more compactible. However, there is another very basic element of mix design that has a big impact on the optimum asphalt of mixes - the aggregate blend bulk specific gravity (G_{sb}). Using a G_{sb} that is higher than its true value, either by error or intent, will result in a calculated VMA that is higher than it actually is, and the net effect will be a lower asphalt content for the mix. A small change in the blend's G_{sb} can have a significant impact

on VMA; for example, increasing G_{sb} by 0.029 (a change that is within the repeatability of the tests) can increase the calculated VMA by 1.0%. Therefore, it is incumbent on agencies to check the G_{sb} of materials used in both mix designs and mix production. The frequency of checking G_{sb} should be based on historical data for how much the G_{sb} values change over time for aggregate and RAP components.

It is also important to consider changes made to mixtures during production. In many quality assurance specifications, the air voids of lab compacted specimens have a greater impact on the contractor's pay per lot of mixture than asphalt content. This encourages a reduction of asphalt content in order to maintain air voids (and VMA), which essentially sacrifices durability in favor of rutting resistance. Agencies can discourage this practice by limiting the reduction of the target asphalt content during mix production, forcing contractors to make other adjustments in the mix to maintain volumetric properties. This will motivate mix designers to account for changes in gradation, particle shapes, and dust contents that often occur during plant production as they develop new mix designs.

Lower Ndesign

Reducing the laboratory compactive effort by itself will not necessarily increase the asphalt content of mixes, but it can help improve mixes in other ways such as enabling mix designers to use finer gradations. In general, fine-graded mixes are easier to compact than coarse-graded mixes both in the laboratory and in the field. When Superpave was introduced in many parts of the country, mix designers were encouraged to use coarse gradations in an effort to make mixes more rut resistant. A direct impact of using high-gradation, coarse-graded mixes was that achieving the minimum density specification in the field also became much tougher. NCHRP Project 9-9(1) found the SGC compactive effort table in AASHTO R35 to be too high. This study was published as NCHRP Report 573. Using data from numerous projects across the US, it showed that pavements were not densifying under traffic to the levels achieved in the SGC. The report recommended Ndesign levels 20 to 25% lower than in R35. A few states took a more radical step and set Ndesign to 60 or 65 gyrations for all mixes, regardless of the design traffic level, and have encountered no ill effects of that change. As long as Superpave aggregate criteria are met and the appropriate binder grade is used, those states found that lower gyration levels improved mix designs without causing rutting problems. The NCAT Test Track has also proven that 65 gyration mixes can hold up to very heavy traffic conditions.



Voids in Mineral Aggregate (VMA) is the volume of intergranular void space between the aggregate particles of a compacted paving mixture. It includes the air voids and effective volume of asphalt. It must be calculated using the G_{sb} of the aggregate blend.

In-Place Density

Achieving a high relative density of each asphalt layer during construction is perhaps the most important factor that impacts long-term pavement performance. Therefore, most highway agencies use in-place density as a key pay factor in acceptance testing. The specified minimum density level is typically 92 to 93% of Gmm. It is generally understood that pavements with densities below that level tend to be permeable to water. However, the relationship between density and permeability is also greatly influenced by other simple gradation characteristics: nominal maximum aggregate size (NMAS) and the relative coarseness or fineness of the gradation. Figure 1 shows regressions between in-place air voids and permeability for different NMAS and coarse/fine gradations. From this graph it can be seen that 9.5 mm and 4.75 mm mixes are relatively impermeable at 8% air voids (92% of Gmm), whereas coarse-graded 12.5 mm mixes are on the cusp of a dramatic increase in permeability at 7% air voids, and 19.0 mm mixes are highly permeable to water at 7% air voids. This illustrates the advantage of smaller NMAS mixes for reduced permeability and the obvious need for higher density target levels when coarse mixes are used. When water is kept out of the pavement layers they will obviously be much more resistant to freeze-thaw, moisture damage, and age-hardening. Some asphalt experts have suggested that the industry should test in-place permeability rather than density. However, more work is needed to refine permeability testing before that can be seriously considered.

Thickness of the layer is a critical factor that affects a contractor's ability to adequately compact the material. NCHRP Report 531 recommends that fine-graded mixes be constructed at a minimum of three times the mixture's NMAS and course-graded mixes be constructed at least four times the NMAS. Trying to compact mixes below these thresholds is very challenging. This is a common problem for thin overlays on an existing pavement with a variable profile.

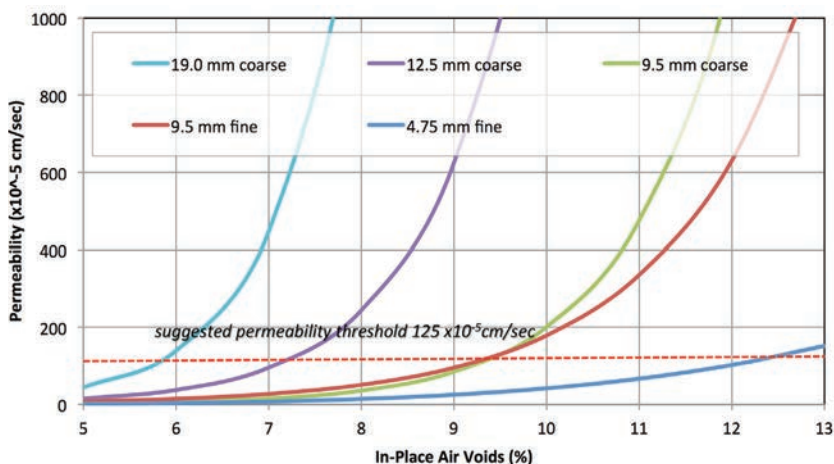


Figure 1: Relationship between air void content and permeability of various NMAS mixes (based on data from NCHRP Report 531 and NCAT Report 11-01).

