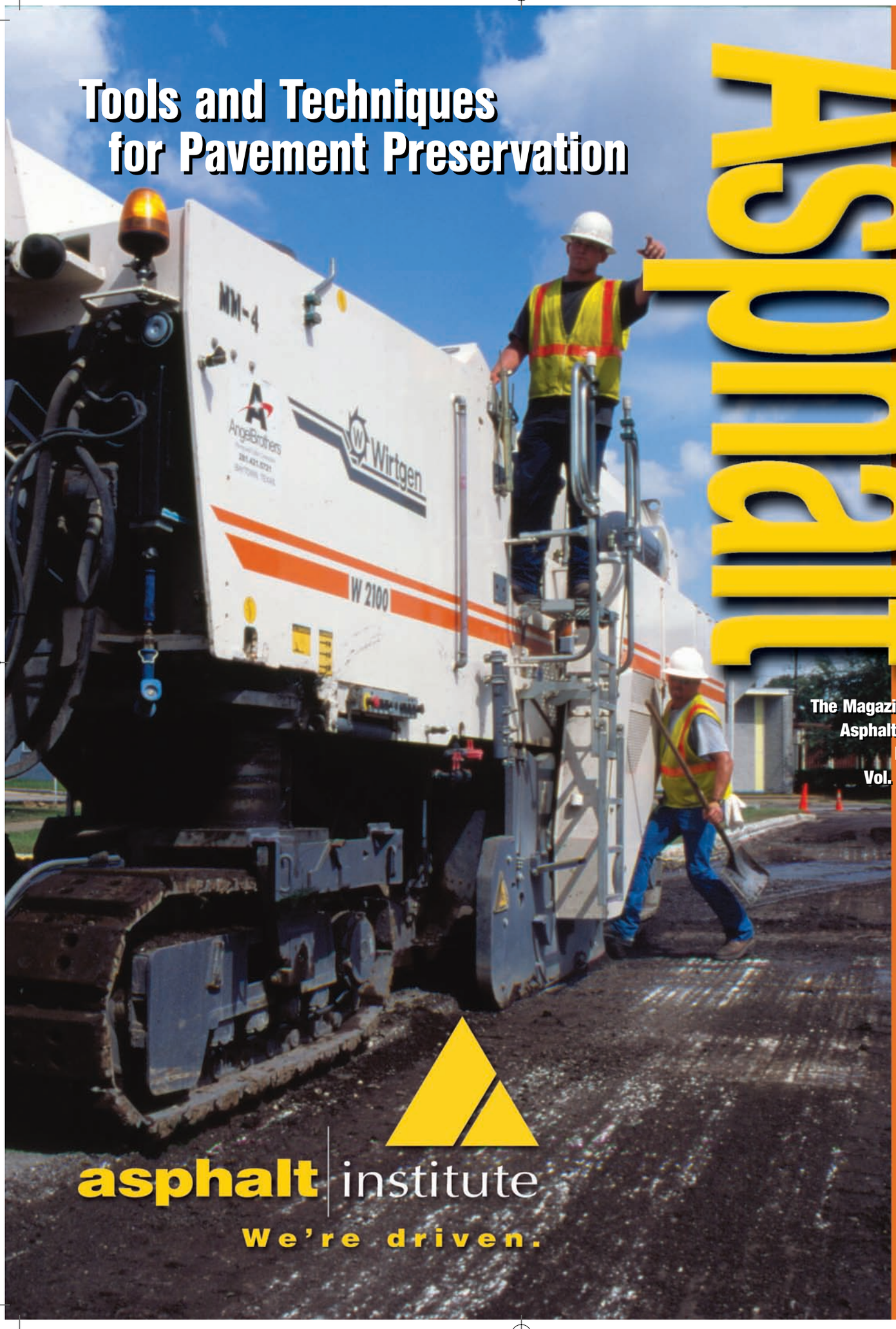
# Asphalt

## Tools and Techniques for Pavement Preservation

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asphalt institute

We're driven.

Asphalt Lab Corner

# Proficiency Sample Program for Roofing Asphalt Binders

**The Asphalt Institute's lab is available to perform research, testing and training.**

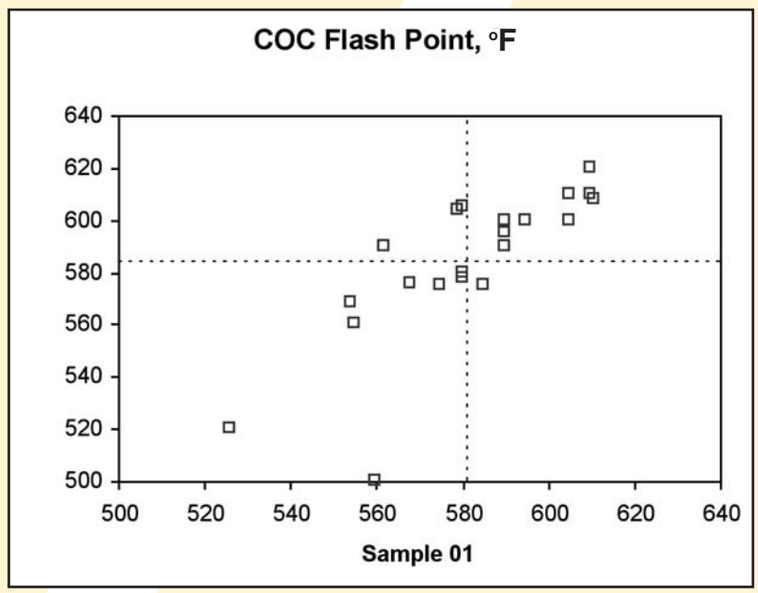
For many years, the AASHTO Materials Reference Laboratory (AMRL) has conducted proficiency sample programs for a variety of tests related to highway materials. Using the data generated in these programs, the appropriate between-lab reproducibility of a specific test could be determined. This estimate of variability has helped testing labs understand why another lab, such as a state highway agency's lab, could have a seemingly different, and possibly failing, result even though the testing lab's result passed the specification.

Starting in 1999, Paramount Petroleum Corporation initiated a similar program for roofing asphalt binders based on the tests in ASTM D312, *Standard Specification for Asphalt Used in Roofing*. In 2005, the Asphalt Institute became involved with the operation of the proficiency sample program. The price for the 2005 program was established at $270 for each set of two samples.

This year's program started in June with each participating lab receiving two individual pint containers (Sample 01 and 02) of roofing asphalt binder. Participants were asked to perform four tests – Ring and Ball Softening Point (ASTM D36); Cleveland Open Cup Flash Point (ASTM D92); Penetration at 77°F (ASTM D5); and Rotational Viscosity at 400°F (ASTM D4402) – on each sample and provide results back to AI by the end of July. AI then analyzed the data and returned a report to the participants in early September.

A survey is currently being conducted to provide feedback on the proficiency sample program. Responses to questions regarding the clarity of the data form and instructions, best and worst time of year for the program, and participant cost will help shape the program details for the future. It is expected that the proficiency sample program will better help labs to understand the appropriate testing reproducibility of some common tests for roofing asphalts.

For more information on the Asphalt Institute's Proficiency Sample Program for Roofing Asphalts, please contact either Shay Emmons, Program Manager (semmons@asphaltinstitute.org) or Mike Anderson (manderson@asphaltinstitute.org).




*This scatter diagram illustrates the variability of test results obtained for the flash point of two roofing asphalt samples.*

**FOR LAB SERVICES CONTACT MIKE ANDERSON AT MANDERSON@ASPHALTINSTITUTE.ORG**

## Moisture Sensitivity and Antistrip Compatibility

For acidic aggregates such as granite, PPA typically enhances the moisture resistance of the asphalt mix, possibly to a level where an antistrip additive may not be required. When an amine-based antistrip additive is used, a partial neutralization between the PPA and the antistrip can occur, possibly leading to a partial loss of the increased binder stiffness ($G^*/\sin \delta$) achieved from the PPA modification. According to recently published research, this partial neutralization does not affect the improved binder-aggregate adhesion properties from the addition of antistrip.

The partial neutralization that may occur is dependent on the nature of the asphalt, aggregate and antistrip, and may be avoided by correctly formulating the mix with a compatible antistrip. One class of antistrip chemicals known as phosphate esters does not react with PPA functionality, so they are effective in both conventional and PPA modified binders.

## Summary

PPA modified binder has no additional safety issues beyond those of neat asphalt. However, PPA by itself is a corrosive agent, so the Material Safety Data Sheet information should be reviewed carefully.

The improvements realized with the addition of PPA are not the same with all asphalts. As with most modifiers, the interaction is dependent on the asphalt's chemistry (aromaticity, asphaltene content, etc.). PPA modified mixtures are generally resistant to moisture degradation or can be made moisture resistant through the use of appropriate antistrip additives.

