national superpave news

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Charlie Potts' Top Ten List

1. **Use more RAP** – break down the barriers and extend the use of this "mine of black gold."
2. **Manage your risk** – understand the risks associated with fixed price contracts in a time of rising fuel and asphalt prices and potential for reduced availability.
3. **Conduct an energy audit** – to identify options to conserve energy
4. **Reduce energy consumption** – by taking steps such as paving under stockpiles, tuning your burner, insulating lines, using different fuels and increasing RAP use.
5. **Adopt an asphalt conservation strategy** – as recommended in NAPA Special Report 101, which includes things like use of large stone mixes (lower surface area to coat), recycling shingles, appropriate binder grade selection, using thin surfaces for functional overlays, and more.
6. **Implement Warm Mix** – with the energy savings this technology offers.
7. **Understand the new asphalt economics** – US refining capacity has dropped and types of refineries have changed leading to less asphalt production.
8. **Increase funding for highway construction** – through gas tax/user fee increases, public-private partnerships and reduced special projects, which siphon off funding.
9. **Partner with your customers** – to find ways to conserve fuel and materials while accomplishing our goals.
10. **Be on the inside looking out, not the outside looking in** – be an active participant, take home ideas from this workshop and promote them at the local level.

Conference Focuses on Conserving Energy and Materials

By Rebecca McDaniel

Today's high petroleum prices have had an impact on everyone. The impact on the asphalt paving industry may be particularly hard, since we use petroleum products to fire our plants, fuel our construction equipment and produce the paving materials themselves. The asphalt industry also has some unique opportunities, however, to conserve materials and fuel. Over 250 industry, agency and academic representatives attended a national workshop on Materials and Energy Conservation in Indianapolis November 1 and 2 to learn more about those opportunities.

The conference -- sponsored by the National Asphalt Pavement Association, Federal Highway Administration, American Association of State Highway and Transportation Officials and the Asphalt Pavement Association of Indiana -- provided a forum to share research results, philosophies and practical experience about conservation.

Indiana Department of Transportation (INDOT) Commissioner Tom Sharp opened the meeting by sharing some of the approaches taken recently by INDOT to streamline the planning, designing and construction of highway improvements. He cited the benefits of the agency working together with consultants and contractors to improve the process. He also noted that Indiana is working with three other states to reduce congestion on the I-70 corridor through dedicated truck lanes; reduced congestion allows more efficient usage of fuel.

David Geiger, Director of the FHWA Office of Asset Management, then provided the FHWA philosophy on recycling, which is that recycled materials should get first consideration in material selection. Old paving materials should be reused in new transportation projects, since that is where they originated. FHWA is working in partnership with the Environmental Protection Agency (EPA) to explore recycling options. Geiger went on to say that restrictions against using recycled materials that are without technical basis should be removed.

The keynote address was given by Charles Potts, CEO of Heritage Construction and Materials and Chairman of NAPA's Energy Task Force. Potts offered ten practical things the highway community can do to improve our conservation efforts. (See sidebar.) Potts concluded that better utilization of RAP is the biggest thing we can do to improve our economics.

Recycling

Jim Musselman, Bituminous Engineer for the Florida Department of Transportation, credited Potts with many of Florida's policies on recycling, established when Potts was with the department. Florida has used recycled mixes since the 1970's with good success, though there have been changes in what they do along the way. He also commented that although some local agencies are reluctant to use RAP, the state sets the example and locals generally go along.

David Lippert, Materials and Physical Research Bureau Chief for the Illinois DOT, also shared his state's experience with RAP. Illinois started recycling in the 1980's, but use declined in the 1990's when Superpave was implemented. A Recycling Summit was held in 2006 because the industry was having a real problem with growing RAP piles. IDOT developed a strategy for expanding RAP usage while maintaining quality; RAP can be reused in different applications (surface, lower lifts, shoulders) based on the quality and consistency of the RAP stockpiles.

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2006 Experiment Begins at NCAT Pavement Test Track

By Buzz Powell

The Pavement Test Track is a full-scale accelerated performance test (APT) facility managed by the National Center for Asphalt Technology (NCAT) at Auburn University. The project is funded and directed by a multi-state research co-op in which sponsors ship in hot-mix asphalt materials for placement on the Track using methods that are local to their jurisdictions. Forty-six different 200 ft sections have been built around the 1.7-mile oval to facilitate field performance comparisons in an identical climate where traffic conditions are precisely monitored. The primary objective of the project is to identify pavements with superior field performance and lower life cycle costs through the application of a design lifetime of truck traffic (10 million ESALs over 1.6 million miles) in two years.

The Track was originally constructed in the summer of 2000, with many sections replaced in the summer of 2003 after the first cycle of truck traffic had been completed. All 2000 sections survived with minimal rutting, but many were replaced to facilitate new research in the 2003 experiment. Eight sections were rebuilt in 2003 from the subgrade up to facilitate a mechanistic structural response experiment, and 14 sections were milled from 0.75 to 4 inches to facilitate new mix performance studies.

