

High RAP Takes on High Profile

By Don Watson

A RAP Summit sponsored by the National Center for Asphalt Technology (NCAT) and the Federal Highway Administration (FHWA) was held in Auburn, Alabama, in October 2009. The Summit was attended by about 70 executives from state and federal DOT agencies, contractors, material suppliers, and equipment manufacturers. The purpose of the meeting was to encourage agencies to implement provisions for use of higher proportions of reclaimed asphalt pavement (RAP) in an effort to help reduce costs associated with the production of hot mix asphalt (HMA). Several speakers addressed the benefits of using RAP, barriers to using RAP, and beginning the process of implementing use of higher RAP contents.

Several speakers noted that the quality of RAP mixes needs to be as good as or better than conventional mixtures without RAP. Randy West, Director of NCAT, emphasized that "quality should not be sacrificed to save a few dollars."

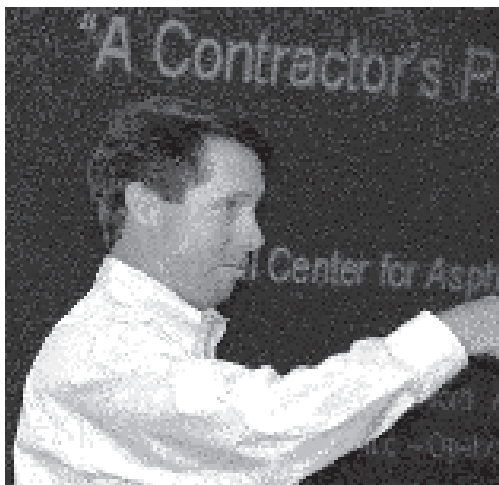
One theme consistent throughout the summit was that mixtures with higher RAP content can and should be produced. Kevin Keith, Chief Engineer with Missouri DOT, stated, "There should be no limit on the proportion of RAP; don't control the process, control the results." If high RAP mixes meet established performance standards for rutting, cracking, and fatigue, they should be allowed.

Keith's comments represent a significant change for the Missouri DOT, which did not allow the use of RAP until 2003. The reason for the change is obvious; Keith noted that over the last five years MoDOT has incorporated more than 1.2 million tons of RAP in its HMA mixes, and the savings to the department is estimated at \$34 million. MoDOT is commonly seeing mix designs now with 25-35% RAP. He noted that the changes MoDOT has made have not sacrificed quality.

Keith's comments were reinforced by Charlie Potts, CEO of Heritage Construction and Materials, who said, "It amazes me that we have had this capability for nearly 30 years now, and we're still just

talking about it." He added that 30-40% RAP mixes have worked extremely well.

Why use more RAP? There are a number of benefits -- the foremost of which is reduced costs for HMA. Jon Epps, Manager of Engineering Services for Granite Construction, pointed out the reason for escalating costs of HMA. In 1970 the cost of crude oil was less than \$4/barrel; in 2008 crude oil was as high as \$120/barrel. Dennis Rickard, President of the liquid asphalt division of Oldcastle Materials, showed that the number of refineries in the U.S. has decreased by about 25% over the past 30 years. He



Jay Winford addresses participants at RAP Summit

estimated that 15-19 million tons of residuum crude per year will be shifted from asphalt and fuel oil to coker feed production.

Epps also showed that recycling RAP into HMA represented the most efficient use of RAP. If 50% RAP is incorporated into an HMA mix, the savings are more than 25% over the cost of conventional mix whereas if 100% RAP is used as an aggregate base course, the savings to the owner is only about 14%.

Ron Sines, VP with Oldcastle Materials, stated that "recycled asphalt pavements save U.S. taxpayers

more than \$300 million each year. A 10,000 ton project with 25% RAP can save \$100,000."

Don Brock, CEO of Astec Industries, showed that for an investment of \$5 million an agency would be able to place just over 70,400 tons of HMA at typical prices today. By using a mix with 50% RAP, the same agency would be able to place more than 97,000 tons of HMA.

Brock also added that "RAP represents a sustainable product for the industry in that 100% of the material can be recycled. By increasing RAP proportions in HMA from 15% to 50%, the industry can reduce the requirement for new aggregate by 245 million tons per year, and can reduce oil consumption by 80 million barrels/year."

Ron Sines stated, "Each year over 90 million tons of HMA is reclaimed and 80% is recycled. The asphalt industry recycles nearly twice the combined total of paper, glass, aluminum, and plastics." He also pointed out that if only 80% is recycled, that means some of the RAP is being used for purposes other than for HMA. He added, "If RAP is being used for other purposes, its value will never be realized, and it will not be available for future recycling."

Peter Stephanos, Director of FHWA's Office of Pavement Technology, pointed out that the total demand for aggregates used in highway pavements exceeds 700 million annually. The majority of that amount is used to produce over 600 million tons of HMA.

In spite of the benefits of using RAP, Cecil Jones, State Materials Engineer for the North Carolina DOT, presented results of a 2007 survey that showed most states are using only about 10-20% RAP in HMA mixes. The survey showed that two states do not allow RAP in any HMA mixtures, and that six states have not used RAP in surface mixes. This was an important point because about 80% of the mixes produced today are surface courses.

What then are the barriers to use of RAP, or increased use of RAP? This question was answered by David Newcomb, VP of Research for NAPA.

Continued on page 10

Asphalt Technologists Meet in Minnesota

by Rebecca McDaniel and Michael Heitzman

After heavy snow in Minnesota the week before, spring greeted the attendees at the annual meeting of the Association of Asphalt Paving Technologists (AAPT) in March. The meeting gave an opportunity for agency, industry and academic personnel to network and to share the latest information on advances in asphalt technology.