Good communication between the asphalt supplier, contractor and agency regarding potential use of amine-based antistripping agents is necessary. This is because under certain conditions, PPA may react with some liquid amine antistrips leading to a partial decrease of the PG high temperature improvement realized with PPA modification. Correct formulation is required to address the effects of amines on binder stiffness. Binder testing, especially for stiffness, is recommended both before and after the addition of antistrip.

Mixture testing may also be used to evaluate moisture susceptibility. Tests, such as AASHTO T-283 or any suitable under water wheel tracking test, can be used as an additional assurance of compatibility and performance.

*Mark Buncher is Director of Field Engineering for the Asphalt Institute.*

# Polyphosphoric Acid Modification of Asphalt

*By Mark Buncher, Ph.D., P.E.*

*The Asphalt Institute supports the responsible modification of asphalt materials for improved performance and better life cycle costs, without endorsing any specific or proprietary form of modification.*

Polyphosphoric acid, or PPA, is a liquid mineral polymer and just one of many additives used to modify and enhance paving grade asphalts. It is the Asphalt Institute's position that the correct use of PPA, in the appropriate amount, can improve the physical properties of bituminous paving grade binders. On the other hand, incorrect application of PPA technology can result in construction or performance problems.

When used in combination with a polymer, PPA provides flexibility in reaching the requested test specifications (Dynamic Shear Rheometer, Elastic Recovery, etc.) while limiting the increase in asphalt viscosity at 135°C (275°F).

To assist agencies in making informed decisions, the Asphalt Institute recently published Informational Series (IS) 220, *Polyphosphoric Acid Modification of Asphalt.* The purpose of this educational document is to clarify the issues regarding acid modification, particularly, PPA modification. This article provides some highlights of IS-220.

## Orthophosphoric Acid versus Polyphosphoric Acid

It is important to understand that there are major differences between the two generic acid types, and how they behave in asphalt. Orthophosphoric acid, which includes purified phosphoric acid, is not recommended for use in asphalt modification. Orthophosphoric acid has approximately 15 percent free water content which creates poor miscibility in asphalt and leads to separation issues. The free water also leads to corrosion problems when the orthophosphoric acid is blended in asphalt and stored in steel tanks.

PPA, on the other hand, has no free water allowing a total miscibility with asphalt. The PPA blended with a neat or polymer modified asphalt does not create any binder storage issues such as separation or corrosion.

## Literature and Presentations

The first patent describing asphalt modification using PPA was published in 1973. Since the early 1990s, PPA has also been used in combination with various polymer modifiers to enhance the quality of paving grade asphalts.

Concerns by some users within the bituminous supply and paving sectors regarding the performance quality of acid modified binders have resulted in numerous studies by researchers. The process of orthophosphoric and PPA modification has been examined as well as their impact on asphalt and hot mix asphalt mixtures. The IS-220 publication summarizes nine technical papers that have been published since 2001 on the topic of acid modification. The Federal Highway Administration is currently conducting a study at their Turner Fairbanks Research Center on the use of PPA and other acids in asphalt.

In addition to the nine published papers, IS-220 also provides a partial listing and summaries of many recent formal presentations at events such as a one-day symposium on acid modification hosted by the Rocky Mountain User Producer Group (March 2003), a symposium on predicting pavement performance sponsored by the Western Research Institute (2004), and the annual Petersen Conferences.

## Effects on High and Low Temperature Performance

PPA can be an effective and economical tool for chemical modification, used alone or in conjunction with a polymer. PPA can improve the high temperature PG grade, and with some asphalts may improve the low temperature PG grade. This modification does not oxidize the asphalt, thereby avoiding the low m-value issues that have been associated with binder brittleness at low temperatures. PPA chemically modifies the asphalt as a result of irreversible and sometimes partially reversible reactions. Two main reactions may be considered—phosphate ester formation (irreversible reaction) and acid-basic neutralization (reversible reaction).

Although the oxidation of some petroleum compounds is known to be catalyzed by strong acids, such mechanisms have not been found for PPA modified bitumens. Comparison of Dynamic Shear Rheometer measurements after short-term and long-term lab aging, chromatography results and infrared data all indicate there is no accelerated aging of PPA modified asphalt as compared to the neat asphalt.

both at the plant as well as at the paving site, and analysis tools helped reduce cycle times and minimize truck usage.

### Plant to Office Communication

Up to this point, plant to office communication had been limited to crude file exchanges in which most systems were merely capable of sending a file of tickets back to the office at the end of the day. Some systems could also accept replacements of entire data files from the office. But, in 1997, the first online gateway between office and plants was introduced to provide seamless, real-time integration of plant production data with office accounting and management information systems.

Multiple plants could all be in sync with the headquarters. Office personnel had the ability to access company-wide production and operational data to manage logistics, answer customer questions and plan production.

### The New Millennium and Beyond...

In 2002, the first asphalt automation system with highly configurable software was introduced to the industry. For years, custom requests meant custom programming at the producer's expense. Now, software has been introduced that can be configured to meet the exacting requirements of the users without programmer involvement. Producers have the ability to mold the system to their unique business processes. This includes the ability to add data fields, lay out printing on delivery tickets, add or modify reports, add special logic, create their own pricing schemes, etc.

Whereas custom software had the effect of locking producers out of new versions, the configurable and modular design of today's software allows users to receive new releases and features.

New office software utilizes open database architecture, such as open database connectivity, to allow seamless integration with virtually any office application. Customer and job changes are automatically broadcast to all plants and transactions are automatically retrieved and invoiced.

The technological advancements in automation and plant to office integration have brought about many changes to our industry. Thankfully, they have all been integral in helping producers to improve quality, maximize productivity, provide valuable management information and realize greater profits.

*Kenneth Cardy is president of Libra Systems Corporation, based in Harleysville, Pennsylvania, www.librasystems.com.*

and smaller, dedicated systems added more and more capacity without increasing the physical size of the controls.

## The 1980s

The ’80s brought about the personal computer revolution, and in 1984 the first PC was used to control an asphalt plant. Computers were everywhere and the ability to interface the office with the plant was a logical step to eliminate handwritten administrative functions. Prior to building the communication interface between office and plant computers, information generated at the plant had to be re-entered into the office computer. This was often time-consuming, expensive and prone to error.

Background communications to the plants were introduced in 1989. Background means that another task can be occurring and be invisible to the plant operator. More specifically, the plant operator could be running the asphalt plant with all of its requirements, and at the same time the office could call in and update files, retrieve data or generate reports. Office tasks became completely invisible to the plant operators and did not interfere with their work.

Multi-tasking environments were also introduced to the industry during this period. This technique allows many tasks to occur virtually simultaneously. For example, operators could simultaneously mix material in the batch tower, load material out of the silos and access the database files without performance degradation.

## The 1990s

Memory constraints were no longer a concern in the early ’90s. With the rapid technology advancements in the PC industry, producers could easily store information about customers, products and thousands of trucks.


***Graphical user interface (GUI) for control of an asphalt plant***

Microsoft Windows® paved the way for the first graphical user interface to be introduced for control of an asphalt plant. The use of animated pictures and “live” graphs to depict real-time trends aided operators in quick problem detection and response.

While radio frequency identification technology had been around for some time, the mid-’90s saw the asphalt industry utilize this technology to solve truck management issues. Truck waiting times were monitored,

# Evolution of Asphalt Plant Automation

BY KEN CARDY

Today, plant automation plays many roles in a hot mix asphalt producer's enterprise. Plant automation must support real-time management decisions by providing up-to-the-minute company-wide data, accessible from anywhere.

Plant automation must allow management personnel to control business data in real time, while allowing operators to concentrate on running plants. It must mold itself to fit the unique business processes of the producer without requiring the custom programming that has stunted the agility of past systems.

## Prior to 1970

Early asphalt plant automation was entirely electromechanical. This meant the controls for the plant were based on what is known as relay logic.

These controls were composed of relay switches which, being mechanical, wore out quickly. The switches were very susceptible to heat, dust, moisture and other natural elements, making them unreliable. Early controls were very large and required a lot of control-room space. They were extremely heavy and not portable. Although these machines were cumbersome by today's standards, they did increase productivity by speeding up the mixing/loading process.

## The 1970s

With the advent of transistor and integrated circuit technology, controls became entirely electronic instead of electromechanical. Physically, integrated circuits were much smaller than relay switches. The integrated circuits were also faster, but the biggest advantage was their reliability. They used no moving parts and were therefore immune to the mechanical (moving) problems encountered with relay switches.