The Track was most recently rebuilt in the Fall of 2006 to facilitate an experiment that again included options for traffic continuation on existing sections, surface mix performance, and structural response test sections. Six sections were rebuilt in 2006 from the subgrade up to facilitate a mechanistic structural response experiment, and 16 sections were milled from 1.25 to 4 inches to facilitate new mix performance studies. (Figure 1)

Figure 1. Milling N1 and N2

Structural Experiment

The 2006 structural experiment is a comprehensive validation and calibration exercise for mechanistic-empirical (M-E) pavement design. The total thickness of hot mix asphalt (HMA) layers in the structural sections varies from 7 to 14 inches. The unbound bases range in thickness from 6 to 10 inches, and for the first time a soft subgrade was hauled in to replace the Track's onsite stiff material. (Figure 2)

Figure 2. Installing Soft Subgrade

Research in the structural sections is not limited to M-E analysis and design. Dissipated creep strain energy is being studied as a predictive mechanism for top-down cracking by one state sponsor in comparison sections with identical buildups using mixes with different fracture energy ratios. Response prediction in perpetual pavement designs is also a major point of interest.

Mix Performance Experiment

The 2006 mix performance experiment similarly encompasses a broad range of research objectives. The effect of different coarse aggregate particle shapes on the performance of permeable mixes is being studied. In one section, dual permeable lifts were placed simultaneously with a European twin layer paver for the first time in the United States.

Several state sponsors are researching the design, construction and performance of high RAP content mixes. In this experiment, mixes containing 20 and 45 percent RAP blended with various grades of liquid asphalt are being compared to a control version of the same mix that does not contain RAP. (Figure 3) This same virgin mix serves as the control section for another study in which mixes were placed with intentionally low laboratory air voids (caused by both high asphalt content and changes in the aggregate blend) in order to optimize pay factors.

Based on past Track experiences with a gravel SMA, one sponsor installed a gravel OGFC that will help them better utilize locally available materials.

Several sponsors have installed sections that will help them determine where they should set design gyration levels in order to optimize both rutting performance and durability.

One of the more creative experiments required the Track's perpetual foundation to be sawed into 12x15 foot slabs that could be overlaid with a rich bottom layer intended to inhibit reflective cracking in rigid pavement overlays. The total HMA thickness in all the mix performance sections is approximately 24 inches in order to ensure that all distresses originate near the surface, therefore most of the Track is supported by a perpetual foundation.

Loading and Performance

After pavement test sections have been rebuilt in the first year of each research cycle, a design lifetime of truck traffic is applied to the surface of experimental mixes in the second and third years of each research cycle in order to accelerate damage. NCAT operates a fleet of five trucks (heavy triples with one legal single) five days a week over two shifts in order to accomplish this goal. Trucking operations are suspended on Sunday and Monday each week to allow for drivers' down time, preventive and corrective maintenance on trucks, and field performance testing.

The necessity of the 1.6 million mile trucking operation also provides an opportunity to conduct research for the trucking industry. Examples of studies utilized to offset the cost of fleet operations include tire wear rate studies (which require an aggressive rotation scheme), axle durability testing, fuel economy determination studies using synthetic lubricants and fuels, etc.

Figure 3. Paving E5 with 45% RAP

Over 3.3 million miles have been safely run on the NCAT Pavement Test Track as of the end of the second research cycle.

As traffic accumulates over the course of the two-year trucking operation, weekly testing is conducted to document how the experimental pavements are changing with traffic and time. Cracking, rutting, roughness, texture, high-speed pavement response and density are monitored weekly. Deflection and surface friction are measured monthly.

Each test section is outfitted with multi-depth temperature probes that are used to thoroughly document relevant environmental conditions for each research pavement. Structural sections are also equipped with response instrumentation such as strain gauges, pressure cells, etc., that are used to calibrate mechanistic design methodologies.

Another objective of the research is to utilize laboratory testing to successfully predict differences in performance that are observed in the field. Samples prepared before, during and after construction are often included in the study. Testing plans have included compaction testing (e.g., gyratory shear), simulative testing (e.g., Asphalt Pavement Analyzer) and fundamental testing (e.g., confined cyclic creep). Methods have been developed to successfully predict field performance from data generated in the laboratory.

Sponsoring state DOTs have modified their methods and materials as a result of participation in the Test Track research. Progressive mixes have been implemented that provide both structural (e.g., SMA) and functional (e.g., OGFC) benefits. Questionable materials have been evaluated under actual heavy truck traffic without exposing the motoring public to unacceptable safety hazards (e.g., new products, polishing aggregates, etc.), and design methodologies have been evaluated to determine their return on investment (e.g., bumping binder grade, changing gradation, increasing asphalt content, changing modifier type, etc.). Structural sections have been used to validate response estimation techniques and calibrate predictive models (e.g., fatigue cracking, rutting performance, etc.). Work in these areas continues in the 2006 research cycle.