Other important aspects of in-place density specifications deal with how density is measured and how frequent measurements are obtained to determine specification compliance. Some agencies use nuclear density gauges and others use roadway cores. Although there are advantages and disadvantages with both approaches, most asphalt experts consider cores to be the preferred method. If we consider that each core and nuclear density test represents areas of about 0.2 to 1.0 square feet, respectively and one test is taken every 1000 feet of pavement, then we are only sampling approximately 0.0016% to 0.0083% of the paved area. With this miniscule proportion of testing it is easy to miss areas of segregation and low density. It is in those missed areas where pavement performance problems likely begin. A greater frequency of in-place density testing should be considered in future specifications.

Another density measurement issue is the amount of water absorption of cores when using AASHTO T 166 or ASTM D2726. These methods use Archimedes' principle to determine the volume of a compacted asphalt sample, in this case a roadway core. The problem with this technique is that when cores with large voids are submerged, some of the water that enters those voids drains out of the core before the surface water is dried with a damp towel. This causes an error in the saturated surface dry (SSD) mass and the volume determination. The result is a higher calculated density (bulk specific gravity) than what the core actually has. In other words, AASHTO T166/ASTM D2726 is not accurate for density determination of some coarse-graded mixtures, particularly when water permeable voids are interconnected. The current AASHTO and ASTM standards recommend a slightly different solution to this error by requiring that samples with greater than 2% water absorption be tested with different alternative methods. For T 166, the alternative method is the paraffin coating method, AASHTO T 275. The ASTM method allows either the paraffin method, ASTM D1188, or the vacuum sealing method, ASTM D6752.

NCAT research has shown that the most accurate alternate method is the vacuum sealing method, and it should be used when water absorption exceeds 1.0% rather than the current limit of 2%. Data has shown that calculated in-place air voids are approximately 1.0% higher on average for coarse-graded mixtures when using the vacuum-sealing method in place of AASHTO T 166/ASTM D2726. Therefore, changing to the vacuum-sealing method for acceptance testing of in-place density results in lower density results than those typically obtained in current practice for coarse-graded mixes.

Contractors and highway departments should examine Gmb data for cores from recent projects to determine how often the cores absorb more

than one percent water. Cores for longitudinal joint tests should especially be scrutinized. Even projects using nuclear density gauge tests should examine data for cores from test strips used to establish bias (correction) factors or equations. If more than 10% of cores have greater than 1.0% water absorption, then the highway agency should strongly consider adopting the vacuum sealing method when the 1.0% limit is exceeded. Greater attention to this detail could reveal that the adequate in-place density results that we think we have been getting on projects actually have a significant percentage of results below the target levels.

In effect, using the vacuum sealing method to determine core densities could mean that better field compaction methods are needed to reach appropriate in-place density targets. However, if other details described in this article are implemented at the same time, such as adjusting volumetric mix design criteria, correcting Gsb values, and lowering N_{design}, then achieving higher density levels should be attainable. There are also several other new tools and technologies available today that can help improve in-place densities: warm-mix asphalt (WMA), infrared mat temperature mapping, and intelligent compaction. Many contractors across the U.S. are using WMA because these technologies can help improve the compactibility of mixes. Infrared mat temperature systems are an excellent tool to help identify areas with temperature segregation, which can be challenging to achieve uniform densities and smoothness. Finally, intelligent compaction systems that map out roller passes are available to provide roller operators with a visual guide to compacting every part of the asphalt mat.

RAP and RAS

Using RAP and RAS can be an important part of the industry's effort to be more sustainable and cost-effective if good practices with these recycled materials are followed. Although a complete review of the best practices for handling these materials is beyond the scope of this article, there are a few key points to emphasize.

There is still considerable debate about exactly how much RAP and RAS binders are activated as effective asphalt, but most research indicates that we can assume that all of the RAP binder is effective. NCHRP Report 752 recommends that when the RAP binder exceeds 25% of the total binder in the mix, the virgin binder grade should be selected based on a blending equation. In effect, softer grades of virgin binder are often needed for high RAP content mixes, and several studies have shown that softer binders are effective in improving their cracking resistance.

Since RAS binders are much stiffer than RAP binders, all of the RAS binder may not be initially activated during mix design or mix production, particularly for post-consumer (tear-off) RAS. Therefore, the growing consensus is that the RAS binder availability factor be set in the range of 0.7 to 0.85, meaning that only 70 to 85% of the RAS binder

should be considered effective. Currently, there is not a proven method on how to determine the availability factor; rather, most asphalt technologists with experience in production and placement of mixes containing RAS recognize that the effect of using a factor of 0.7 to 0.85 is to increase the virgin binder content by 0.3% to 0.15%, respectively, which helps improve placement, compaction, and durability of the mixes. There are several factors that are likely to affect how much RAS binder is effective in a given mix. Smaller grind size (essentially the nominal maximum particle size) of the recycled shingle material is generally considered to help improve blending of the RAS and virgin binder. Lower moisture contents of RAS being fed into a plant is also desired, since less energy is needed to drive off the moisture and more heat energy is available to raise the RAS binder to its melting point. Longer mixing times and silo storage times are also believed to be helpful in activating more RAS binder.