*EPROM-Based Asphalt Batching System, circa 1977*

During this time, memory in the controls became economically feasible. Cassette tapes became a popular choice for memory because of their capability to store information indefinitely. However, the tapes were very susceptible to dust, dirt and moisture.

In 1974, the first microprocessor-based control was installed on an asphalt plant. This year also marked the first time that cassette tapes were bypassed in favor of another type of memory storage— floppy disks. The disks were much faster than tapes but, like tapes, they were susceptible to environmental damage.

## EPROM

In 1977, two new types of memory, known as Erasable Programmable Read Only Memory (EPROM) and Read Only Memory (ROM), were introduced. These types of memory were impervious to dust, dirt, heat and even coffee spills. EPROMs were also extremely fast.

In this era, control systems also became much smaller and could fit on a tabletop desk. As integrated circuits grew smaller


***Roadtec's SP-200 Asphalt Spray Paver*** allows asphalt cement or emulsion (tack) to be sprayed directly in front of the asphalt mix before it is laid. Spraying the tack only seconds before the asphalt is laid provides a strong bond between the existing surface and the new pavement, which is especially important with thin overlays. The SP-200 also eliminates the need for separate tack trucks and does away with the inconvenience of tack adhering to tires of other construction vehicles.

*For more information, phone (423) 265-0600 or visit www.roadtec.com.*

The ***Rosco RA-300 Spray Injection Patcher,*** with its one-person, from-the-cab operation makes safely and effectively repairing potholes a year-round activity. The RA-300 features its in-cab controls, full-function spray nozzle with joystick control and front-mounted patching boom and rear-mounted arrowboard for maximum simplicity, effectiveness and safety. Its hydraulic "Patch-on-the-Go" feature allows for patching on the move with no auxiliary power.

*For additional information, phone (704) 966-3358 or email ssimons@leeboy.com.*

***Sakai America's Vibratory Rubber Tire Roller, the GW750***, has a 77 inch rolling width, over 13,000 pounds centrifugal force per axle and a total force equal to that of a 55,000 pound pneumatic roller. Like double drum steel vibratories, the new roller offers four different amplitude settings to suit the application. The roller can also run static, like a conventional pneumatic roller. The machine itself weighs just over 20,000 pounds, providing a considerable amount of force from a relatively small package.

*For more information, phone (800) 323-0535 or email d-brown@sakaiamerica.com.*

The ***Wirtgen W 2000*** from Wirtgen America is a high-performance, large-volume, compact milling machine with broad cutting width for removing deteriorated asphalt pavement or complete roadway structures down to 13 inches in a single pass. The W 2000 boasts a 565 hp engine and features front loading of RAP for ease of operations. It has a base cutting width of 79 or 87 inches, can operate at speeds up to 180 fpm, and has an operating weight of approximately 64,000 pounds.

*For more information, phone (615) 501-0600 or visit www.wirtgenamerica.com.*

# Asphalt Product Showcase


The ***Bearcat 501 Asphalt Distributor*** features several innovations. The internal poppet spray valves are immersed in hot asphalt, providing instant spray when valves open. Uniform spray patterns are assured and clogs are eliminated. The wings break away both forward and backward to prevent damage. Limit switches prevent accidental spray when wings are in the upright position. The Computer Rate Control system controls the asphalt pump and monitors truck speed, distance traveled, flow rate and spray bar width.

*For additional information, phone (520) 684-7851 or email bearcat@primenet.com.*

***Etnyre Chip Spreaders*** are designed to spread aggregate in the chip seal process. The spreaders feature controlled application rates and have individual one foot wide power gates across the entire spreader width. Engine options range from 200 to 240 hp and the chip spreaders are available in front wheel or four wheel drive models.

*For more information, phone (800) 995-2116 or email sales@etnyre.com.*

***RoadArmor High Performance Chip Seal*** is a single pass surface treatment developed for cost-effective pavement preservation with low user delays. It is designed for high traffic roads in good condition but with minor surface distresses. A new ultra-fast setting polymer modified emulsion is used with a single-sized aggregate in a continuous synchronized application. RoadArmor surfacing means quick traffic return, reliable performance, and low risk of vehicle damage.

*For additional information, phone (918) 388-8100 or email info@semgrouplp.com.*

The patented ***Ray-Tech Joint Heating System*** effectively eliminates longitudinal cold joint failure by providing 98-100 percent density at the joint. The infrared heating system is capable of in-depth heating of longitudinal joints without burning or damaging the asphalt. This complete system is a proven, effective method of eliminating joint failure.

*For additional information, phone (800) 884-2072 or email info@raytechinfrared.com.*

chairman of numerous subcommittees. He was chairman of the *Use of Waste Materials in Hot Mix Asphalt Symposium*, for which he received the Award of Merit and the 2003 ASTM Charles B. Dudley Award.

Fred is a lifetime member of the Association of Asphalt Paving Technologists and served as its President in 1994. He has also been an active participant in the Transportation Research Board for 35 years.

**How did AI most help the asphalt industry?**

After working in the asphalt industry for 50 years, Fred has some perspective on its achievements and also on its current needs. And he has a good fix on AI's contributions. "I think the Institute has contributed significantly to the development of good pavements and to long-term pavement performance," stated Fred. "And more than any other organization, I believe AI deserves credit for developing and promoting Superpave."

As for the current needs of the industry, Fred believes that "long-term pavement performance is still the biggest challenge. Fifteen or twenty years ago, we built asphalt pavements that would last 8 to 12 years, now we need to build them to last 15 to 20 years."

**What are you doing nowadays?**

"I just finished overseeing the construction of a 110-space parking lot for a U.S. Post Office facility," says Fred. "We used the right mix, the right structural design and it turned out to be one of the most successful jobs I have seen."

Several years ago, Fred spent 15 months as the volunteer construction supervisor for his new Baptist church building. Upon completion, the congregation grew so fast that another building was built to accommodate the rapid growth. Fred oversaw the construction of that building too.

"A few years ago, I had the pleasure of overseeing the design and paving of a new parking lot for our church." said Fred. "We built it right. We specified 6 inches of aggregate base course and 2 inches of I-2 hot mix asphalt. The only maintenance expense on that lot has been for re-striping."

Even at age 78, Fred has really not retired from his asphalt career. "The first six years after retiring from the Institute, I worked 60 hours a week," says Fred. "Now I've slacked off to about 40 hours a week. But next year, as I told my wife Phyllis, I think I really might retire."

# WALLER

## *Asphalt Engineer Par Excellence*

Fred Waller's long, distinguished career with the asphalt industry began when he enrolled at North Carolina State University (NC State) at the age of 16. "I was first introduced to asphalt right in the middle of World War II," said Fred. "I wanted to enlist the day I turned 17." He hoped to be a fighter pilot but ended up at boot camp and aerial gunnery school.

When the war ended, Fred went back to NC State and graduated with a B.S. in Civil Engineering and an officer's commission in the U.S. Air Force. The North Carolina DOT hired him and asked him to start an asphalt laboratory. At the time there were very few asphalt labs. Most mixes were put together based simply on experience.

Fred created an asphalt laboratory and NCDOT hired Bruce Marshall of Marshall Mix Design fame to train him. The Marshall procedure at that time used 50 hammer blows and a manual hammer.

### The Waller I-2 Mix

"I was developing NCDOT's lab about the same time the Interstate program began," says Fred. "We were experiencing a lot of failures with our Interstate surface mix because of increasing traffic and heavier loads. It was obvious we needed a better mix. My boss called me in and told me that I had one week to design a new surface mix or I was fired.

"Well, I had been working on a new surface mix, so when the boss called me back in after a week, I was ready. He looked it over, tested it, and said, 'We're going to accept this mix and use it.' " Fred traveled all over the state for NCDOT working with contractors to get them familiar with the new mix.

NCDOT later gave Fred a special award for his work on that mix. The agency used it for 40 years, until they started using Superpave. Even now, the I-2 mix is used for many local applications.

### Humble Oil

After 11 years with NCDOT, Fred joined the Asphalt Division of Humble Oil (later Exxon), serving Virginia and West Virginia. Fred did such a good job that Humble offered him a job in a big office in the Humble building on Times Square in New York City. "Only thing was," said Fred, "I would have had to travel all over the U.S. and I had three little boys at home that I wanted to see grow up. I didn't take that New York City job but I did go to work as an asphalt consultant for Miller-Warden when they moved their office to Raleigh, North Carolina."

### Asphalt Consultant

While Fred was with Miller-Warden, he led five key projects with the National Cooperative Highway Research Program (NCHRP). The projects involved the proper use of aggregates and aggregate stockpiling. The purpose of one NCHRP contract was to find the most efficient method of building an aggregate stockpile and feeding the aggregate into the hot mix plant. Fred took 3,000 pounds of aggregate, colored it and screened it into four different sizes, then photographically traced the colored aggregate to show how it would flow down the stockpile.