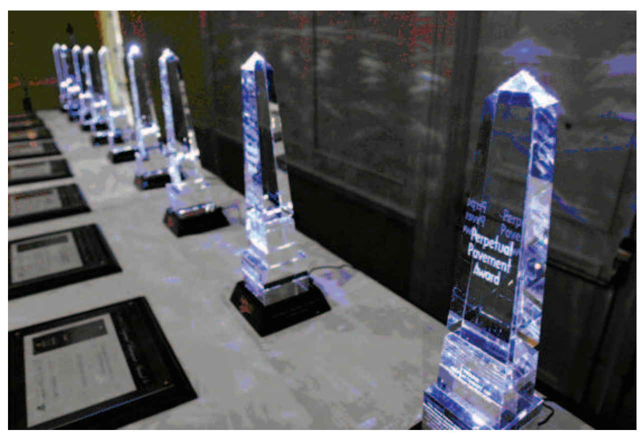
Perpetual Pavement Experiences Shared at International Conference

By Lee Gallivan, Federal Highway Administration, and Wayne Jones, Asphalt Institute

On September 13-15, 2006, professionals from around the world met in Columbus, Ohio, to discuss and advance the technology for long lasting hot mix asphalt perpetual pavements. The conference was attended by 150 representatives from federal, state and local agencies, industry and academia from across the U.S. and ten other countries. Presentations were given on local experiences with Perpetual Hot Mix Asphalt pavements.

Welcoming presentations given by Roderick McDavis from Ohio University, Gordon Proctor from the Ohio DOT, and King Gee from the Federal Highway Administration set the stage for a successful conference. Professor Carl Monismith from the University of California at Berkeley and Dr. Mike Dunn from the United Kingdom were the conference keynote speakers, and each provided the attendees background information on the programs and some of the successes from two different continents.

A perpetual pavement is defined as a pavement that is designed and built with hot mix asphalt to last for 35 years without major structural rehabilitation or reconstruction. The pavement may have received periodic surface replacements or treatments over the years.



The Asphalt Pavement Alliance awarded crystal obelisks to exemplary perpetual pavement projects in twelve states.

The Asphalt Pavement Alliance recognized twelve award winning perpetual pavement projects for 2005 that included three repeat agencies. Agencies receiving awards included: Alabama, Connecticut, Maryland, Minnesota, Mississippi, Montana, South Carolina, Tennessee and Texas. Representatives from each agency and industry accepted an engraved crystal obelisk and a plaque from the Alliance.

International Perpetual Pavement activities were especially impressive with presentations of projects in the United Kingdom and Shandong Providence, China. (See the accompanying article about China's perpetual pavement study on page 6.)

The International Conference on Perpetual Pavements was organized and hosted by the Ohio Research Institute for Transportation and Environment at Ohio University.

Perpetual Pavements in China

By D. Timm and A. Priest

China has emerged in recent years as a burgeoning economy with vast resources. With a current population of over 1.2 billion, the current annual economic growth rate in China hovers near 9%. Supporting this growth has meant considerable infrastructure investments by the Chinese government. For example, China currently ranks as one of the top concrete and copper consumers worldwide.

With respect to infrastructure, much attention has been placed on civil works projects. An extensive road network is being developed to sustain commerce and trade between cities and provinces as a critical component toward the continued economic growth of China.

One of the most significant challenges facing road designers and builders in China is the extremely heavy traffic loads. Seventy percent of the five-axle trucks are heavier than the U.S. limit, and the 90th percentile truck is an astounding 202,000 pounds (91,600 kg)!

Trucks made in China are designed and built to carry extremely heavy loads. Figure 1 shows a typical four-axle truck (S 1-1-2). It has a steer axle, one drive axle and two trailer axles. The

Figure 1. Typical truck configuration in China

consequences of heavy trucks to the road network, however, can be quite detrimental. Using the fourth-power relationship between axle load and pavement damage, a well documented approach, the average single axle in China (25,000 lb (11,340 kg)) causes roughly 40 times more damage than the average single axle in the U.S. weighing 10,000 lb (4,540 kg).

The typical design on an expressway in Shandong Province consists of 6 to 8 inches (150 to 200 mm) of hot mix over 14 to 24 inches

Figure 2. Chinese and American team of experts visits construction site of perpetual pavement experiment.

(350 to 600 mm) of cement bound stabilized granular material on top of 8 to 12 inches (200 to 300 mm) of stabilized soil on the untreated embankment. Another unique feature of Chinese expressways is the 10 ft (3 m) high embankment serving as the pavement foundation. The resulting pavement structure has guardrails on each side and down the median, and access is controlled through tollgates.