There are different views on how to make mixes containing RAS more resistant to cracking, partly because different studies have used different tests to evaluate cracking resistance. Presently, there are about a dozen different tests that have been used to evaluate the different modes of cracking for asphalt pavements: fatigue cracking, low-temperature cracking, reflection cracking, and top-down cracking. Many believe that the single greatest research need in the asphalt paving industry is to validate the cracking tests and their criteria using correlations to field performance. It will take a concerted effort and several more years to meet this need. In the meantime, we need to revive the basic principles of mix design, testing, and construction described above to help improve the durability of asphalt mixes in the field.

RELATED REPORTS & RESEARCH SYNOPSSES

The following research is available at: ncat.us/info-pubs

NCAT Report 12-06: A Review of Aggregate and Asphalt Mixture Specific Gravity Requirements and Their Impacts on Asphalt Mix Design Properties and Mix Acceptance

NCHRP 531 Synopsis: Relationship of Air Voids, Lift Thickness and Permeability in Hot-Mix Asphalt Pavements

NCHRP 573 Synopsis: Superpave Mix Design: Verifying Gyrations Levels in the N_{design} Table

Research Synopsis: Relationships Between Laboratory-Measured Characteristics of HMA and Field Compactability

Research Synopsis 03-02: Factors Affecting Permeability of Superpave Mixes

Bonding of Layers is Critical to Good Performance

Building asphalt pavements in layers provides a number of advantages, since each layer can be engineered to have specific characteristics and properties. For example, surface layers may be designed to provide high levels of friction, be porous to drain water and eliminate hydroplaning, and optimized to provide a low levels of tire-pavement noise. Intermediate layers can be designed to be highly crack resistant if placed over an existing pavement with joints and/or cracks, or they can be designed as high-modulus layers to provide structural stiffness to the pavement to minimize tensile strains that lead to fatigue cracking and limit high compressive strains that lead to permanent deformation in lower unbound layers. Asphalt base layers can be designed to be highly strain tolerant to eliminate fatigue cracking.

Building asphalt pavements in multiple layers is also an advantage for stage construction, whereby an initial thickness is designed for a predicted amount of traffic over a period of time shorter than the typical design period, and a structural overlay is planned to be added later. This is a great advantage when there is significant uncertainty about future traffic growth. Rather than guessing at traffic 20 or 30 years into the future, it can be more prudent to design for a shorter period of time, such as 15 years. At that point, traffic demand can then be reassessed to set

the thickness of the structural overlay.

Finally, layered asphalt structures are an advantage for future rehabilitation work where existing surface layers can be milled-off quickly to restore smoothness and remove surface distresses so that a new surface can be placed. This type of rehabilitation work is quick and with milling depths commonly less than two inches, traffic can maneuver safely across milled and unmilled lanes, thereby minimizing long lane closures. However, if the layers are not bonded together, the interface between layers becomes the weak link in the system and the pavement will not perform as intended. Although we can design, construct, and rehabilitate each layer independently, the layers must be bonded together for the pavement to respond to loads as intended. That is the purpose of tack coats.

A great deal more attention has been given to tack coats in the last few years. New tack coat products have come into the market. Some agencies are specifying spray pavers that apply tack coats right in front of the screed for certain mix types. Several major research studies have examined how to determine the optimum application rates for a variety of tack coat products as well as for different types and conditions of the underlying surfaces. A few states have also implemented bond strength testing on cores taken from projects to verify the adequacy of the tack coats. Workshops and webinars are now available to share information on the best practices for selecting and applying tack coats. All training courses for paving crews and roadway construction inspectors should emphasize the importance of tack coats and instructions on do's and don'ts for their application.

Common distresses associated with poor bonding of layers include slippage cracks, delamination, and alligator cracking, examples of which are shown in Figure 2 on page 11. Alligator cracking may be perceived as a bottom-up fatigue distress when in fact the damage may have initiated at the poorly bonded interface. Highway agencies should routinely core pavements in need of rehabilitation to determine if poor bonding is contributing to pavement deterioration.

In the past 10 years, forensic investigations of a few test sections on the NCAT Test Track revealed bond failures that led to rapid structural deterioration of the pavements. As illustrated in Figure 3, an engineering analysis of a pavement with and without one of the layers bonded will substantially increase the tensile stresses beneath the load. Cracking will initiate when a layer is unable to withstand the strains applied. Although tack coats are a small cost item in the overall cost of building and rehabilitating pavements, bonding of asphalt layers is critical to good performance.

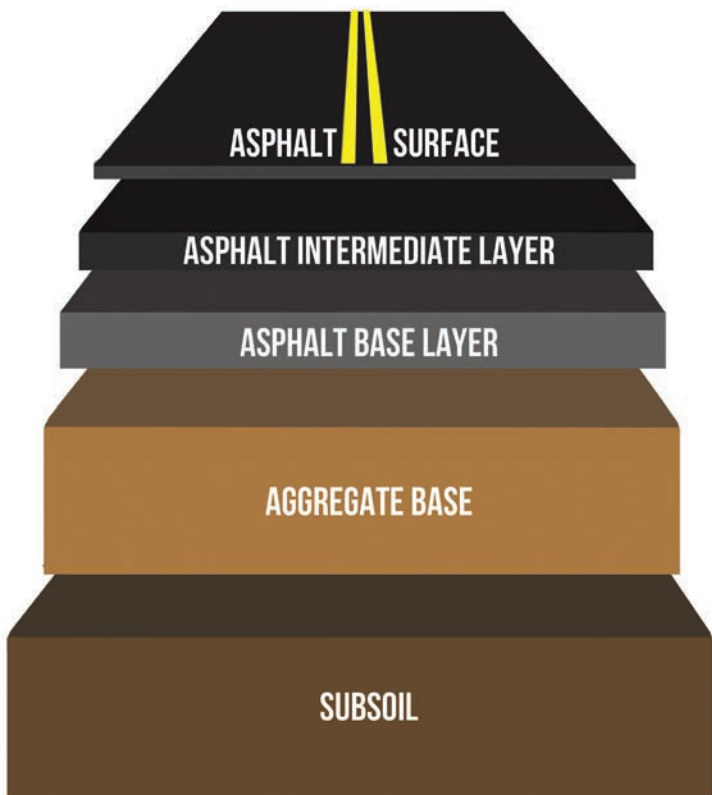


Figure 1: A typical asphalt pavement is comprised of multiple layers.