"Even back in the 1960s, we were trying to build stockpiles to avoid segregation. The NCHRP study was the first to measure and demonstrate how to minimize segregation. We found out it was better to use a system that built stockpiles in layers rather than building them with a conveyor," explained Fred. While at Miller-Warden, Fred also helped rewrite the pavement specifications for the District of Columbia.

After seven years with Miller-Warden, Fred was called back into active duty for the U.S. Air Force during the Korean War. After 6 and a half years with the Air Force and reaching the rank of Colonel, Fred went to work for Troxler, developing and promoting soil testing equipment. Later, Gerry Triplett, then president of the Asphalt Institute (AI), talked him into coming to work for the Institute.

### Asphalt Institute

"I worked for the Asphalt Institute for 19 and a half years," said Fred, "and I enjoyed every week of it." One of the significant contributions Fred made while he was there was writing the *Asphalt Emulsion Manual*. Fred researched and wrote the entire manual with the help of the Asphalt Emulsion Manufacturing Association and FHWA. After writing the manual, Fred went all over the U.S., developing emulsion seminars.

While Fred was at the Institute he saw a need for practical guidelines for repairing utility cuts with asphalt, so he developed an extensive slide show training program for AI field engineers.

During his career with the Institute, Fred was active with a host of asphalt industry organizations. He is still an active participant in ASTM Committee D-4 on Road and Paving Material. During his 45 years of membership with ASTM, he served as


***Crack sealing prior to applying a surface treatment reduces moisture damage.***

situations and is more cost-effective, making it a good choice, so long as quality materials are used.

## Rejuvenating Pavements

Pavement rejuvenators are applied to existing aged or oxidized HMA pavements in order to restore pavement surface flexibility and to retard block cracking. Emulsified sealers, binders and rejuvenators are used in pavement preservation to protect oxidized asphalt surfaces or actually penetrate and rejuvenate them.

The oxidative aging of pavements begins at the time of construction and continues throughout a pavement's life. However, most aging occurs within the first two to four years of service life. This results in the top half-inch or so of the pavement surface becoming more brittle than the underlying material due to the actions of water and environment. This can result in raveling and/or premature cracking, which begins at the pavement surface.

Rejuvenators are formulated to penetrate into the pavement and then enhance the properties of the asphalt binder of the existing pavement. These treatments are most commonly used in the western states where ultraviolet exposure appears to promote greater oxidation. Treatments can begin immediately after construction but more typically occur many years later when some form of distress is observed.

## Slurry Surfacings

A slurry surfacing, also known as a slurry seal, is not the same as a chip seal. Instead, it is a mixture of aggregates dispersed in an asphalt emulsion and applied in a slurry state. It is usually a mix of polymer-modified emulsion and fine crushed aggregate that is spread simultaneously in one pass over the street at a particular thickness. The slurry cures as the water evaporates, leaving only the asphalt to coat the aggregate.

Slurry surfacings are designed in a lab, are proportioned by a slurry machine, and laid down and cured so the asphalt-to-aggregate ratio is maintained at the optimum value to assure uniform aggregate coating and adhesion. Such friction courses use very large fractions of fine material, giving a very high surface area and a lot of microstructure, leading to a sandpaper surface and a high skid resistance while maintaining a smooth finish.

A variant of the slurry surfacing is microsurfacing, which is a mix of polymer-modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, which is proportioned, mixed, and spread on a paved surface. Microsurfacing differs from slurry seal in that it can be used on high volume roadways to correct wheel path rutting and provide a skid-resistant pavement surface.

## HMA as a Preservation Treatment

For severely distressed surfaces, thin HMA overlays will provide a like-new surface, prolong pavement structure life, and make a pavement stronger for only an incrementally higher expenditure than competing surface treatments like chip seals or slurry surfacings.

For many roads and streets the best preventive maintenance strategy may be a thin HMA overlay. This thin (0.5 to 1.5 inch) surfacing combines the best attributes of HMA's strength and smoothness with a low cost that makes maintenance dollars go farther. Aesthetically, the overall impression is of a brand-new road, at the price of a thin overlay. Other benefits include HMA's trademark quiet pavement and smooth ride.

*Tom Kuennen is principal of ExpresswaysOnline.com, Buffalo Grove, Illinois.*

*Pavement preservation is promoted by the National Center for Pavement Preservation (NCPP) at Michigan State University, and the Foundation for Pavement Preservation (FP²), both of which maintain that the key to optimized pavement life is the application of the "right treatment, to the right pavement, at the right time". NCPP and FP² are allied with the Office of Asset Management of the Federal Highway Administration in expanding pavement preservation and transportation asset management among state, county and municipal road agencies.*

*This article covers some of the basic techniques for pavement preservation. However, space did not allow for inclusion of all of the preservation options. Future articles will cover such techniques as hot-in-place recycling and cold-in-place recycling.*

surface treatment in which the pavement is sprayed with asphalt and then immediately covered with aggregate and rolled. Chip seals are used primarily to seal a pavement with non-load-associated cracks, and to improve surface friction. They also are common as a wearing course on low volume roads.

The asphalt binder can be modified with a blend of ground tire or latex rubber, or polymer modifiers, to enhance the elasticity and adhesion characteristics of the binder. A variant of the chip seal is the fog seal, a light application of slow-setting asphalt emulsion diluted with water, and without the addition of any aggregate applied to the surface of an asphalt pavement. Fog seals are used to renew aged asphalt surfaces, seal small cracks and surface voids, or adjust the quality of binder in newly applied chip seals.

A cape seal is a combination of a chip seal and a slurry surfacing or seal. For paved roads, the chip seal is applied first and, between four and 10 days later, the slurry seal is applied. For unsurfaced roads, an application of MC-70 or SC-70 cutback asphalt is applied first as a prime coat, followed about two days later by a chip seal and about two weeks later by a slurry seal.

## Joints, Cracks and Potholes

In advance of any surface treatment, pavements are prepared by sweeping and sealing the joints and cracks. "It is critical that all necessary preparation work such as crack filling, pothole repair, patching, leveling, and dig-outs be done prior to surface treatments being placed," reports the California Department of Transportation (Caltrans).

Caltrans says crack filling and sealing is its first line of defense in roadway maintenance. Caltrans urges that cracks 1/4 inch or wider be filled or sealed before rainy seasons or before the application of maintenance surface treatments such as fog seals, sand seals, slurry seals, chip seals or maintenance overlays.

Potholes are bowl-shaped holes of various sizes which are associated with pavement fatigue and poor drainage. Highway departments can minimize potholes by keeping water out of the base material. Water weakens pavement support and contributes to frost heave and cracking.

A long-term study that began under the Strategic Highway Research Program, and continued under FHWA's Long-term Pavement Performance program, found that for patching potholes, quality of materials is more important than method or machine. The use of quality, even premium, materials is the utmost variable in effective pothole patching. The throw-and-roll technique proved as effective as the semipermanent procedure in most


*Chip seals have been used for decades to preserve riding surfaces.*

Three varieties of liquid asphalts are used in conventional surface treatments.

- Liquid asphalt cement is used to construct chip seals in regions that have very hot weather. The asphalt cement is shot at high temperatures where it flows well and accepts chips readily. A fairly warm pavement surface is required so the asphalt does not cool off too quickly before placement of the chips.
- Cutback asphalts are blends of asphalt cement with solvents, which make the asphalt cement fluid for spraying or mixing. The solvents then evaporate, leaving the base asphalt cement in place to bind the rock. Solvents used include gasoline for rapid-curing, kerosene for medium-curing, and diesel fuel for slow-curing cutbacks. The use of cutback asphalts, once common for chip seals, has declined considerably because of environmental restrictions on hydrocarbon emissions from evaporating solvents in specific regions around the country.
- Emulsified asphalts are an emulsion of very small asphalt cement particles held in suspension in water with the use of an emulsifying agent. Like cutback asphalts, emulsified asphalts come in rapid-, medium-, and slow-setting grades for different uses. The various grades are developed through the use of different emulsifying agents and the addition of some solvents. These asphalt particles are either anionic (negatively charged) or cationic (positively charged).

The rapid-setting emulsions are used mostly for chip sealing, while the medium and slow setting grades are used for emulsion mixes or recycling and fog or tack seals. The emulsified asphalt 'sets' or 'breaks' when the asphalt particles precipitate or fall out of the water suspension and coat the aggregates. The emulsion changes color from brown to black during this process.

## Ever Popular Chip Seals

Chip seals have been used for decades to preserve riding surfaces. A chip seal is a

# PAVEMENT PRESERVATION:

BY TOM KUENNEN

## *Techniques for Making Roads Last*

Pavement preservation is a planned system of treating pavements at the optimum time to maximize their useful life, thus enhancing pavement longevity at the lowest cost.