While this design has been used throughout China for expressway routes, there have been cases of early pavement deterioration. To help investigate this, a team of Chinese and U.S. engineers met in Shandong Province in November 2004 to collaborate with the Shandong Department of Transportation and the Shandong Transportation Research Institute (Figure 2). The U.S. team represented the Federal Highway Administration, Indiana Department of Transportation, Virginia Transportation Research Council, the National Center for Asphalt Technology and the Heritage Research Group. The main objective of the visit was to devise a joint Chinese-U.S. project to investigate pavement design alternatives to meet the extreme traffic conditions present in China.

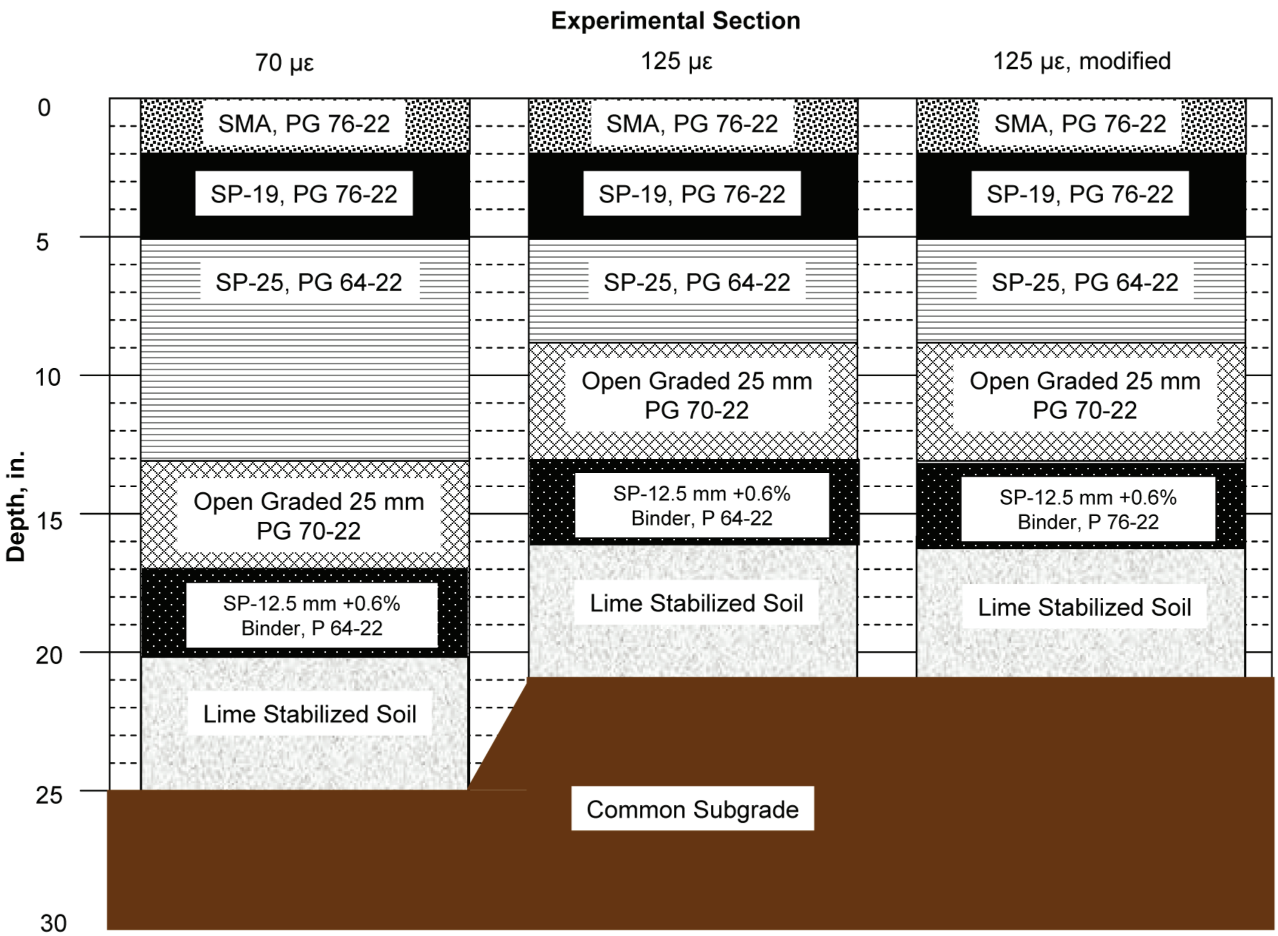
Given the need for high-performing, long-lasting pavement structures, the perpetual pavement concept was presented as the best approach. Central to perpetual pavement design is calculating the mechanistic response of the pavement structure under expected traffic and intentionally designing the layers to maintain stresses and deformation below prescribed limits. This design approach prevents deep structural problems, such as fatigue cracking and base or subgrade rutting.