The traditional Government and Industry Forum on Sunday afternoon highlighted two of the hottest topics in asphalt today – Reclaimed Asphalt Pavement (RAP) and Warm Mix Asphalt (WMA). Audrey Copeland, FHWA, and Andrea Kvasnak, NCAT, updated the audience on efforts to evaluate higher RAP content mixes and the use of shingles. Matt Corrigan, FHWA, summarized the issues associated with the design, specification and performance of WMA.

Monday morning, Thomas Sorel, Commissioner of the Minnesota DOT (Mn/DOT), welcomed everyone to Minnesota. He noted how August 1, 2007, the day of the I35W bridge collapse, changed lives – those of the victims and the families, as well as those of the DOT employees. Mn/DOT has worked hard in an attempt to rebuild the public's trust, along with the new bridge that opened in a little more than one year. This changed the public's perceptions of what could be achieved. Sorel also commented on the importance of research, including MnROAD and the Transportation Engineering Road Research Alliance (TERRA). He said we "need to be innovative in our solutions and move forward."

Blair Bury, Vice President of Midwest Asphalt Corporation and president of the Minnesota Asphalt Pavement Association, commented on the many "firsts" that have occurred as Minnesota has led innovations in a number of areas. Some of these include the first HMA recycling in 1976, implementation of a permissive RAP specification in 1979 and porous asphalt in 2004.

Next, Tim Clyne, from MnROAD, shared some of the research highlights from that multi-use facility. It has been estimated that innovations from MnROAD will result in about \$33 million in annual savings for Minnesota taxpayers. Findings there suggest that the environment drives performance and that current designs are too conservative.

These welcoming addresses were followed by a Business Meeting where members of the AAPT Board laid out some proposed changes arising from the strategic planning process initiated in 2007. Several changes to promote membership are being contemplated, starting with simplification

of the membership levels and application process. Another major proposed change involves the journal. In order to increase its value by offering more papers covering a wide range of topics, and to increase the recognition of the quality of those papers, a two-part publication is being considered. Both topics generated an ongoing flurry of discussion.

Stiffness and Deformation Testing

The first technical session focused on stiffness and deformation testing. Nam Tran, NCAT, reported on a study comparing the results of rut testing using the Asphalt Pavement Analyzer (APA) to field rutting on the NCAT track and evaluating changes in APA test parameters such as hose pressure and wheel load. In general, they found "reasonable correlations" between the APA and the field.

Nelson Gibson, FHWA, discussed another, more fundamental test related to rutting – the flow number test. He presented concepts for analyzing the test results to characterize asphalt mixtures undergoing permanent deformation and to separate the effects of the binder and the aggregate in the mix.

The last paper in the session, presented by Richard Kim of North Carolina State University, offered a means to construct mixture master curves using an Impact Resonance (IR) test rather than dynamic modulus. The test is simpler and less expensive than dynamic modulus but it requires some other means of determining the low frequency, high temperature behavior of the mix.

Innovations, New Procedures and New Ideas for Existing Paving Techniques

In the second technical session, Richard Kim returned to present the findings of a study on the performance of chip seals with polymer-modified emulsions. This laboratory study showed that polymer-modified emulsions can improve chip seal performance, especially at early ages and low temperatures, by improving chip retention.

Scott Shuler, Colorado State University, also reported on a test for chip seals. The study developed a modification of the ASTM D7000 Sweep Test that could be used to estimate, in advance, when a chip seal can be opened to traffic.

Next, Robert Schmitt outlined work at the University of Wisconsin (UW) to explore the effects of compactive effort and temperature on field and lab densification of hot mix. The research confirmed many points about field compaction of HMA. Lab compaction was found to be very mixture specific.

Bao-Liang Chen, from Wooster Polytechnic Institute, summarized the results of a study on an innovative approach to reduce the heat island effect in asphalt pavements. One solution is to pass a liquid through pipes in the pavement to absorb the heat. This study showed the concept is feasible in principle and pointed out some things that need to be considered to make it practical.

Lastly, Louay Mohammad, Louisiana State University, reviewed the findings of a study on emulsified tack coats. This study compared Trackless tack, SS-1 and CRS-1. The Trackless provided the highest shear strength at the interface and the CRS-1 the lowest. Dusty conditions on the surface before tacking significantly lowered the shear strength.

Materials Characterization and Modeling

The third technical session opened with two papers on RAP. The first investigated the effects of RAP on HMA volumetrics and mechanical properties using complex modulus testing and fracture energy. Hasan Ozer, University of Illinois (U of I), presented the results, which suggested that the assumption that the RAP binder does contribute to the overall mixture stiffness was appropriate at the design stage. They also supported conventional wisdom that RAP use may increase the potential for thermal cracking.

The second RAP paper was presented by Jo Daniel, University of New Hampshire. She reported on the sensitivity of performance predictions from the MEPDG because of changes in the assumed RAP binder grade. The study showed that the performance predictions are affected by the RAP binder grade, especially when Level 2 or 3 analysis is used. Until more research refines the procedures, a reasonable approach when using Level 2 or 3 analysis is to run the software with two different RAP binder grades to determine bounds on the performance predictions.

Don Christensen, Advanced Asphalt Technologies, then presented a study on fatigue. He offered two new concepts for fatigue analysis including using reduced loading cycles and effective strain. A method of testing and analysis was presented to determine the fatigue endurance limit.

Long term laboratory aging and its effects on fracture energy were discussed in the next paper by William Buttlar, from the U of I. He presented a proposed 24 hour, 135°C aging procedure to be used in lieu of AASHTO R30. He concluded that the proposed method of aging loose mix is more realistic in terms of its effects on tensile strength but may overage the binder. Neither procedure reflected field

aging at MnROAD, especially for polymer modified mixes.