Typically, pavements perform well under loads until a particular point in their life spans, at which time they deteriorate precipitously and rapidly to failure. Experience shows that spending $1 on pavement preservation before that point eliminates or delays spending $6 to $10 dollars on future rehabilitation or reconstruction costs.

Ideally, pavement preservation can mean maintenance of a pavement even when there is nothing apparently wrong with it. "The number one fault of agencies is that they wait until a problem develops before they address it," said Larry Galehouse, P.E., executive director of the National Center for Pavement Preservation (NCPP) at Michigan State University. "Instead, successful pavement preservation demands a pavement that's not in bad shape to start. If the structure is good, we can keep water out of the pavement, prevent oxidation of the asphalt, and maintain good skid resistance. With pavement preservation techniques, we will improve their performance and extend their life."

That approach is directly opposed to the politically popular road management method of "worst-first", in which scarce maintenance dollars are used to provide band-aid repairs to pavements which have gone too far and are failing. Soon after repairs are made, base or pavement failures are reflected through to the surface and the effort has been wasted.

### Strong FHWA Support

In May 2005, the FHWA came out strongly in support of pavement preservation. "Each highway agency faces different challenges in applying pavement preservation treatments and establishing an effective preservation program," said David R. Geiger, P.E., director, FHWA Office of Asset Management. "Preservation involves a paradigm shift from worst-first to optimum timing. Preservation programs must focus on demonstrating benefit, securing commitment of top agency management, convincing the public, and selecting the right treatment for the right pavement at the right time."

According to Tom Deddens of the FHWA's Construction and System Preservation Team, "The goal is to help states assess where they are and provide comments and recommendations on what they can do to further develop and enhance their pavement preservation programs." Those preventive maintenance treatments include crack sealing, chip seals, slurry surfacings and hot mix asphalt (HMA) thin overlays that will bolster ride quality, provide surface drainage and friction, and correct surface irregularities.

### Preservation with Asphalt Treatments

As NCPP's Galehouse implied, a big part of pavement preservation is keeping water out of pavements, and the waterproofing properties of asphalt surface treatments and liquid asphalt mean they take top billing in pavement preservation techniques.

Such pavement preservation practices include crack sealing, patching, fog seals (a combination of mixing-type emulsion and approximately 50 percent water, used to seal shoulders and patches), rejuvenation (application of a rejuvenator agent in a procedure similar to fog sealing), and chip seals (surface treatment in which the pavement is sprayed with asphalt emulsion and then immediately covered with aggregate and rolled).

Also included are slurry seals (an application of mixing-type asphalt emulsion, sometimes with additives, mineral aggregate and proportioned water, mixed and spread on clean pavement free of dirt and loose gravel); microsurfacing (polymer-modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, properly proportioned, mixed, and spread on a pavement); cape seals (application of slurry seal to a newly constructed surface treatment or chip seal); and thin and ultrathin hot mix asphalt overlays (HMA overlay with one lift of surface course, generally with a thickness of 1.5 inches or less).

the MTAG. Upon completing a module, the student will be tested on his understanding of the subject material. A pass or fail grade will be issued based on the test scores. If the student passes, a verification notice will be issued to his employer. If the student fails, he will be instructed to retake the module and repeat the test.

### National Center for Pavement Preservation

In August of 2004, the National Center for Pavement Preservation (NCPP) was created through the partnership of the FHWA, private industry and Michigan State University. The purposes of the NCPP are to:

- Provide technical training related to pavement preservation and management
- Reach out to state agencies and provide assistance in development of specifications and be a repository for technical research related to pavement preservation issues
- Coordinate the research activities of regional or national pooled-fund studies and those research activities undertaken by other regional pavement preservation centers as they develop.

The website of the NCPP is www.pavementpreservation.org. Presently the NCPP is available to teach two courses, *Chip Seal Design* and *Pavement Preservation: Applied Asset Management.*

### Voluntary Assessment Program

The most recent FHWA activity is directed toward assisting the states by providing a voluntary assessment of an agency's pavement preservation program. This assessment program is being implemented through a contract between the FHWA Office of Asset Management and the NCPP. Representatives from NCPP and/or FHWA will meet with the various components of a highway agency—upper management, contract administration, asset management, maintenance, materials and construction—involved with implementation of maintenance of the roadway system.

The assessments will be guided by a set of standard questions regarding the implementation of pavement preservation practices and policies within that state. A report will then be prepared based on the responses to these standard questions. The report will also include general suggestions for improvement, in particular, noting the best practices effectively used in other states. The information obtained from this study will be compiled and placed in a large database that can be accessed by the agencies. Each agency will be assigned a unique identifier that will permit anonymous viewing of the data for purposes of comparison with their peer agencies.

### Conclusion

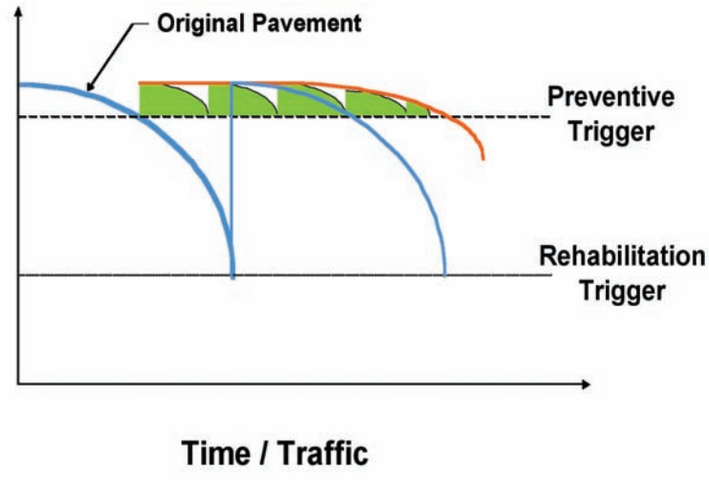
Interpretations of the various FHWA memorandums can lead to significant differences in the manner in which programs are administered among the various agencies. In order to mitigate some confusion, the FHWA has just finalized a document standardizing the use of the various categories of roadway maintenance. It is FHWA's intent to have this "Definitions Statement" endorsed by the AASHTO's Standing Committee on Construction.

The intent of all this activity is to firmly establish pavement preservation as those activities focusing on maintenance of functional surface characteristics of a pavement. The preventive maintenance program is intended to complement expenditures made for capital improvements by providing a strategy to cost effectively prolong the life of pavement systems of the National Highway System. As the mantra says, pavement preservation is about placing the right treatment on the right pavement at the right time.

*Tom Deddens is the Pavement Preservation and Construction Engineer in FHWA's Office of Asset Management.*

## PAVEMENT PRESERVATION CONCEPT

The pavement preservation concept is that an agency can apply a relatively low cost treatment to a pavement surface while it is still "good." After treatment, the pavement will be improved and its life extended for some period of time. Pavement preservation requires a commitment by the agency to apply the preservation activities before significant pavement failure occurs.



thin surface treatments that extend the life of a road, such as crack and joint sealing, chip seals, slurry seals, microsurfacing and thin and ultrathin hot mix asphalt overlays for flexible pavements, and partial and full depth repairs, dowel bar retrofits, and surface grinding of rigid pavements. To be effective, these treatments must be selected carefully and applied before the pavement sustains any structural damage.

## Available Resources

The FHWA's shift to an emphasis on preservation motivated the Office of Asset Management to reach out to the state DOTs and the highway industry through a number of activities. The available research and "conventional wisdom" was previously collected and assembled in a "toolbox" by the Foundation for Pavement Preservation ($FP^2$). The Foundation collected its industry members' technical manuals, brochures, and pamphlets that described the "best practices" for the various preservation techniques. About this time, FHWA and $FP^2$ produced two videos addressing pavement preservation entitled: *Protecting Our Pavement: Preventive Maintenance* and *Preventive Maintenance: Project Selection*. The content of these videos were consolidated later onto a single DVD.

Next, a *Compendium on Pavement Preservation* was compiled and is presently available on the FHWA's Pavement Preservation website, www.fhwa.dot.gov/preservation/. In 2003, a sequel to the toolbox entitled *Pavement Preservation State of the Practice Volume 2* was produced and distributed on CD by $FP^2$.

Due to the popularity of these resources, all the information was compiled on a CD, which is now available from the Foundation for Pavement Preservation.

## Training Efforts

Training is another significant part of this transition. Four courses specifically addressing pavement preservation issues have been developed and are available through the National Highway Institute (NHI).