Figure 2: Common distresses associated with poor bonding of layers include slippage cracks, delamination, and alligator cracking, as shown in 2a, 2b, and 2c, respectively.

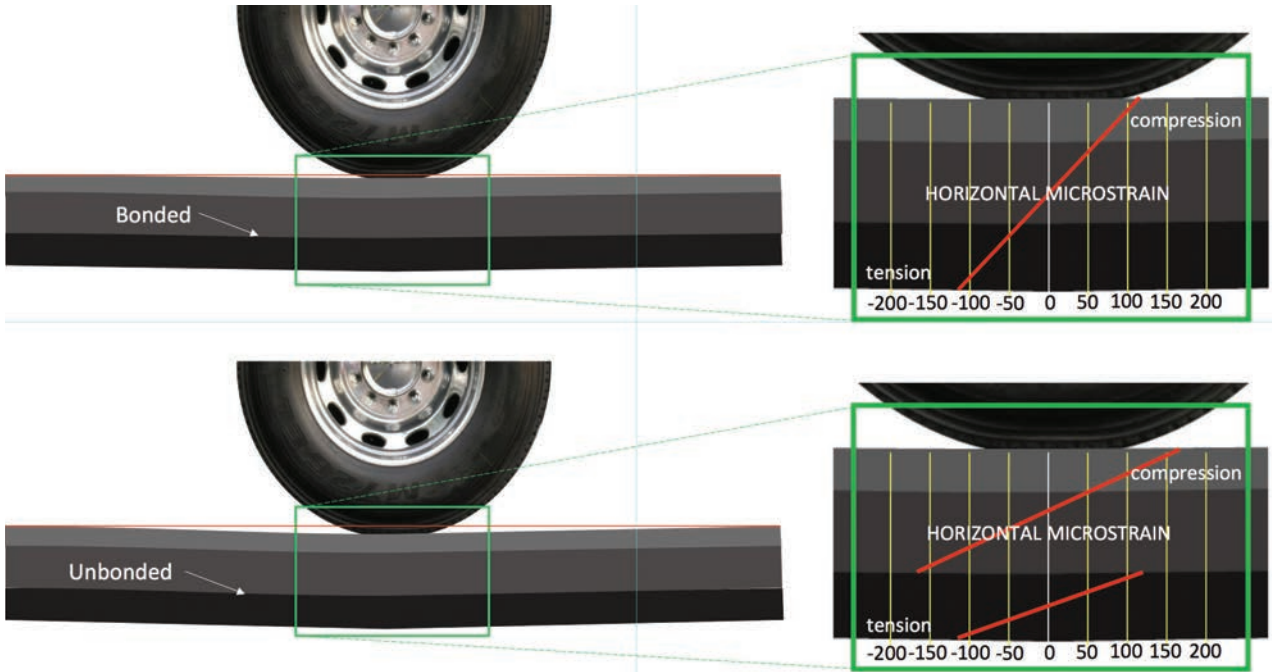
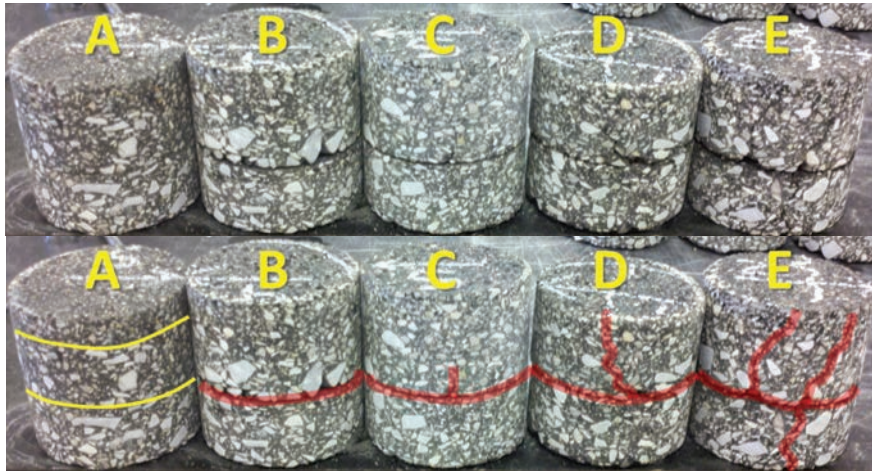


Figure 3: An engineering analysis of a flexible pavement with and without one of the layers bonded.



These cores were taken at several test section locations during a forensic investigation at the NCAT Test Track to assess crack progression. In core A, the interface between the intermediate and base lift is visible, but intact. No surface cracking was evident at this location. In core B, debonding along the same interface can be seen. In core C, a middle-up crack has originated and is propagating towards the surface. The crack has reached the surface in core D and in core E there are cracks throughout the entire core.

Figure 4: Core samples taken from NCAT's Test Track to assess crack progression (cracks are highlighted in second image).

2014 Research Review

In 2014, NCAT released eight technical reports and two NCHRP reports covering a wide range of topics. A short summary of each follows. The full reports are available for download at www.ncat.us.