Symposium

The traditional AAPT symposium session includes invited presentations on a focused topic. This year's symposium examined the ideal asphalt pavement and how to achieve it. Adam Hand, Granite Construction, discussed material selection. He urged agencies to allow some flexibility for contractors to optimize mixes for performance. Either fine or coarse gradations can work in different locations. Adequate density and smoothness can be achieved with some attention to detail.

John Harvey, University of California Davis, gave a presentation put together by Carl Monismith, UC Berkeley, on pavement design. He noted that there are many variables to consider in pavement design, but that we have the tools available to help. He also noted that lack of bonding between lifts can cut the life of an overlay by 50%, which reinforces the need for good tack coats.

Next Harold Von Quintus, ARA, said the four major things that can go wrong and reduce pavement life are

1. Aggregate and thermal segregation,
2. Poor longitudinal joint construction,
3. Checking and cracking caused by rolling in the temperature sensitive zone, and
4. Inadequate bond between lifts.

He concluded that we have the tools needed to design and build the ideal asphalt pavement.

Carlos Rosenberger, Asphalt Institute, wrapped up the symposium with a discussion of life cycle economics. He noted that about 80% of life cycle costs comes from the initial costs. The LCC analysis results are dependent on the initial service life used and that 15 years or less is too short. Night time paving has a huge impact on user costs, making it an economic advantage over other construction.

An international forum followed the symposium, providing updates on current work and advances in Europe and Canada.

Advanced Characterization

The fourth technical session dealt with advanced characterization of binders and sealants. Jean-Francois Masson, National Research Council of Canada, reported on a study of the chemistry and effects of polyphosphoric acid (PPA). The study showed that PPA does have a stiffening effect at high

temperatures and little impact at low temperatures.

Next, Shih-Hsien Yang, U of I, reported on a pooled fund project to develop a specification table (similar to asphalt binder PG grading) for hot-poured crack sealants. The proposed table includes the following factors:

- Apparent viscosity (to measure constructability)
- Vacuum Oven Aging (to short-term "kettle" age sealant)
- DSR (for high temp wheel tracking)
- BBR (for low temp flexibility)
- DTT (for low temp extendibility)
- Surface Energy (for low temp adhesion)
- Direct Bond (for low temp adhesion QC test)
- Blister Test (for low temp adhesion)

The Multi-Stress Creep and Recovery test (MSCR) has been growing in popularity to characterize the resistance of a binder to permanent deformation. Dallas Little, Texas A&M, summarized an improved analysis technique that can identify both the recoverable and irrecoverable strain components. Little concluded that the new stress-strain model did a better job of predicting rutting on FHWA ALF sections.

The next paper, presented by Ezio Santagata of the Polytechnic University of Turin, addressed the possible relationships between the composition and structure of unmodified binders and their fatigue and healing properties. The study showed that the balance of asphaltenes+saturates to aromatics+resins appears to determine fatigue properties, while the saturates and aromatics influence the healing properties.

Carl Johnson, UW, presented a new concept for characterizing the resistance of binder to fatigue damage. The new test, called the Binder Yield Energy Test, uses monotonic constant shear rate loading on a sample to quantify damage. The test uses the existing DSR. Results correlated well with observed fatigue in sections at the FHWA ALF. More development is needed prior to implementation.

Models to Predict Behavior

The final session of the 2009 AAPT Meeting concerned various aspects of modeling mixtures and pavement to predict their performance. First up, Saradhi Koneru, Texas A&M, presented a framework for modeling compaction of asphalt mixtures in the lab and in the field. The model includes eight factors that divide into binder viscosity components for initial compaction and mixture shear components for final compaction. The model could be used to

predict mixture compactability in the field based on lab tests.

A concept for a model to understand the relationship between asphalt binders and mineral fillers was presented by Ahmed Faheem from UW. Asphalt binder/mineral filler behavior is modeled by two parts: (1) asphalt binder behavior for low filler contents and (2) asphalt mastic behavior for high filler contents. The model will be integrated into ongoing research under NCHRP 9-45, which is developing test methods and specifications for mineral fillers.

Hao Wang, U of I, used finite element modeling and accelerated testing to study the effects of wide based tires. The study found that dual tire configurations have higher pavement surface contact stresses, but lower stresses at the bottom of the pavement in comparison to super-single wide tires. Therefore, standard dual tires play a greater role in the development of top-down cracking.

The current MEPDG software program reduces computational time (from >24 hrs to 40 minutes) by using linear assumptions across axial loads and tire pressures. This assumption, though, is frequently violated. Senthilmurugan Thyagarajan, FHWA, showed that this can lead to significant errors in predicted rutting. An alternate approach to better estimate the pavement strains is offered in this paper.

Jongeon Baek, U of I, studied reflective cracking and two types of interlayer systems compared to a control section with no interlayer. A sand mix interlayer was found to reduce cracking in the leveling course. A steel mesh interlayer, when properly installed, reduced reflective cracking and controlled vertical shear deformations of the overlay.

Where Theory and Practice Meet

Abstracts of the papers presented here are included in the North Central Superpave Center's searchable database at <http://rebar.ecn.purdue.edu/Superpave/search.asp> and the complete proceedings will be available for purchase from AAPT. (Past proceedings are available now.) Streamlined membership levels make joining easier than ever; see the website (www.asphalttechnology.org) and the article on page 7 for details.

As past president Erv Dukatz put it, "The value of AAPT is for theory and experience to be merged." The next meeting will be in Sacramento, California, March 8-10, 2010.