To investigate this approach, and its impact on long-term performance, it was jointly decided to construct a number of perpetual pavement test sections on an expressway currently under construction in Shandong Province. The experimental site, located near the city of Binzhou, consists of five 1 km (0.6 mile) test sections.

The Shandong Highway Bureau and Shandong Research Institute provided material property data for the embankment, stabilized materials and hot mix, in addition to traffic characteristics. The U.S. team developed three perpetual pavement test sections, and the China team developed an alternate structure using cement stabilized layers and HMA surface. The typical design described above will be used as the primary control for the experiment.

Perpetual pavement sections were designed using the PerRoad software available from the Asphalt Pavement Alliance. From the analysis and discussions with the Highway Bureau and Research Institute, three perpetual pavement test sections were recommended for construction as shown in Figure 3. The first section used a conservative strain threshold to prevent fatigue cracking and resulted in a 20-inches (500 mm) full depth HMA pavement. The second section used a less conservative strain threshold, resulting in a 15-inches (380 mm) full depth HMA pavement. Both sections used stone matrix asphalt (SMA) as a wearing course with Superpave mixes in the lower lifts. The third section was identical to the second with the exception of the bottom 3-inches (75 mm) of HMA. This layer was redesigned to be more strain tolerant through the use of fatigue resistant materials.

Figure 3. Perpetual pavement experimental sections.



Two cross-sections currently used in China will serve as controls for the experiment. The first section, described above, is used throughout Shandong Province. The other control section was based upon a design used for the Guang-Shen Expressway in southern China consisting of 13 inches (330 mm) of HMA over 9 inches (228 mm) of cement-treated base over 18 inches (457 mm) of untreated aggregate base built on the embankment.

In addition to the structural design of the test sections, the U.S. and Chinese teams worked closely together to develop the mix design, construction specifications, quality control/quality assurance and long-term testing plans to ensure success of the project.

A key component of the experiment is instrumentation embedded in each test section and a weigh-in-motion station to measure actual loads. Figure 4 illustrates some of the asphalt strain gauges, just prior to paving, during construction in May 2005. Dynamic strain gauges, earth pressure cells and thermocouples enable mechanistic comparison of each design and provide valuable data regarding the effects of excessive loadings on perpetual pavements. This information will be critical to understanding perpetual pavement performance under heavy loads.

This investigation is important to the development of the highway infrastructure in China as the Chinese motorway system continues to be constructed. Additionally, in the U.S., there is discussion of separating trucks and cars on reconfigured interstate highways. With automobile traffic separated from trucks it may be possible to increase truck weights substantially, thereby reducing the cost of freight transportation. The data collected from these perpetual pavement sections under extremely heavy trucks will be invaluable in arriving at rational decisions regarding the U.S. highway network based upon actual field observations. As a result, this research is expected to benefit both China and the U.S., improving the performance of highways in both countries.

Construction occurred in May 2005 and the project was opened to traffic on December 2, 2005. Currently, the joint U.S.–Chinese research team is working toward collecting pavement response data under varying conditions and load magnitudes. These observations will help to establish “baseline” responses before any damage has accumulated. Pavement performance monitoring will be conducted periodically as the sections age and are subjected to more traffic so that relationships between pavement response and damage can be established.

Figure 4. Asphalt Strain Gauges During Construction in May 2005.

Missouri Warm Mix Demonstration Project

By Brian D. Prowell and Graham C. Hurley

Warm mix asphalt (WMA) has received a lot of attention for its potential to reduce production and laydown temperatures resulting in fuel savings, reduced emissions, and reduced worker exposure. The potential benefits of WMA for cold weather paving or long hauls have even been discussed. But in the spring of 2006 a Missouri contractor, Pace Construction, approached Missouri DOT about using WMA for a new purpose; the reduction of bumps in the pavement surface resulting from paving over cracks sealed with crack sealing material.

In the fall of 2005, Pace construction began paving a 3.4 mile section of Hall Street in northern St. Louis. Hall Street is located in a commercial area with relatively heavy, slow moving truck traffic during portions of the day. Hall Street consists of two lanes in each direction plus a center turn lane. The pavement is constructed on land reclaimed from a swamp. Figure 1 shows an example of the reflective bumps that occurred when placing hot mix asphalt (HMA) at normal production temperatures of 320°F. The contractor had to go back and mill off the bumps to improve the pavement smoothness.