NCHRP Report 779: Field Performance of Warm Mix Asphalt Technologies

This report details the findings from NCHRP Project 9-47A, which documented field performance of 12 WMA technologies at 14 regionally diverse sites, compared engineering properties of WMA to HMA, and evaluated energy savings and emissions reductions for WMA production.

Field performance was essentially the same for both WMA and HMA at all projects. Minimal rutting was observed, no moisture damage was evident, and very little cracking was seen after several years in service. Dynamic modulus testing indicated lower stiffness for most of the WMA materials sampled during construction; however, these differences in material properties had no effect on rutting and cracking performance. Discrepancies were also seen between field performance and laboratory testing for rutting and moisture damage. Producing and placing WMA at lower temperatures was shown to reduce energy consumption and carbon dioxide emissions, as well as worker exposure to respirable fumes.

NCHRP Synthesis 464: Thin Asphalt Concrete Overlays

This document summarizes the state of the practice in using thin asphalt overlays based on a literature review, a survey of state highway agencies, and input from industry experts. Thin asphalt overlays have been frequently used in pavement maintenance, rehabilitation, and preservation for many years. They improve ride quality, which is of utmost importance to the traveling public and can have lower life-cycle costs than other pavement preservation treatments. The expected service life reported by highway departments is typically between 7 and 11 years. Thin overlays are not recommended when the existing pavement exhibits moderate to severe cracking.

A uniform tack coat applied at an appropriate rate is critical to the success of thin asphalt overlays, as streaked or insufficient tack coats can lead to raveling and bond failures. Since thin overlays cool more quickly than thicker layers, the use of WMA can help maintain workability. In order to obtain greater cost savings, ongoing research is evaluating the performance of RAP and/or RAS in SMA and OGFC mixes.

NCAT Report 14-01: Results of Inter-Laboratory Study for AMPT Pooled Fund Study TPF-5(178)

Analysis for this report included Asphalt Mix Performance Tester (AMPT) test results from 22 of the 29 laboratories participating in the inter-laboratory study (ILS). Test specimens were prepared from plant-produced mix at $6 \pm 0.5\%$, $7 \pm 0.5\%$, and $8 \pm 0.5\%$ air voids. For dynamic modulus and phase angle, the repeatability statistics were typically equal to or higher than those obtained during the NCHRP Project 09-29 ILS, while the reproducibility statistics were equal to or lower than the previous results. For flow number, both repeatability and reproducibility statistics showed significant improvement over the previous study, likely due to standardized AMPT training and a more consistent procedure for specimen preparation. Specimen air voids were shown to have a significant effect on dynamic modulus and flow number. The results of this study did not support loosening the specimen air void tolerances from $\pm 0.5\%$ to $\pm 1.0\%$, as was recommended in NCHRP Project 09-29.

NCAT Report 14-02: Life-Cycle Assessment of 2012 NCAT Pavement Test Track Green Group Mixtures

The environmental benefits of recycled materials and WMA technologies used in NCAT's Pavement Test Track Green Group Experiment were compared to an all-virgin HMA pavement using Pavia Systems' Roadprint© Life-Cycle Assessment (LCA) tool. This analysis did not include all aspects of a full LCA, only the relative benefits of sustainable materials and technologies as compared to all-virgin materials and conventional HMA. The Green Group included three test sections incorporating high percentages of recycled materials: RAP, RAP and RAS, and GTR. Each section had an SMA surface that included recycled materials.

When compared to the extraction and processing of raw materials, the use of recycled materials in the Green Group reduced energy consumption between 9 and 26 percent and produced 5 to 29 percent less CO₂ emissions. With respect to transporting raw materials and asphalt mixtures, the use of recycled and local materials used between 19 and 42 percent less energy and reduced CO₂ emissions by 6 to 39 percent. By using WMA technology in producing the Green Group mixtures, 12 to 17 percent less energy was used and 6 to 9 percent less CO₂ emissions were produced.

NCAT Report 14-03: Evaluation of a Rubber-Modified Mixture in Alabama

This study compared two asphalt mixtures placed in south Alabama in 2010. One used PG 67-22 binder modified with 11 percent #30-40 mesh GTR using the wet process. The other mixture used SBS-modified binder. Plant-produced mixes and binders sampled at the plant were characterized in the laboratory. Both binders had similar high temperature performance grades, but the rubber-modified binder did not meet the low temperature grade of -22°C. Based on MSCR testing, both binders were rated for extremely heavy traffic levels (greater than 30 million ESALs or standing traffic) at 64°C. Both mixtures met TSR criteria, and both mixtures were expected to be resistant to rutting and moisture damage based on the Hamburg wheel tracking test. APA results were statistically similar, with less than 4 mm of rutting for both mixtures. Dynamic modulus testing showed that the rubber-modified mixture was generally stiffer than the polymer-modified mixture, particularly at high and intermediate temperatures.

After one year, both sections were performing well with respect to rutting, smoothness, and texture, and no cracking was observed. Field performance will continue to be monitored for a total of five years. Based on similar laboratory and field performance, it was recommended that GTR be allowed as an alternative to polymer-modification at the contractor's request.

NCAT Report 14-04: Flexible Pavement Design—State of the Practice

As advances have been made in asphalt pavement materials and construction, the empirical correlations between pavement thickness and amount of traffic loading developed in the early 1960's have become outdated, leading to overly conservative designs. Newer mechanistic-empirical (M-E) design methods have been developed that predict pavement distresses by modeling pavement response to loading. M-E design can provide optimized pavement cross-sections when the framework has been locally calibrated, but this process can be time-consuming and costly. M-E design also includes the concept of perpetual pavements, where critical strain levels are limited to prevent the development of deep structural distresses and avoid costly reconstruction.