Polyphosphoric Acid Modification: Is it Effective?

by Rebecca McDaniel

Modification of asphalt binders has grown considerably with the implementation of Performance Graded specifications. Asphalt suppliers have explored many options to find an economical, effective binder modifier. One modifier in particular, though, has caused concerns for many people. That modifier—polyphosphoric acid, or PPA.

Concerns have been raised that PPA may interact with lime—a base—which is used as an antistripping agent. The effects of PPA on the binder properties and in combination with other binder additives, such as liquid antistrippers have also raised questions. There have also been stories about pavement failures that have been attributed to the use of acid modified binders.

Is PPA an effective modifier or a problem waiting to happen? Answering that question was the focus of a recent workshop sponsored by the Federal Highway Administration (FHWA), Transportation Research Board, Asphalt Institute, Minnesota Department of Transportation (Mn/DOT), Association of Modified Asphalt Producers, Innophos, ICL Performance Products LP and TERRA. The workshop, held in Minneapolis April 7 and 8, brought together contractors, material suppliers, agency personnel and researchers to discuss the facts and myths about acid use.

Phil Blankenship, Asphalt Institute, opened by noting that we fear things we do not know. When faced with something unknown, the best thing to do is learn about it, which is why we had the workshop. John Bukowski, FHWA, added that in these economic times we must look for cost effective technologies. Roger Olson, Mn/DOT, welcomed everyone to Minnesota and described the MnROAD test sections that would be toured on the second day of the workshop.

Binder Effects

Mark Buncher stated the Asphalt Institute position; the AI does not endorse any specific process but does believe PPA can improve the physical properties of some binders if used responsibly. However, it can also cause problems if used inappropriately. Responsible use by suppliers involves careful formulation at an appropriate addition rate, ensuring compatibility, communicating with the contractor and mix designer, and heeding the MSDS. Specifiers and agencies should consider a DSR test on the binder to ensure compatibility of PPA with amine based antistrippers and a mixture performance test for moisture susceptibility (T283 or the Hamburg, for example).

Dean Maurer, formerly with PennDOT and now with Evotherm, surveyed states about their specifications and experience with PPA. Some states

specifically disallow acid, others indirectly restrict its use (through a PG+ test) and some do not address its use at all. Concerns raised by the states included possible inferior quality compared to polymers, potential for improper dosing or unexpected reactions and binder recovery issues.

Gaylon Baumgardner, Paragon Technical Services, gave a very informative presentation on how PPA worked and why industry used it in some applications. He showed how PPA could increase the useful temperature interval of a binder (the span from the high to low temperature grade) without oxidizing or embrittling the binder. He cautioned, however, that the effects of PPA are dependent on the chemical composition of the asphalt.

John D'Angelo, FHWA, compared linear and radial SBS modifiers with and without PPA. He showed that the addition of PPA to the polymer could improve its dispersion and cross-linking. PPA could also increase the stiffness of the binder and improve the recovery shown by the Multi-Stress Creep and Recovery (MSCR) test. The addition of hydrated lime did partially offset the stiffening effect of the PPA, but it did not affect the recovery, which is improved by cross-linking.

Terry Arnold, FHWA, reported on a number of issues the FHWA has researched in the binder area. Questions addressed included whether adding a hydrophilic material like acid increases the moisture susceptibility of the binder and how to determine if a binder contains PPA. The results suggest that moisture sensitivity can increase at higher levels of acid. FHWA has developed a simple test to detect the presence of phosphorous, but that does not necessarily mean the binder contains acid; some used engine oils contain a zinc-based heat stabilizer that also contains phosphorous.

Next, Gerry Reinke, from Mathy Technology, offered a number of analytical tests to detect the presence of phosphorous. He also reported on issues related to extracting binders that contain PPA. Some extraction solvents, including n Propyl Bromide and TCE, contain stabilizers that are acid scavengers and therefore neutralize acid. Toluene or toluene-ethanol blends can be used for extractions. Reinke also noted that some aggregates “lock on” to phosphorous more than others.

Mixture Effects

Turning to mixture testing, Tom Bennert from Rutgers University reported on a study comparing mixtures made with neat 64-22 to SBS modified (4% SBS) and SBS+PPA (2.5% SBS + 0.5% PPA) mixes. He found that both the SBS and SBS+PPA

mixes performed better than the unmodified mix in terms of permanent deformation. The SBS+PPA mix had comparable fatigue and durability performance to the polymer only mix, and both were superior to the control.

Terry Arnold then returned to discuss mixture testing. This study looked at mixes with different types of aggregate, some that were stripping prone and others that were not, and two different asphalts. Hamburg testing was used to compare mixes with acid only, acid with hydrated lime, and acid with liquid anti-strip. The acid contents evaluated were as high as 3%. The results showed that acid alone may increase the rutting and moisture damage as measured by the Hamburg test. Mixture resistance to stripping should be evaluated with the aggregates, binders and additives that will be used.

Gerry Reinke also returned to discuss mixture test results. Reinke noted that PPA has been used in asphalt for about 20 years and over 3 million tons of binder with PPA have been used; that equates to some 51 million tons of mix. He asked if we would not be keenly aware of wholesale problems if they did exist. A study at Mathy found that hydrated lime improves the moisture susceptibility of all mixes, with or without acid. Phosphate ester antistripping agents also work well. Reinke stated that some binders are not suitable for PPA modification, at least not without polymer. In addition, for every binder there is a level of acid that is too high and will lead to a decrease in moisture resistance. He also said PPA by itself is not the equivalent of polymer, but PPA plus polymer can be better than polymer alone. PPA can also greatly reduce the amount of polymer that is needed to achieve a certain PG grade. Reinke suggested limiting the amount of acid used to that which achieves a one-grade bump.