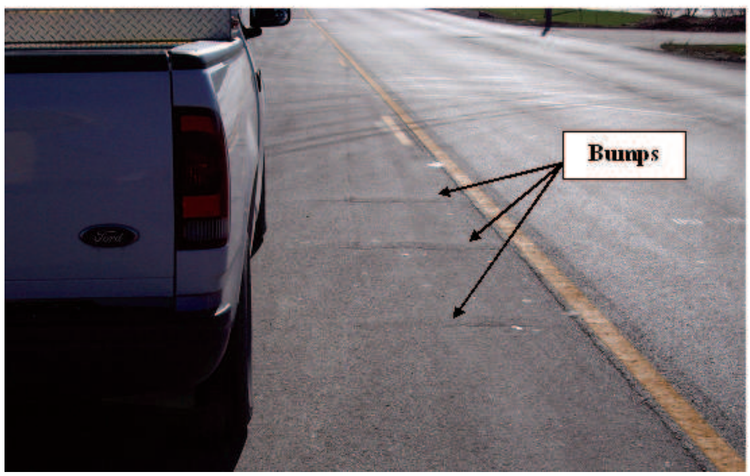


Figure 1. Reflective bumps and cracks over crack sealant.

In the winter of 2006, Pace Construction, in conjunction with Missouri DOT, conducted an extensive investigation, including cutting out trenches over the bumps. Pace Construction concluded that the heat from the HMA was turning water in the underlying crack into steam that was contributing to the formation of the bumps. They hypothesized that the lower laydown temperatures used with WMA may prevent the formation of the steam and the resulting bumps.

Missouri DOT approved the use of WMA as long as the resulting mix met all of their specifications for HMA. Pace Construction secured donations of enough Evotherm and Sasobit to pave 3.4 lane miles and enough Aspha-min zeolite to pave 1.9 miles. The WMA additives were added to a 12.5 mm nominal maximum aggregate size Superpave mix. The mixture consisted of a porphyry (traprock) and limestone coarse aggregate, limestone fine aggregate and recycled asphalt pavement mixed with a PG 70-22 binder. The mix was designed using an Ndesign level of 100 gyrations.

The mixture was produced with a 400 ton per hour (tph) CMI counter flow drum plant. The WMA was produced at approximately 250 tph. Field compaction temperatures for the WMA varied from over 250°F to 200°F with the contractor initially starting at a higher temperature to ensure that they could achieve density and then reducing the temperature for later production as allowed by the additive being placed.

Both the FHWA Mobile Asphalt Mixture Testing Laboratory and the NCAT Mobile Laboratory conducted testing during the project in addition to Pace Construction and Missouri DOT. FHWA concentrated on evaluating WMA using the new Superpave Performance Tester. NCAT conducted testing in support of the FHWA WMA Technical Working Group data collection plan.

There has been some concern that WMA samples reheated for testing by the agency may produce different volumetric properties than samples compacted on site without reheating. Figure 2 shows comparison testing of laboratory air voids performed by NCAT at the plant site and then on reheated samples. The results in Figure 2 represent the average of six gyratory samples. Only reheated samples were tested for the Aspha-min zeolite. The data indicates little difference between the air voids of gyratory samples compacted on site and the reheated gyratory samples. Contrary to expectations, the reheated samples generally produced slightly lower air voids.

TABLE 1. In-place air voids, Hall Street WMA project

WMA Technology	Field Compaction Temperature, °F	Construction Air Voids, %	6-Month In-Place Air Voids, %
Aspha-min®	250	5.1	3.1
Evotherm®	225	7.2	3.9
Sasobit®	225	8.8	5.5

NCAT later tested the gyratory samples compacted to Ndesign in the Asphalt Pavement Analyzer (APA). The samples were tested at 64°C, the high temperature climatic grade for St. Louis based on LTPPBind, with a 100 lb vertical load and 100 psi hose pressure. The APA rut depths in Figure 3 represent the average of six samples. One control sample and one Sasobit sample compacted at the plant site exhibited slightly higher rut depths than the reheated samples.

Contamination from unburned fuel is suspected for the higher rut depth in the Sasobit sample produced at 225°F. Similar problems were noted at a WMA open house project conducted by Payne and Dolan in Milwaukee, WI. Payne and Dolan's experience on a later project in Michigan suggests that turning down the fuel pressure resulted in better burner operation at the lower temperatures used for WMA.

Tensile strength ratio (TSR) testing was conducted both on samples produced at the plant and reheated samples. All of the reheated samples except one had TSR values above 80%.

The project was cored and rut depth measurements taken in November 2006, after six months of traffic, including the heat of summer. Rut depth measurements were very small, ranging from 0.3 to 1.1 mm for both the WMA and control sections. A significant amount of in-place densification was noted for some of the WMA sections (Table 1).

Overall, the project looks great. There was no evidence of bumps in the WMA sections. WMA technologies appear to have a lot of promise. Pace Construction went on to use WMA on two additional projects in 2006.