Four states currently use some form of M-E design exclusively. Eighteen states are beginning to use some form of M-E design in addition to their pre-existing empirical method, while 28 states use only empirical pavement design. Many states are working toward implementing M-E design methods in order to optimize pavement thickness design. Alabama and Washington have made improvements to their empirical design methods by revising the asphalt structural coefficient to reflect local pavement performance. Their new coefficients translate into thinner, more cost-effective cross-sections.

NCAT Report 14-05: Field and Laboratory Study of Trinidad Lake Asphalt Mixtures at the NCAT Test Track

Trinidad Lake Asphalt (TLA), pelletized natural asphalt imported from Trinidad and Tobago, was used as a partial replacement for conventional paving grade asphalt in a 2009 NCAT Pavement Test Track section. TLA pellets accounted for 25 percent of the total binder in the mixture. The base binder was PG 67-28 so that the blended binder would be comparable to the PG 76-22 binder used in the control mixture.

Laboratory characterization included binder testing (PG grading and MSCR), dynamic modulus, flow number, beam fatigue, APA, Hamburg wheel tracking, and energy ratio. Results were favorable, and beam fatigue testing showed that the TLA mixture had a 20 percent higher fatigue endurance limit and significantly outperformed the control mixture at lower strain levels. The TLA section had higher backcalculated moduli and lower measured structural responses, probably due to higher in-place density than the control section. Both sections performed successfully with no cracking and very little rutting after 10 million ESALs.

NCAT Report 14-06: Case Studies on Successful Utilization of RAP and RAS in Asphalt Pavements

This report details specifications and practices employed by several agencies to maintain a high level of performance when using RAP and RAS. Florida and Ohio have strong track records with using RAP in higher percentages than many other agencies. Contractor ownership of RAP is a key element of these and other successful RAP programs. As RAP contents increase, it is especially important to ensure consistent RAP characteristics, obtain accurate RAP specific gravity measurements, and select appropriate virgin binders based on RAP stiffness and percent recycled binder relative to total binder.

Missouri and Texas are leading states in using RAS in asphalt mixtures. Maximum RAS content is typically 5 percent, and RAS properties such as gradation and deleterious materials should be controlled to produce a quality mixture. A finer grind ensures that the RAS binder is more fully incorporated in the mixture. RAS stockpiles can be covered to prevent high moisture contents, which consumes additional energy at the plant and can cause the mix to appear dry, possibly leading to early cracking. When RAP and RAS are processed consistently and properly characterized, these sustainable materials can be used to construct cost-effective pavements that perform well.

NCAT Report 14-07: Effects of Pavement Properties on Vehicular Rolling Resistance: A Literature Review

As a vehicle travels along a roadway, the energy that is lost (converted into heat) is called rolling resistance, which contributes to the vehicle's fuel economy. This report investigates the influence of pavement texture, smoothness, and deflection (i.e. pavement type) on rolling resistance, and thus fuel economy. The review of existing literature included more than 30 studies.

No single study has yet determined how texture, smoothness, and pavement stiffness work together to influence rolling resistance. However, it is well understood that smoothness has the greatest influence on rolling resistance. Simply put, smooth roads improve fuel economy. Greater pavement texture has been shown to increase rolling resistance, but texture has less effect than smoothness for well-maintained pavements. Studies on the effect of pavement stiffness and type have yielded inconsistent results, so no consensus has been reached as to how pavement type actually influences fuel economy.

NCAT Report 14-08: Recalibration Procedures for the Structural Asphalt Layer Coefficient in the 1993 AASHTO Pavement Design Guide

Although many states plan to implement M-E pavement design, the empirical AASHTO design procedure is still widely used. However, the AASHTO design guide has not been updated to reflect advances in materials and construction methods. This can result in non-optimized thickness designs and unnecessary cost.

This report describes three methods for recalibrating the asphalt structural coefficient used in the AASHTO design procedure to better reflect the actual performance of today's pavements. Recalibration can be based on deflection data or performance data or can be accomplished by matching M-E design thicknesses. The latter option can be used primarily by those states that have already conducted local calibration of the MEPDG. Two states have recently recalibrated their structural asphalt coefficients; Alabama used a performance-based method, while Washington used an M-E approach.

Asphalt Forum

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

Eric Biehl, Ohio DOT

Last year we used our PG 88-22M binder on two projects at heavy intersections. At one intersection (placed July 2014) we did a mill and fill with a 19mm intermediate and 12.5mm surface course. This district decided to try the PG 88-22M mixes in lieu of full depth replacement with PCC pavement, because this intersection could not be closed due to the heavy truck traffic it receives. It is still too early to evaluate the performance.

Cliff Selkinghaus, South Carolina DOT

We have concerns with the possible use of refined engine oil bottoms (REOB) in PG Binder. We are starting to collect and test samples with X-Ray fluorescence (XRF).

Mark Woods, Tennessee DOT

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?

Save the date!

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Asphalt Forum Responses

The following responses have been received to questions shared in the Spring 2014 Asphalt Forum.

1. Does anyone have success with micro-surfacing on medium to higher traffic volume roads (greater than 5 million ESALs for a 20 year design)? If so, what is the life expectancy in years? (Greg Sholar, Florida DOT)

Mark Woods, Tennessee DOT

We have had multiple micro-surfacing projects in medium-traffic areas (ADT>15,000) and have seen positive performance. TDOT's guidelines for resurfacing currently estimate these applications to extend pavement life anywhere from five to eight years.

Cliff Selkinghaus, South Carolina DOT

No, but six to eight years is what we are experiencing on lower ADT roads depending on the existing condition of the road requiring the preservation treatment.