Field Studies/Experience

The NCAT Test Track has incorporated test sections with PPA, including a Venezulean crude with SBS, PPA and liquid antistripping in 2000 and a PG70-22 made with SBS and acid in 2003. Nine sections with PPA from the 2000 Track were left in service for additional trafficking in 2003. Don Watson, NCAT, reported that in both rounds at the track, the acid plus polymer sections performed slightly better than unmodified sections.

Another field case study was presented by Jerry Westerman, who recently retired from the Arkansas DOT. Arkansas began using polymers in 1981 and PG binders in 1995. When they undertook a massive interstate rehabilitation program from 2000 to 2005, some of the binders used were PPA modified, though

they did not know that at the time. They later found out that significant amounts of the PG70-22 they had used contained PPA. The rehabbed interstates have been performing very well with only minor distresses. Based on this, Westerman believes that PPA served its function in modifying the binders.

Kai Tam offered another agency perspective from north of the border in Ontario. Tam opined that PPA modification is a legitimate technology but it must be managed properly to control risk. Ontario had experienced some unexplained poor performance (rutting, flushing, instability and cracking) that may have been related to PPA problems. The Ontario Ministry of Transport set up a task group with industry to develop short- and medium-term plans to manage the potential risk without stifling technology. The short term plan includes limiting acid to 0.5% and allowing it only in combination with a polymer for heavy duty highways. Lower volume roadways may contain up to 1% acid. Suppliers must notify the ministry if acid is used in a binder. The ministry will test binders and monitor performance over time to manage risk in the future.

Kevin Van Frank reported on Utah's experience with elastomers and PPA. Utah has a variety of climatic regions and temperatures that range from a low of about -20°F to a high of 115°F with potentially large variations within a day. Their past experience leads them to conclude that refinery run binders will either rut or crack, so almost all of their binders now are modified. They use direct tension and elastic recovery to help ensure desirable performance. They also run the Hamburg test on mixes to verify resistance to rutting and stripping. Van Frank noted the need for a low temperature mix performance test.

Tim Clyne then described a study of PPA performance at MnROAD. Cells on the Low Volume Road contain PPA only, SBS only, SBS+PPA and Elvaloy+PPA in instrumented test sections. The

sections, which were constructed in 2007, are performing well. Field samples show excellent rutting and stripping resistance in lab tests. The PPA + polymer mixes appear to be superior to either modifier alone. Low temperature testing will be done, and the sections will be monitored for five years.

Best Practices

Henry Romagosa and Jean-Valery Martin gave an overview of a best practices document prepared jointly by their companies, ICL Performance Products LP and Innophos, Inc., respectively. These companies estimate that over 200 million tons of mix have been produced with PPA with no failures. They indicated that low temperature binder properties are generally determined by the base asphalt, and PPA can increase the high temperature grade. When used in combination with polymers, however, the PPA can lead to improvements at both high and low temperatures. The amount of PPA to be used depends on the asphalt, how large a grade change is desired and whether polymer is also used. Both PPA suppliers have in-house expertise to assist in appropriate use.

A panel discussion was then held with agency and industry representatives from three states. Bob McGennis, Holly Asphalt, reported on Arizona experience. He recounted how a change in philosophy in Arizona calling for wide use of PG76-16 made it challenging for binder suppliers to produce the desired grade. PPA could help do that more economically and practically than straight polymers. ADOT was willing to try it. A 2003 field review of projects containing PPA showed good performance. Visits to the same sites in 2009 showed the pavements were still performing well.

Chris Abadie then spoke for the Louisiana DOT. Louisiana currently specifies PG76-22 with elastic recovery and force ductility requirements, though

they are moving towards adopting the MSCR test. Their position is that any modifier, including PPA, that will meet the specifications and reduce costs will be allowed. They support the development of mixture tests to verify the performance of mixtures under realistic conditions.

Judie Ryan, Wisconsin DOT, gave yet another perspective. Wisconsin has a great deal of experience with pavement warranties. They give the contractor control over material selection and set criteria to ensure they get the performance they desire. PPA is one modification technique that producers can use to achieve the desired PG + performance. WisDOT has not experienced any problems they even partially attribute to the use of PPA. WisDOT believes in a combination of research, scientific exploration and open communication to improve performance and economics.

A question and answer period followed before a tour of the MnROAD Low Volume Roadway and its PPA sections. In summary, the workshop showed that PPA can be a viable and effective modifier by itself and especially when used in combination with polymers. Care must be exercised, however, to use acid appropriately and to best benefit. The effects of PPA are dependent on the chemistry of the asphalt binder in which it is used and can also be impacted by the aggregates and other additives in the mix. Guidance on how to effectively use the technology in specific applications is available from the PPA producers and others.

Presentations from the workshop are available online at <https://engineering.purdue.edu/NCSC/PPA%20Workshop/2009/index.html>. Recordings of most of the presentations, made by the North Central Superpave Center, can be viewed at the same URL. The discussion during the question and answer period is being transcribed and will be made available at the same website.

Thinking about Joining AAPT?

The article on pages 4 and 5 describes the 84th meeting of the Association of Asphalt Paving Technologists. If that piqued your interest, you might be wondering how you can become a member of that venerable group. Members enjoy a reduced registration fee for the meeting and a printed copy of the papers and discussion following the meeting. (All meeting attendees receive a CD with the paper preprints at the meeting.)

Why become a member?