131054A *Pavement Preservation: The Preventive Maintenance Concept*

131058A *Pavement Preservation: Selecting Pavements for Preventive Maintenance*

131103A *Pavement Preservation: Design & Construction of Quality Preventive Maintenance Treatments*

131104A *Pavement Preservation: Integrating Pavement Preservation Practices & Pavement Management*

A listing of these courses can be found on the NHI's website, www.nhi.fhwa.dot.gov/coursec.asp, under Pavements and Materials.

## Interactive Manual

The FHWA's Office of Asset Management and the Pavement Preservation Expert Task Group are in the process of developing an interactive, online version of a manual originally developed by the California Department of Transportation entitled *Maintenance Technical Advisory Guide* (MTAG). The training will include modules on crack sealing, patching and edge repairs, chip seals, slurry seals, microseals, ultrathin bonded asphalt overlays, and thin overlays. When this project is complete in January 2006, an individual requiring training will be able to access the specific technique at his convenience.

Modules will be taught by referring the students to the corresponding section of

# Tools for the Pavement Preservation Industry


*By Tom Deddens, P.E.*

Over the years, the Federal Highway Administration (FHWA) has changed its emphasis from construction to preservation of the National Highway System (NHS). FHWA is now providing assistance to the state DOTs and the highway industry through a number of new programs.

## History

Historically, preventive maintenance activities have been excluded from federal-aid funding. When President Eisenhower initiated the construction of the Interstate System in 1956, he left the maintenance responsibility of the newly constructed roadway system squarely on the shoulders of the individual state transportation agencies. As the interstate system aged, Congress initiated the 4R Program (resurfacing, restoration, rehabilitation and reconstruction) which funded the activities to maintain the serviceability of the Interstate system. The passage of the Intermodal Surface Transportation Efficiency Act of 1991 created the Interstate Maintenance program and provided funds using the existing 4R equation. A 1993 FHWA memorandum identified any work which provided additional structural capacity, prevented the intrusion of water into the pavement, or any other work that extended the life of the highway, as being eligible for federal funding.

A 1998 memorandum gave state DOTs more flexibility in managing their federal-aid highway program. This memorandum permitted the use of "planned staged construction" for the completion of surface paving independent of other required project modifications. The memorandum simultaneously placed added emphasis on transportation systems preservation and encouraged the state DOTs to properly fund preservation programs without any additional federal assistance.

## New Definition

In October of 2004, a memorandum issued by the Office of Infrastructure now makes preventive maintenance activities eligible for federal-aid funding based on a definition of pavement preservation which was consistent with the AASHTO definition: "… The planned strategy of cost effective treatments to an existing roadway system and its appurtances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without increasing structural capacity."

The memorandum explains that "… projects that address deficiencies in the pavement structure or increase the capacity of the facility are not considered preventive maintenance and should be designed using appropriate 3R standards. Functionally, federal-aid eligibility preventive maintenance activities are those that address aging, oxidation, surface deterioration and normal wear and tear from day-to-day performance and environmental conditions."

FHWA now accepts that pavement preservation is a proactive, long-term strategy to improve pavement performance through a variety of cost effective,

## Is It Durable?

Shively adds that so far his company has not seen any problems with Smoothseal on any of the projects. "We are using Smoothseal in both rural and urban areas. We did a few jobs in southern Ohio, but most of the jobs we've done are in the middle of the state. Some jobs are five years old; some are only two years old. So far we have not heard anything negative."

Finally, Shively and other contractors expect good durability from Smoothseal. "If we use it for its proper purpose, for pavement preservation, to prolong the surface life of roads that are not in need of extensive repair, then we can expect good durability."

Durability is a big question in the minds of city street engineers, says Eric Smith, City Manager of Englewood, Ohio. "We began using Smoothseal and found it was not only more durable, but was also more economically viable. The Smoothseal is lasting ten years, while the slurry was lasting only five. The Smoothseal is thick enough and tough enough to resist reflective cracking. We also found that Smoothseal was less expensive than a conventional HMA overlay.

"We used the Smoothseal on residential streets, usually two-lane residential streets, with an average daily traffic between 200 and 500. Sometimes we used it on collectors, but mostly on residential streets. We put down a 3/4-inch or 1-inch overlay over the entire roadway. We don't use Smoothseal on state roads or interstates. We use a 1 1/2-inch HMA overlay on those."

Smith says Englewood uses Type B Smoothseal exclusively. "We found it works better for our purposes than Type A. Type B takes only two hours to set up, then you can drive on it."

## Problems with Smoothseal?

Smith doesn't see any critical problems with Smoothseal, but he has found the modified mix is highly susceptible to cool temperatures. "When the weather is hot, Type B works well," says Smith. "When the weather gets cooler, like late October, it is hard to work with—it won't compact easily."

Smith says that after paving and rolling, Type B looks as smooth as a billiard table. He adds that even though it looks smooth, there is no problem with skid resistance, even when it rains.

## Future Applications

Smith says that quite a few communities in Ohio are beginning to use Smoothseal. Although community engineers are often reluctant to try new things, Smoothseal is starting to have a wider and wider appeal.

last between 10 and 15 years. ODOT also is placing Type B on the Ohio Test Road (concrete on one side, asphalt on the other) to test its use as an impermeable surface mix that can provide long pavement life.

Both types of Smoothseal can be used as a viable alternative to a conventional HMA overlay. The Ohio Asphalt Pavement Alliance has promoted Type B rather than Type A because it requires less asphalt binder content and is a coarser mix, which improves rutting resistance. Some local agencies that previously didn't consider using Smoothseal are now looking at Type B.

### ODOT Experience

ODOT has had good experience with both types. "I've had more experience with Type A than Type B," says Jim Marszal, ODOT Pavement Engineer in the Cleveland area. "We cover three counties and many of our roads are urban and suburban, and some are rural. In this District, we use Smoothseal primarily as an overlay to restore rideability. As far as performance and durability, we expect the Type A sections to last 8, 10 or 12 years, or longer. So far I've done one project using Type B, although I am considering several others.

"In Type A," says Marszal, "there is a little more asphalt binder along with styrene butadiene rubber or styrene butadiene styrene, and it pays off in durability. In the Type B, we use slightly larger aggregate and less modified asphalt binder in the mix. This provides some additional structure or strength for use in heavier traffic applications."

### Smoothseal or HMA?

Ohio contractors think that Smoothseal compares favorably with traditional HMA overlays. "If it is the proper thickness, and under proper conditions, yes, Smoothseal can compete," says Larry Shively of the Shelly Company. "If it is placed over a roadway in need of extensive surface repair, then Smoothseal is not as effective as a regular HMA overlay.

"Type B has more aggregate matrix than Type A," says Shively. "Type A is composed of natural sands, but Type B requires crushed faces and limestone coarse aggregate for heavier traffic. Type B can take the place of a traditional HMA overlay if it contains the proper aggregate gradation. Traditional overlays are usually 1 1/4 to 1 1/2 inches in thickness."

Shively says that Smoothseal roads are getting good density, "but ODOT gives us a method specification to go by. We use a specific type of roller and a specified rolling pattern. We don't often check density because we are following the ODOT specification."

# Ohio Smoothseal

## HMA PAVEMENT PRESERVATION OPTION

Local and state transportation agencies in Ohio started to use Smoothseal™ in the early 1990s because they were looking for a hot mix asphalt (HMA) alternative pavement preservation option. They were looking for a speedy, effective, durable method of resurfacing their roads and streets other than traditional microsurfacing or chip seals.

Seeing the need for a thin-lift hot mix pavement preservation option, representatives of Flexible Pavements of Ohio (FPO), the state hot mix paving association, developed what is known today as Smoothseal. Smoothseal is a heavily polymer-modified hot mix that incorporates styrene butadiene latex. The mixture has a fine gradation comprised of a sprinkling of coarse aggregate — 8s and 9s — with mostly natural and manufactured sand. The Marshall Method was used for developing the mix design.

In recent years pavement preservation techniques have seen renewed interest in Ohio. Like many departments of transportation, the Ohio DOT is seeking to be fiscally prudent with its resources. In these later years, when the ODOT re-initiated pavement preservation measures throughout the state, they reverted to the use of traditional micro-surfacing and chip seals. So, FPO reminded them, "Wait, you have specifications for HMA microsurfacing called Smoothseal." So ODOT agreed to do some Smoothseal projects. And they are still using it.

### Type A and Type B

ODOT adopted two versions of Smoothseal, Type A and Type B. Type A is an all sand mix using 8.5 percent asphalt binder. It was first used by ODOT in the Akron, Canton and Cleveland areas.

Type A has been used on non-high-speed roads and four lane boulevards by a number of urban communities. It has been used for rural roads and park roads and calls for a 5/8 to 3/4-inch thickness.