Eric Biehl, Ohio DOT

Ohio DOT does not have any traffic restrictions on the use of micro-surfacing and we have used it on high traffic routes. We have not studied life expectancy in relation to traffic volume, but we expect six to ten years from appropriately selected micro-surfacing projects.

Denis Boisvert, New Hampshire DOT

New Hampshire spent several years using this technology on some interstate highways with mixed results. Life expectancy was three to five years in some places, but others were worn through the wheel paths. Both studded tires and chains are allowed in winter, but chains are not commonly seen on the interstate. Durability was variable in projects of similar age and traffic conditions. We moved away from it in 2014 due to variability in the emulsions and the application.

2. What preliminary requirements are states using to select projects for HMA thin lifts or micro-surfacing projects? Are there any quantitative limitations such as IRI or crack width? (Mark Woods, Tennessee DOT)

Cliff Selkinghaus, South Carolina DOT

We are doing micro-surfacing Type II and the preventative maintenance thin-lift surface course (0.75" thickness) 4.75mm mix as alternate bid on some projects. If there is a significant quantity of SY on the project, the microsurfacing is typically the lower bid.

Eric Biehl, Ohio DOT

Ohio DOT has developed decision trees using our Pavement Condition Rating system, individual distress levels, and traffic, to select candidate thin lift asphalt and micro-surfacing projects.

Denis Boisvert, New Hampshire DOT

Our preliminary requirements are little cracking and cross section in good shape (not rutted). There are no quantitative limitations.

Howard Anderson, Utah DOT

We do not have a selection procedure set up for this.

3. We continue to have issues in Montana with our CRS-2P emulsions "reactivating" at higher mat temperatures. The material doesn't fail our distillation and penetration tests, but if the ambient temperature rises after application the emulsion allows for chips to roll and causes all sorts of splash. Ultimately, the emulsion cures and the chip seal performs. Do you believe this is a crude source issue? We allow the use of latex for modification, which could also be a problem. (Oak Metcalfe, Montana DOT)

Update: This issue has seemingly resolved itself, as we didn't see any of these issues in 2014 like we did in 2013. At this time there is no documented reason for either the poor performance of 2013 or the nominal performance of 2014. We made no changes to our specifications.

Mark Woods, Tennessee DOT

TDOT specifies ring-and-ball softening point of 125°F minimum for CRS-2P.

Cliff Selkinghaus, South Carolina DOT

We allow both CRS-2P and 2L in South Carolina, and apply them when temperatures are above 60°F. We require 0.28-0.35 gal/SY of emulsion and 8-10#/SY of lightweight 5/16" aggregate for our single treatments. We encourage the contractors to heat the emulsions material slowly in the distributors to prevent breaking and separation before product application. The polymer-modified emulsions typically have a short storage life if low heat and agitation are not maintained.

Specification Corner

Florida DOT

Effective with projects bid starting January 2015, only trackless tack is permitted with six products currently approved. As part of the approval process for a trackless tack, a test section must be constructed demonstrating little to no tracking via visual observation, and five cores are taken for bond strength testing. An average bond strength of 100 psi must be obtained. The test section must be a new fine graded mix placed over a new fine graded mix. Milled surfaces or overlays are not allowed for test sections because they will inflate the bond strength value.

Massachusetts DOT

We are currently updating our Superpave QA specification.

Montana DOT

We are still in the process of trying to implement multiple stress creep recovery (MSCR). We had some equipment trouble this year that stymied our attempt, but we have new DSR's on the way and hope to spend this construction season gathering the appropriate data to set traffic levels and develop a specification.

We are considering listing our binder suppliers on a QPL/APL, not for the purposes of acceptance but to ensure any formulation changes are communicated. We would still sample and test binder as usual.

We are also working towards dealing with RAP/RAS on a binder replacement basis as opposed to total weight of aggregate in the mix.

New Hampshire DOT

We recently added a penalty for binder failing to meet asphalt binder grade: 10% for one grade below the high grade, or one grade above the low grade. We also disallowed binders that have been blown or that contain used oil products primarily due to their affect on durability.

New Hampshire has disallowed the use of RAS, which has previously been allowed since 2009. We have found that RAS in granular form does not blend with specification grade binders.

We are in the process of expanding the tack specification to include three application rates for differing surface conditions and are also considering generally increasing the rate. Giving consideration to paying for tack to encourage application rate above the minimum and logistics of measurement (weight or metering) are part of the discussion.

Ohio DOT

In January 2015, we removed language that did not

require a binder grade change when using WMA even though the blending chart would require it. The decision was made after a state funded research project and results from a recently finished NCHRP study showed very little change between HMA and WMA mixes. Ohio DOT now requires a binder grade change if there is more than 25% RAP (with no RAS) by weight of mix and if 15% or more RAP and 3% RAS is used. If between 25 to 30% RAP, the contractor may submit a blending chart and RAP sample if they believe a grade change is not needed.

In January 2015, we reduced the amount of RAS from 5.0% to 3.0% by weight of mix if also using RAP in the mix.

Ohio DOT has eliminated rubberized tack as an option for longitudinal joints and now requires PG binder or joint adhesive.

We have modified our micro-surfacing emulsion specification to meet industry manufacturing practices. We combined our emulsion and residue tests into the same specification.

We have changed the PG binder mass change from 0.5 to 0.75% and reduced phase angle requirements by 2° for PG 64-28M, PG 70-22M, and PG76-22M.

Ohio DOT has again changed our CRS-2P material requirements. We reduced the softening point from 60 to 57°C and modified our elastic recovery procedure from a 10 cm pull and hold 5 minutes to a 20 cm pull and hold 5 minutes.