Here are some of the benefits of membership in AAPT:

- Join the leading learned asphalt technology association in the world, and be better informed on up-to-date issues in asphalt technology.
- Be part of a supportive technical community representing all sectors of the asphalt industry including material suppliers, researchers, agency owners, consultants, and equipment manufacturers.
- Receive an annual journal of refereed technical

papers and conference proceedings.

- Have the opportunity to be recognized by an award presented annually for the best paper.
- Network with other professionals at annual meetings in attractive venues.
- Be part of lively debates on important technical asphalt issues.
- Be part of a North American based organization that has significant international membership and focus.
- Be part of an association that operates without organizational biases; policies are set by and for individual members by an elected Board rather than by companies or organizations.
- Have an opportunity to support the next generation of asphalt technologists through a robust student scholarship program.
- Be part of a dynamic growing association that periodically reviews and updates its goals and objectives via a Strategic Development Plan to better serve its members.

How can I become a member?

It is very simple. Go to www.asphalttechnology.org/membership/. Click on Apply for Membership, download the application and send the completed form back to the AAPT office.

You will find that you can choose from three membership categories:

1. Student Member (\$50/Year) – You get an electronic journal and access to a lot of information.
2. Associate Member (\$110/Year) – You get the hard copy of the journal, access to a wealth of information, you can serve on standing committees and you can vote for board members to guide the future direction of the organization.
3. Member (\$110/Year) – You get the associate member privileges, plus the opportunity to be part of the technical paper review process and have a chance to become a board member.

Join today and start enjoying the benefits of membership in the best asphalt technical organization in the world.

Accelerated Performance Testing on the 2009 NCAT Pavement Test Track

by Buzz Powell

The NCAT Pavement Test Track (shown in Figure 1) was originally constructed as a result of interest and support from state Departments of Transportation (DOTs) that shared a concern for reducing and predicting distresses in their flexible pavements. The cost for other states to sponsor the construction, testing, trucking and evaluation of experimental pavements was greatly reduced by a commitment from the Alabama Department of Transportation (ALDOT) to fund the original construction of the facility up to the top of the supporting pavement structure.

The inaugural track, built as a perpetual pavement, was completed in the summer of 2000 and subjected to 10 million ESALs of heavy truck traffic through December of 2002. The first cycle of testing was a study of surface mix performance incorporating 46 test sections 200 feet long.

The facility was rebuilt in the summer of 2003 and loaded with another 10 million ESALs over the next three years. This cycle was used to evaluate a combination of mill/inlay surface mixes and variable thickness structural sections. Likewise, the 2006

well as more mill/inlay surface mixes, with formal research sponsorship expanded to include private sector partners. Track research sponsors have always been encouraged to choose experiments that meet their specific research needs. Individualized test sections will still be optional on the 2009 Track; however, NCAT is also encouraging sponsors to consider supporting a pre-designed six section "Group Experiment" (shown schematically in Figure 2) that is intended to encompass multiple timely issues that are important to the entire pavement community. All sections in the "Group Experiment" will be supported by the same subgrade and base, and the total thickness of all bituminous lifts will be 7 inches. This thickness was chosen because in past studies 7-inch sections exhibited significant performance differences within the planned traffic cycle.

In addition to a control section that will be built with conventional hot-mix asphalt (HMA), two sections in the Group Experiment will be built using different warm mix asphalt (WMA) technologies in every lift. Although the two WMA technologies

rutting, moisture damage and structural performance are not compromised.

As a result of the rising cost of virgin materials, pavement engineers are also very interested in high recycled content mixes. There are some concerns that the use of high percentages of reclaimed asphalt pavement (RAP) in surface mixes may compromise durability. Likewise, there is concern that high RAP content base and binder mixes may compromise fatigue resistance. It is critical that decision makers determine whether high RAP content mixes are suitable for these applications so that specification limits can be set at the highest level that exhibit performance characteristics comparable to virgin mixes. In order to address this issue, one section will be built with a high RAP content in the lower lift(s) and low RAP contents in the upper lift(s). Another section will be built with high RAP contents in both the lower and upper lifts.

Many state DOTs are using drainable surface mixes in order to improve wet weather driving visibility, lower accident/fatality rates, and reduce noise created by tire-pavement interaction. Although drainable surface mixes have aggregate structures that are very similar to rut resistant stone matrix asphalt (SMA) mixes (less the voids-filling dust), it is typically assumed they do not contribute to the load carrying potential of the pavement structure. The sixth section in the "Group Experiment" will be built identical to the control section, except that the conventional surface mix will be replaced with a drainable surface mix.

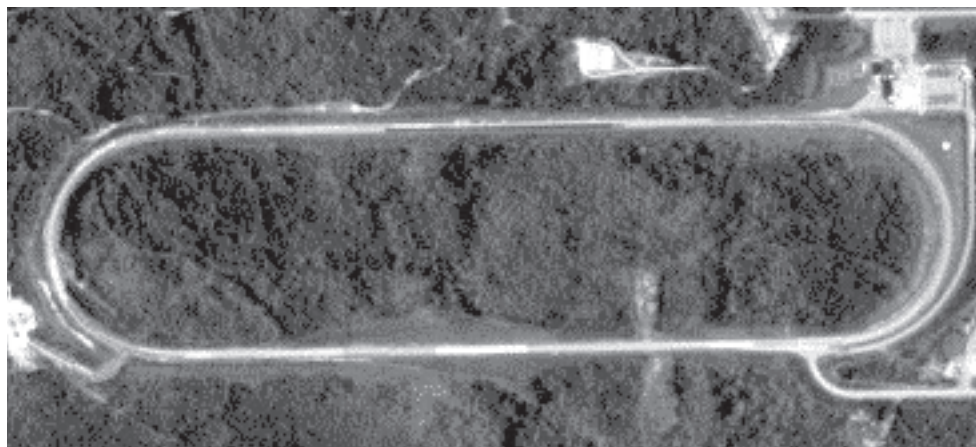


Figure 1. Satellite View of the NCAT Pavement Test Track

track was a combination of more variable thickness structural sections and mill/inlay surface mixes (again subjected to 10 millions ESALs of heavy truck traffic).