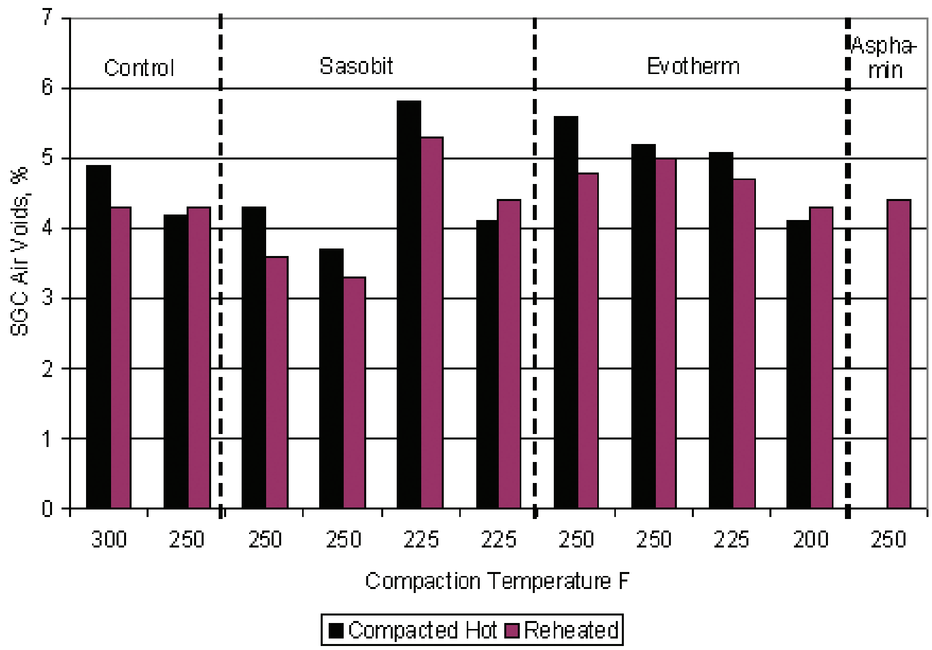


Figure 2. SGC air voids for Hall Street WMA project.

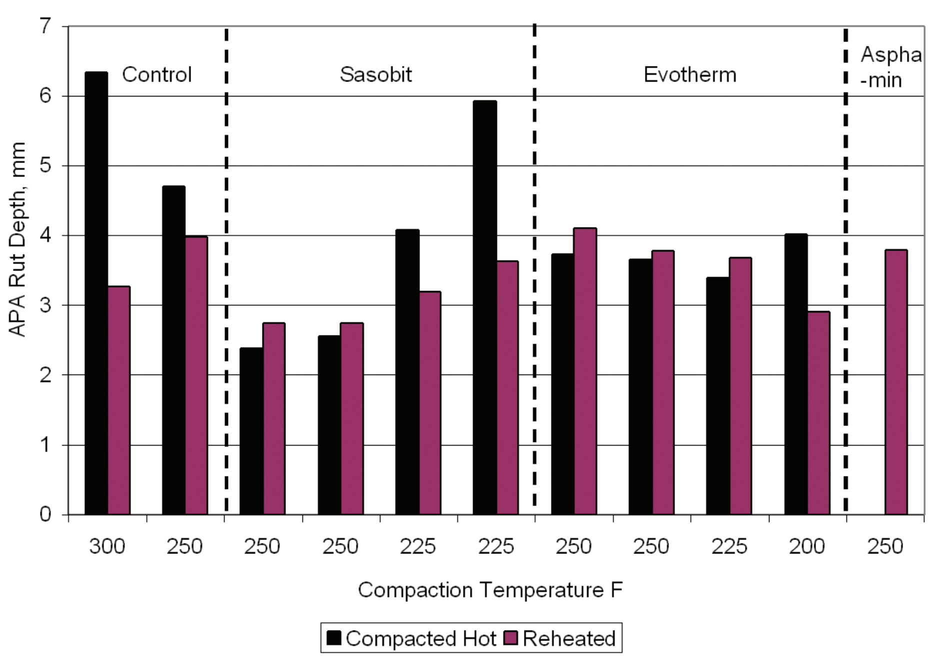


Figure 3. APA rut depths for Hall Street WMA project.

Continued from page 3

John D'Angelo, of the FHWA Office of Pavement Technology, expanded on FHWA's recycling program. FHWA recommends the use of RAP in hot mix asphalt to make the biggest impact, but other uses, like cold in-place recycling, should also be encouraged. FHWA plans to continue research on recycling and form a RAP Technical Working Group to guide future FHWA activities.

Don Brock, Chairman and CEO of Astec Industries, reviewed the progress of hot mix plants from the early 1900's to today. Today's plants offer much better control of the materials and products. Improved plants can "take the RAP apart and put it back together" to control the gradation and reduce segregation. Reuse of RAP can yield substantial cost savings and improve performance.

Reid Banks, President of Banks Construction Company, then outlined some plant processing techniques his company has utilized to maximize RAP use. Their processing of RAP has evolved over the years from a lump crusher at the cold feed bin, to an in-line crusher at the screen deck, to a stand alone crusher and finally to a mobile screening plant. This gives improved separation of the RAP into different size fractions; in fact, Banks said they have tighter control on their RAP gradation than their virgin aggregates.