Smoothseal Type B, with about 6.5 to 7.0 percent asphalt binder content and a 5 percent polymer loading, has performed well on the Georgia Wheel Tester (a rut-testing device) while being compactable during construction. ODOT's Toledo district was an early user of Type B, and its use has been spreading around the state. It is typically placed in a 3/4- to 1 1/2-inch thickness.

Type B has been used on both residential roads and streets and also on interstate pavements. Asphalt industry designers expect the various Smoothseal projects to

| SEIVE | TYPE A | TYPE B |
|---|---|---|
| 1/2 inch (12.5mm) | | 100 |
| 3/8 inch (9.5mm) | 100 | 95 – 100 |
| No. 4 (4.75mm) | 95 – 100 | 85 – 95 |
| No. 8 (2.36mm) | 90 – 100 | 53 – 63 |
| No. 16 (1.18mm) | 80 – 100 | 37 – 47 |
| No. 30 (0.600mm) | 60 – 90 | 25 – 35 |
| No. 50 (0.300mm) | 30 – 65 | 9 – 19 |
| No. 100 (0.150mm) | 10 – 30 | |
| No. 200 (0.075mm) | 3 – 10 | 3 – 8 |

SMOOTHSEAL AGGREGATE GRADATION REQUIREMENTS

est d2s values, Apr 2002 and Apr 2004, occurred when polymer modified samples were tested.)

For other tests, such as penetration, the d2s calculated for each program (Figure 3) is much closer to the ASTM D5 limit. The average d2s limit for penetration for the round robin programs conducted from 1999 to 2004 was 7.9 dmm compared to the ASTM limit of 7.1 dmm.

The calculated d2s limits from the 1999-2004 round robin programs are shown in Table 1 along with the average d2s value (calculated from all 9 programs) and the ASTM d2s value. The higher variability indicates that some work is still needed within the participating labs to tighten down the between-lab variability of common tests for roofing asphalts. It is also worthwhile continuing the programs and analyses to determine if the testing variability is higher because of the material properties being tested (i.e., stiffer roofing asphalt binders compared to softer paving asphalt binders). If so, then a separate set of d2s limits for roofing asphalts may eventually be determined.

## Raise the Roof

Beginning in 2005, the Asphalt Institute, with the cooperation of Paramount Petroleum, has taken the reins of the proficiency sample program. This year's program was started in June with reports being sent to the participants in early September (see *Lab Corner* on page 42 for more details). It is expected that the program will continue either annually or biannually depending on the interests of the participating labs.

Through increased knowledge of testing variability and its causes, we anticipate that the between-lab reproducibility will improve for the common roofing asphalt binder tests, as well as any future tests that may be used in characterizing the physical properties of roofing asphalts. To this end, we believe that the continued success of the Proficiency Sample Program for Roofing Asphalts will play a key role.

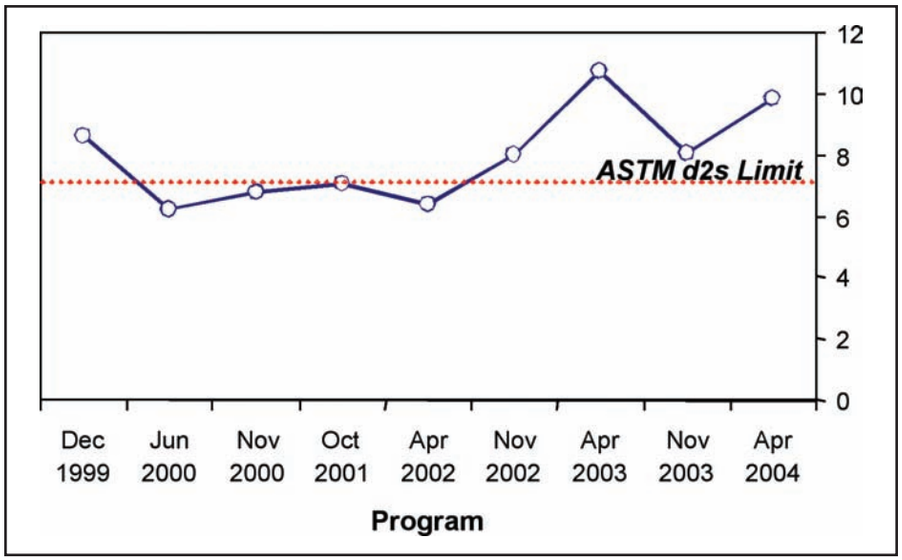



FIGURE 3: REPRODUCIBILITY LIMITS (d2s) FOR PENETRATION AT 77°F (25°C)

TABLE 1: MULTILABORATORY d2s LIMITS FOR ROOFING ASPHALT TESTS

| Period | Softening Point, °F | Flash Point, °F | Penetration @ 77°F, dmm | Rot. Viscosity @ 400°F, cp | Rot. Viscosity |
|---|---|---|---|---|---|
| Apr-2004 | 22.7 | 52.2 | 9.8 | 131.2 | 42.9% |
| Nov-2003 | 16.6 | 58.3 | 8.0 | 171.1 | 45.2% |
| Apr-2003 | 11.9 | 69.4 | 10.7 | 68.1 | 40.9% |
| Nov-2002 | 11.1 | 90.8 | 8.0 | 131.9 | 43.0% |
| Apr-2002 | 34.5 | 51.7 | 6.4 | 45.4 | 23.4% |
| Oct-2001 | 11.0 | 66.4 | 7.1 | 95.7 | 38.2% |
| Nov-2000 | 13.9 | 55.0 | 6.7 | 124.3 | 65.7% |
| Jun-2000 | 17.2 | 50.5 | 6.2 | 210.0 | 74.3% |
| Dec-1999 | 7.7 | 66.5 | 8.6 | 90.8 | 44.0% |
| Average | 16.3 | 62.3 | 7.9 | 118.7 | 46.4% |
| ASTM[1] | 3.5 | 32.0 | 7.1 | | 12.1% |

*1 The d2s limits for Rotational Viscosity come from the recently completed NCHRP 9-26 report, Web Document 71, entitled "Precision Estimates for AASHTO Test Method T308 and the Test Methods for Performance-Graded Asphalt Binder in AASHTO Specification M320".*

*2 Highlighted rows indicate polymer modified binder samples.*

*Mike Anderson is Director of Research and Laboratory Services for the Asphalt Institute. Steve Burhans is the Asphalt Technical Services Director for Paramount Petroleum.*

# BINDERS

By R. Michael Anderson, P.E.
and Steve Burhans

In 1999, Paramount supplied samples of a roofing asphalt binder (Type III) to 20 labs, with 18 labs supplying test data on seven tests in ASTM D312 and an additional test on rotational viscosity. In the first round robin, tests included:

| ASTM | Test Method |
|---|---|
| D36 | Softening Point (Ring and Ball) |
| D92 | Flash Point (Cleveland Open Cup) |
| D5 | Penetration @ 32°F, 77°F, and 115°F |
| D113 | Ductility @ 77°F |
| D4402 | Viscosity Determination using a Rotational Viscometer @ 400°F |

In later programs after 1999, the ductility test and penetration tests at 32°F and 115°F were discontinued because of poor response from the initial round robin labs. Less than half of the 1999 participants conducted these tests.

From its inception, the program continued to grow as samples were supplied and analyzed by Paramount Petroleum on approximately a six-month schedule. Figure 1 shows the participation in the program.

The program also provided some interesting data regarding the reproducibility of the test results for the participating labs. While the results were, in general, more variable for all tests than the ASTM d2s limits, the variability was higher for some tests than others. For example, the ASTM d2s limit for the Ring and Ball Softening Point test is 3.5°F. The average d2s limit for softening point for the round robin programs conducted from 1999 to 2004 was approximately four to five times greater (16.3°F). The varying d2s calculated for each program is shown in Figure 2 along with the ASTM D36 limit. (It is interesting that the two high-

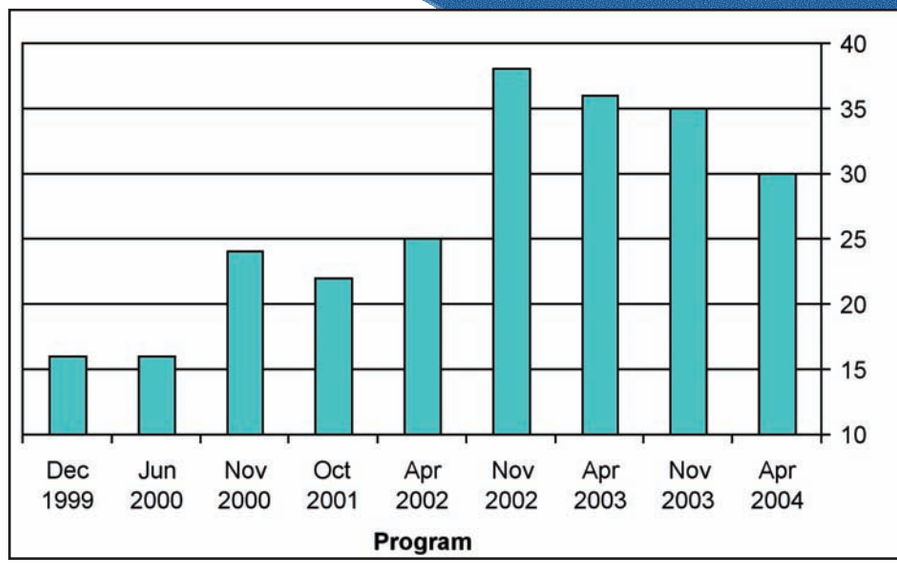



FIGURE 1: NUMBER OF PARTICIPATING LABS (PENETRATION TEST)