Plans for 2009 Track

The 2009 NCAT Pavement Test Track is expected to consist of an even larger structural experiment as

will be selected by the sponsors who choose to financially support the experiment, it is envisioned that one of the sections will be foamed and the other will be produced using an additive. These sections are proposed because reduced energy demand, lower emissions, and enhanced workability make WMA technology a very attractive alternative for the construction industry if it can be proven that early

Advantages of Instrumentation

By monitoring response instrumentation (i.e., pressure plates and strain gauges) installed in each of these sections at the time they are constructed and by documenting changing surface conditions (rutting, roughness, cracking, etc.) under heavy truck traffic, it will be possible to compare both surface and structural performance. It is expected that this information will provide for the optimization of specifications regarding the deployment of these modern technologies on the pavement infrastructure with a high level of confidence. As a complementary bonus, the private sector plans to build additional

instrumented structural test sections to investigate the use of alternative binders through direct comparison with these six “Group Experiment” sections.

Utilization of as many sections as possible for structural purposes would facilitate the implementation of mechanistic-empirical (M-E) methods for structural pavement design. For example, the development of the new Mechanistic-Empirical Pavement Design Guide represents a significant change and advancement over existing design methodologies. Historically, the structural design of asphalt pavements has been largely empirical based upon vehicle designs, axle loads, and material properties. The new design guide, however, relies heavily on principles of engineering mechanics to produce thickness designs that control specific modes of pavement distress. Before this new methodology gains wide acceptance or use, it must be validated and calibrated to ensure that it provides adequate design guidance using modern methods and materials under traffic by actual design vehicles.

If calibration of the conservative distress models could eliminate as little as a 10 percent margin of error in excess design thickness, that would generate an annual taxpayer savings nationwide of as much

as one billion dollars. To this end, there is a need for a full-scale structural experiment to validate the methodology. The existing infrastructure available at the NCAT Pavement Test Track presents a unique opportunity to accomplish this objective. By constructing an array of sections on the 2009 track with varying structural designs and material types, a practical study can be completed within three years that will make widespread, cost-effective adoption of the new Guide possible. Additionally, a larger structural experiment will build upon the experiences of both the 2003 and 2006 research cycles in which different responses and/or surface distresses were observed.

Costs to Participate

The 2009 NCAT Pavement Test Track is eligible for 100% SP&R funding. Each sponsor participating in the study is asked to contribute funding as a function of the scope of their selected research. The cost to participate varies as follows according to the amount of effort required:

- Continue traffic on existing mill/inlay section, \$55k / year (\$165k / section)

- Surface treatment on existing mill/inlay section, \$55k / year (\$165k / section)
 - » Intended to provide access to project for private sector partners
 - » Does not include the cost of materials, construction or mitigation
 - » Commitment to rapid mitigation of failed experiments is required
- Continue traffic on existing structural section, \$70k / year (\$210k / section)
- Mill/inlay surface performance section, \$120k / year (\$360k / section)
- Mill/inlay structural performance section, \$150k / year (\$450k / section)
- Structural performance section, \$180k / year (\$540k / section)
- Group experiment, \$180k / year (\$540k total assuming six sponsors)
 - » Actual amount will be less if more than six sponsors participate
 - » For example, cost will be only \$72k / year (\$216k total) with 15 sponsors

Please visit the project web at www.pavetrack.com for additional information.

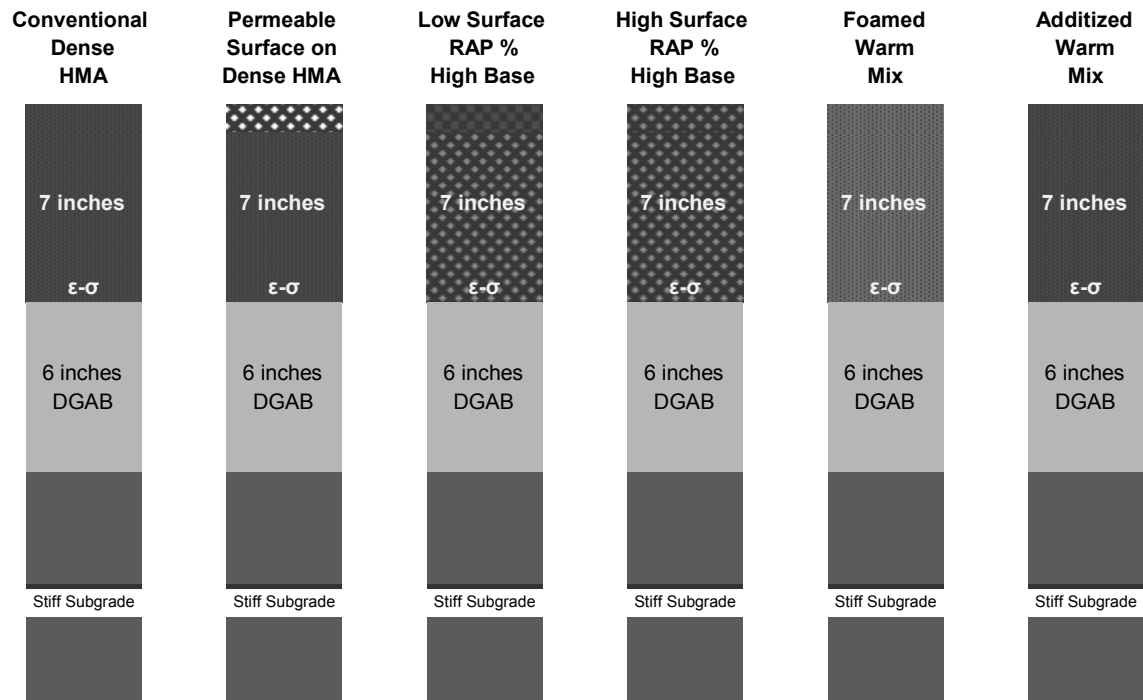


Figure 2. Schematic of the 2009 “Group Experiment”