We have developed a PWL based longitudinal joint density specification and plan to fully implement sometime this year or next.

Tennessee DOT

Tennessee published a new 2015 specification book to begin the new year. Many specifications that were previously provisional and only applied to selected contracts are now standard. These specifications include mixture specs for 4.75 and 9.5-mm NMAS thin-lift mixtures, open-graded friction course (OGFC), and a specification for material transfer devices.

Specifications for chip seals were revised to include a table of recommended aggregate and emulsion shot rates for 4 aggregate sizes: #7, 78, 8, and 9.

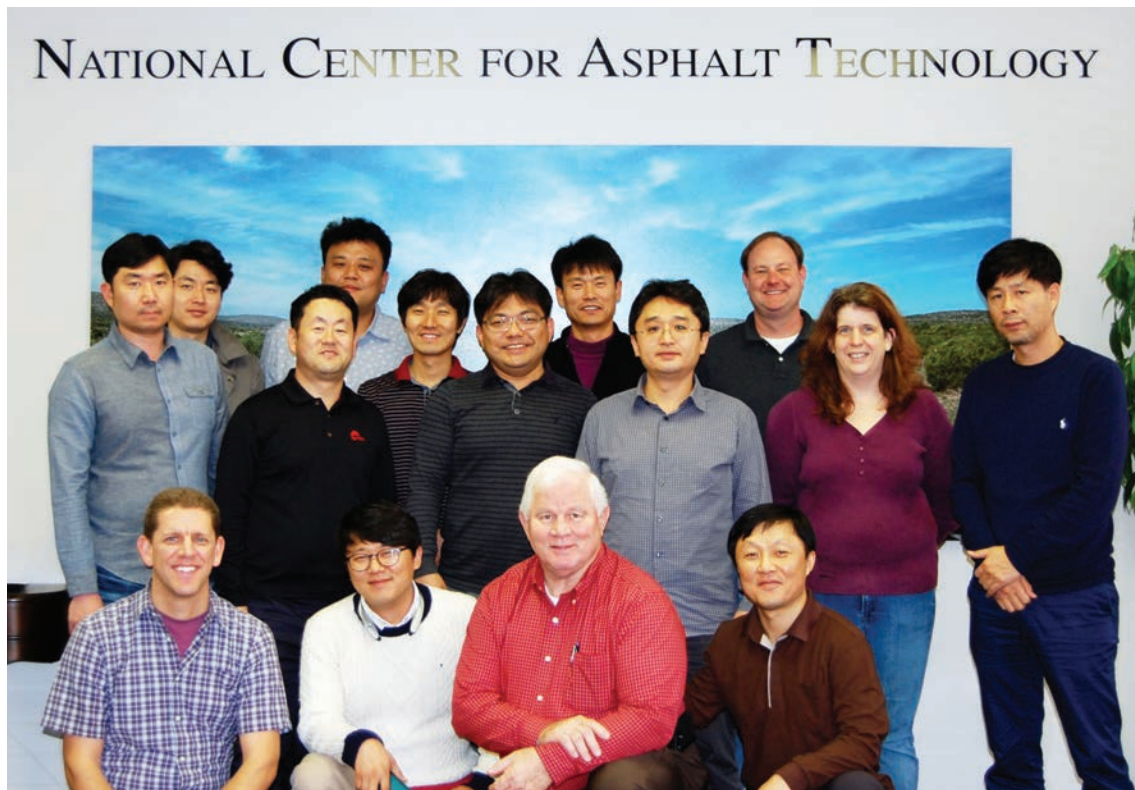
Specifications for cold-planing/milling were modified to require a non-contact leveling system (aka electronics) when milling interstate or controlled-access freeways.

A comment was added to specifications for tack coat indicating a lower tack rate may be required when placing tack on freshly placed asphalt.

Visitors and Training Sessions



NCAT hosted a training program for a group of visitors from Dubai in October 2014.



NCAT had the pleasure of conducting training for a delegation of South Korean visitors in December 2014.

NATIONAL CENTER FOR ASPHALT TECHNOLOGY



Asphalt Technology Course February 23-27, 2015

Front (L-R): Don Watson (Instructor), Abdel Mekhal, Kyle Beck, Deb Mitchelmore, Brett Ruppel, Brian Goliber, Michael Heitzman (Instructor)

Middle (L-R): Carolina Rodezno (Instructor), Manuel Tapia, Ted Billadeau, Alden Jenkins, Jeff Dewey, Dawn D'Angelo, Brickram Kowchai, Jason Waddell, Erin MacCord, Cory Bramlett, Adam Taylor (Instructor)

Back (L-R): David Heinrich, Hojong Lee, James Ripple, Peter Hargadine, Perry Borom, Russ Parker, Jeremy McDonald, Jason Latiolais, Chris Cowan

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 MARCH 18-20, 2015



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 Middle (L-R): Rafael Valentini, Cecilia Lopez, Mariana Mochizuki, Gonzalo Garcia, Ivan Rojo, Pamela Turner (Instructor),
 Rodrigo Rueda, Juan Ramirez, Grant Julian (Instructor)
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NATIONAL CENTER FOR ASPHALT TECHNOLOGY
 SUPERPAVE MIX DESIGN COURSE
 MARCH 23-27, 2015



Front (L-R): Orlando Lagos, Jerry "Red" Harvo Jr, Cory Bramlett, Don Watson (Instructor)
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On November 5, NCAT hosted Australian delegates visiting the U.S. as part of a two-week tour to learn about innovative tools, techniques, and the latest sustainable asphalt pavement solutions.