Mixes to Reduce Costs

Rebecca McDaniel, Technical Director of the North Central Superpave Center (NCSC), then summarized the key points of designing HMA mixtures with RAP. The overall goal is to produce a mix with properties and performance as good as or better than virgin mixes. McDaniel also provided some preliminary findings of an FHWA funded research project underway at the NCSC and Heritage Research Group. The findings to date suggest that with some combinations of materials and plants, it may be possible to use higher percentages of RAP before changing the virgin binder grade. Additional testing of different RAP sources and different hot mix plants is being planned for the Spring.

Next, Paul Lum, from Lafarge Canada, discussed using roofing shingles in HMA and SMA. He noted that recycling shingles not only reduces waste but can also provide benefits to the hot mix. The fibers in the shingles act as reinforcement, reducing cracking and rutting. He then offered practical pointers for success, such as shingles shred better in cool weather and mixing about 15% natural sand into the shingle pile helps to keep them from clumping together.

Kent Hansen, NAPA Director of Engineering, reported on how choosing the right mixture for the right application can conserve resources and save money. NAPA's Pavement Mix Type Selection Guide provides definitions of traffic levels and suggests appropriate mix types and materials for the different courses of the pavement based on those levels. Depending on the traffic and type of distress on the existing pavement, thin lifts may be appropriate, which can result in significant cost savings. It is important to recognize, however that thin lifts cannot repair significant cracking or structural deficiencies.

Gerry Huber, Associate Director of Research at Heritage Research Group, then discussed the use of large stone mixes as one option for saving money without sacrificing quality. Because of the large size of the aggregate, less energy is needed to crush the rock, plus there is less surface area to coat with binder. Huber showed examples of the energy required to crush aggregate to different sizes, showing that the amount of energy increases dramatically as the aggregate size decreases.

Larry Michael, a consultant who worked for many years with the Maryland State Highway Administration, outlined the appropriate use of modified binders. He noted that modifiers would not make a poor mix design good, but when used appropriately can help reduce rutting and cracking. He gave some examples of cases where modifiers were specified but not needed, such as a low volume county road and rural interstate SMA. Modifiers tend to require higher mixing and compaction temperatures, which increase energy usage and cost.

Roger Brown, Vice President of Pace Construction in St. Louis, reported on his experience with Warm Mix Asphalt and RAP. He noted that there are some economic impacts for contractors. The additives can increase mix costs by $2.50 to $10.00 a ton, but can be partly offset by reduced burner fuel usage and the benefits of longer hauls and an extended paving season. (See the article on the Missouri Warm Mix Asphalt trial on page 8 for more information.)

Energy Efficiency

The second day's presentations focused on energy efficiency. Malcolm Swanson, from Astec Industries, discussed the use of alternate fuels to reduce costs. While No. 2 diesel, natural gas and propane are the traditional fuels used by the hot mix industry, recycled oils, biodeisel, coal and even vegetable oil are viable options. Swanson outlined steps to take to use recycled fuels efficiently, including keeping the incoming oil and the burner clean, lowering the excess air and preheating the fuel. Coal is overall the most economical fuel available and can cut fuel costs in half. In some areas, however, permitting a coal fired plant may be difficult due to higher emissions. Swanson concluded that there is no single best fuel for all applications; cost, availability, maintenance impacts and environmental issues must be considered.

Tony Limas, Granite Construction, offered some hints on stockpiling practices to reduce drying costs. He said that reducing stockpile moisture reduces the cost of drying the materials, increases production, lowers paving costs, and lowers maintenance and fuel costs on the loaders. At one plant, paving the stockpile area reduced moisture in the washed sand by 10%, resulting in great savings.

Next, Bill Garrett of Meeker Equipment provided an overview of energy conservation measures for hot mix plants. Simple steps can save energy throughout the system. For example, sloping stockpiles towards the north and picking off the south side, if possible, allows for gravity and the sun to help dry the aggregates. Insulation of the drum, supply lines, liquid storage, etc., also conserves energy. Seals should be kept in good condition to prevent heat loss. Meeker had many other suggestions as well.

Lastly, Buzz Powell from NCAT reported on energy savings they have observed through the construction and trafficking of the NCAT track. During trafficking at NCAT, the trucks travelled about 34,000 miles per week, giving them many opportunities to investigate ways to improve fuel economy. For example, they confirmed that better maintained vehicles have better fuel economy. They also demonstrated that tire rolling resistance is higher in sections that are rougher or have high friction surfaces. They have also explored the use of alternate fuels; synthetic diesel performed well and was clean burning. The aerodynamics of the trucks can also impact fuel efficiency.

The workshop demonstrated that there are opportunities to conserve fuel and resources at nearly every step in the process of producing and placing hot mix asphalt, usually while saving money at the same time, In this time of rising fuel prices and reduced availability of petroleum products, it is important to capitalize on these opportunities.