Use of Warm Mix Warms Up

by Andrea Kvasnak

Warm mix asphalt (WMA) was one of the “hot” topics at the recent 2008 annual meeting of the Southeastern Asphalt User/Producer Group held in Birmingham, Alabama. Warm mix asphalt uses a process or additive that allows traditional hot mix asphalt (HMA) to be produced, placed, and compacted at lower temperatures. Whereas typical HMA mixtures are produced at temperatures around 300°F, the production temperature of WMA mixtures can range between 185 - 275°F. The actual production temperature depends on the type of mix and WMA technology used.

According to Andrea Kvasnak, Lead Research Engineer with NCAT, there are at least 14 different technologies that have been used in North America. Those technologies include foaming additives or processes, organic additives, and chemical additives.

Kvasnak indicates that at least 35 states have placed demonstration projects or test sections using various WMA technologies. Brian Prowell, of Advanced Materials Services, LLC, added that there have been at least 60 such projects involving more than 300,000 tons of WMA. Prowell presented data from a Michigan M95 project that indicated the following:

- Production Temperature - 50°F reduction
- Fuel Use - 10% reduction
- NOX - 34% reduction
- CO₂ - 18% reduction
- VOC - 8% increase
- CO - Slightly increased

According to Prowell, the combined increase in VOC and CO indicated that there may have been incomplete combustion due to improper tuning of the burner.

There are several advantages for using the WMA technology. One of the most obvious benefits is the energy savings by reducing the production temperature. However, the lower temperature not only reduces the fuel demand, it also reduces exhaust stack emissions as well. Both of these advantages are beneficial to the environment.

Another advantage is that the asphalt binder is less oxidized due to the lower temperature. The softer binder may exhibit greater resistance to thermal cracking in cold winter environments, and may allow the use of higher proportions of reclaimed asphalt pavement (RAP) without “grade-bumping” as has been done in the past. The WMA seems to cool at a slower rate than the HMA. This gives a longer window of opportunity for compaction to take place so that density results have typically been as good as

or better than HMA even though the mix is produced at a lower temperature.

One of the concerns with the use of WMA is that, because there is less oxidation of the binder, there may be a resulting increase in rutting susceptibility. However, the early field performance results to date have indicated that there is no increase in rutting potential when compared to conventional HMA.

Moisture susceptibility has also been a concern since the mixture is not being heated to as high a temperature and the aggregate may not be dry. Agencies and contractors are actively checking moisture content in the mixtures, monitoring pavement performance over time, and using anti-strip agents, in some cases, as a precaution. In Europe, anti-stripping agents have been used with all warm mix technologies.

Matt Corrigan, WMA Program Manager for FHWA's Office of Pavement Technology, presented information on various projects across the U.S. He also mentioned two resources for anyone interested in learning more: NAPA Quality Improvement Series 125 on *Warm Mix Asphalt: Best Practices* and FHWA publication FHWA-PL-08-007, which documents the results of a WMA European scan tour.

More information about WMA is also available from the website: www.warmmixasphalt.com.

High RAP...

Continued from page 3

Newcomb gave ten issues, or barriers, related to the use of RAP.

- Need for a mixture quality performance test,
- Perceived need to change binder grade,
- Uncertainty of co-mingling of aged and new binder,
- Use of solvents in binder recovery process,
- Uncertainty as to whether lab heating/mixing procedures represent production,
- RAP availability,
- Variability of RAP,
- Need to establish “best practices” for use of RAP,
- Need to document performance of high RAP mixes, and
- Unknown effect of RAP containing asphalt rubber or polymer-modified binders.

Of the barriers listed, one of the most important to be resolved is the need for standard performance tests. The use of performance tests may help in answering the concerns over whether changes in binder grade are necessary or justified. Newcomb stated that we need performance testing “that will assess the behavior of the mix under different conditions of traffic and climate.” Newcomb also pointed out that we cannot completely replicate the recycling process in the laboratory. During laboratory mixing and compaction, it takes three to four hours to prepare, mix and compact about 11 pounds of material. The typical asphalt plant can produce about 1,000 tons of mix during that same period of time.

Jay Winford, President of Prairie Contractors, Inc., supported those comments. He made what seemed to be a recurring challenge to the group when he said, “You guys went through four calculus courses

on the way to becoming engineers; figuring out how to use more RAP should be a piece of cake.”

Winford suggested a post-summit action plan that would advocate recycling. Increasing the use of RAP will enable agencies to address more of the infrastructure with the same budgeted dollars. Specifications will need to be reviewed for appropriate RAP limits; all surface mixes should be allowed to have at least 15% RAP. Agencies should also reconsider specifications which preclude use of RAP from random, or non-DOT, projects. Winford encouraged adoption of a national RAP goal; “Increase RAP use on DOT projects from the current average of 15% to an average level of 25% over the next five years.” He also urged users to document RAP performance and share the information with neighboring states as well as nationally.