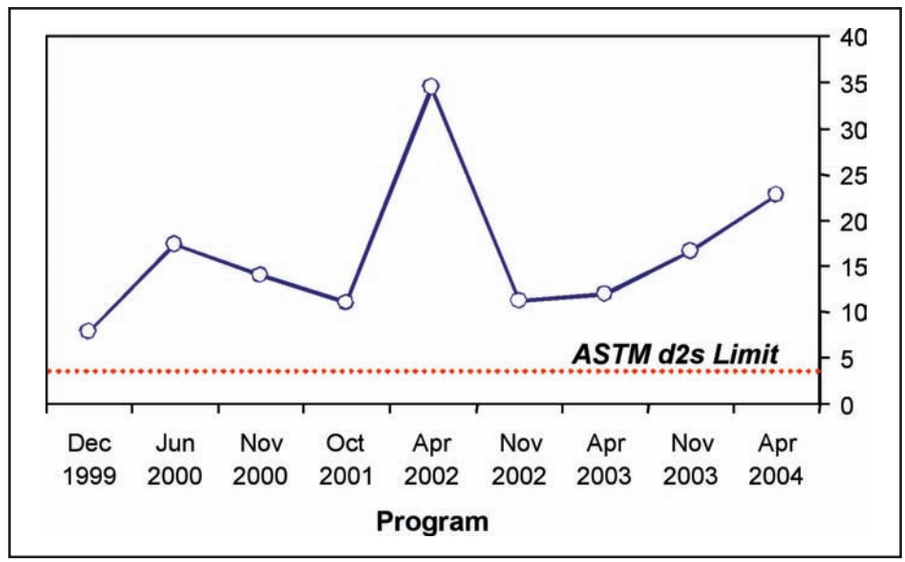



FIGURE 2: REPRODUCIBILITY LIMITS (d2s) FOR RING AND BALL SOFTENING POINT

# Precision of Tests for ROOFING ASPHALT

If you're like me, at one time or another you've made a New Year's resolution to lose weight. The process for me begins on January 1st when I step on the scales to establish my baseline weight. Every week, I then return to the scales to determine my new weight and am sometimes confused by the results. Some weeks my weight will not have changed or I may have gained a pound or two, even though I worked out diligently and generally ate healthy foods. Other weeks, I'm traveling and have eaten poorly and not exercised, and yet my weight will stay the same or even drop by a pound.

Why does this happen? Well, fortunately as someone familiar with science, I know that each time I get on the scales constitutes a single test, the purpose of which is to generate a result (weight). Each test result (weight) is affected by a number of factors including whether or nor I've left my shoes on, or how much pizza I ate the night before. These are all examples of material variability, or variability that is inherent to the material (me) being tested.

A second source of variability may occur as a result of the equipment. Manufacturing tolerances for the load cell (or springs) of the scales can affect the measured result, as can the calibration of the scales. Another potential factor is the time of day when I get on the scales. I may have a different result if I weigh myself in the morning or in the evening. These are examples of testing variability. If I tightly control my test conditions (weigh immediately after getting out of bed in the morning and ensure that the scales have been recently calibrated within the expected weight range), then I can reduce the variability but not completely eliminate it.

## Precisely Speaking

The American Society for Testing and Materials (ASTM) defines a test method as "…a definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material…that produces a test result." For any test method, we want to know how closely test results compare when repeated tests are conducted on the same material. Within-laboratory precision, which is often referred to as repeatability, is a comparison of test results conducted at separate times on the same material in the same lab. In our above example, this would be me stepping on the scales, obtaining a reading, and then repeating the process in a few minutes after I've brushed my teeth. Between-laboratory precision, which is often referred to as reproducibility, is a comparison of test results conducted at separate times on the same material in a different lab. This would be exemplified by me stepping on the scales, obtaining a reading at my house, driving to the gym, and then stepping on the scales at the gym and obtaining a reading.

For testing laboratories, we are concerned not only about repeatability within our lab, but also our reproducibility with other labs. In this instance, a statistical term called the difference two-sigma limit, or d2s for short, is used to provide an estimate of the acceptable range of test results from two labs that can be expected as a result of normal testing variability. It is determined by multiplying the calculated standard deviation (s) by $2\sqrt{2}$ or 2.83. In cases where the standard deviation is proportional to the average for different levels of the measured property, the d2s% is calculated as the d2s divided by the average of the two test results.

The d2s and d2s% limits are useful in evaluating test results because it lets us know how to respond to a set of test data in our lab compared to another lab. If the difference between the test results in Lab A and Lab B are within the d2s limits, then both results could be considered "correct" and the "actual" value could be somewhere between the two results. If, however, the difference between the test results in Lab A and Lab B exceeds the d2s limits, then a retest, and possibly re-evaluation of test equipment and procedures, may be needed. Needless to say, the smaller the d2s or d2s%, the more reproducible the test result.

## Testing Variability of Roofing Asphalts

In 1999, Paramount Petroleum Corporation started a round robin program for evaluating the variability in some of the most common tests used in the Standard Specification for Asphalt Used in Roofing (ASTM D312). The purpose was to allow roofing asphalt suppliers and other testing labs the opportunity to compare their lab results to the average results from a larger group of labs. A repeated high variation from the average could be an indication of equipment or procedural problems within a lab.

According to the 1993 AASHTO Pavement Design Guide methodology, the pavement needed to be 23 inches thick to carry the design traffic volume. Using the PerRoad Perpetual Pavement design software, the design thickness was 14 inches.

## Layer Considerations

In addition to thickness considerations, the various layers within a Perpetual Pavement need to satisfy materials concerns. The base layer is made more resistant to fatigue cracking from bending under traffic loads by increasing the asphalt content to provide increased flexibility. Typically, an asphalt binder content which corresponds to 3 percent air voids in the mix is used.

The intermediate layer of a Perpetual Pavement has to be both stable and durable. This layer must provide rutting resistance. This is accomplished by achieving stone-to-stone contact in the coarse aggregate and using an asphalt binder with sufficient stiffness to meet the high temperature needs.

Marshall Thompson, Professor Emeritus at the University of Illinois, indicated that achieving rutting resistance should not be an issue—given current asphalt technology.

If the Perpetual Pavement is designed and built correctly, any distresses are limited to the surface course and can be readily fixed. The necessary wearing course properties depend on traffic, weather conditions and economics. Particular requirements include resistance to rutting and cracking, skid resistance and noise mitigation. The wide range of available types of HMA mixes allows the surface mix to be customized to fit the specific application.

## Kansas Approach

The Kansas project evaluated several pavement cross-sections. The thickness of the base layer varied from about 7.5 inches to 11.8 inches. The intermediate layer (about 2.5 inches) and the surface course (about 1.5 inches) were constant for all sections.

The Perpetual Pavement design approach is based upon providing enough thickness to limit the bending strain at the bottom of the HMA layer to less than the strains associated with fatigue damage, a concept known as the fatigue limit. Kansas installed instruments at the test site to measure the strains that occurred at the bottom of the asphalt layer when a load moves over the pavement. Information and experience gained from this project will be used to build longer lasting asphalt pavements.

*For more information on Perpetual Pavements, visit the Asphalt Pavement Alliance's website, www.AsphaltAlliance.com.*

APA ASPHALT PAVEMENT ALLIANCE

# Kansas Showcases Perpetual Pavements Construction

*By Dwight Walker, P.E.*

*The Asphalt Pavement Alliance defines a Perpetual Pavement as an asphalt pavement designed and built to last longer than 50 years without requiring structural rehabilitation or reconstruction, and needing only periodic surface renewal in response to distresses confined to the top of the pavement.*

Perpetual Pavements are not new. Some of them were constructed in the 1960s or even earlier. Pavements that were well designed and well constructed have performed without structural failures for many years—even under heavy traffic.

Kansas is one of the latest states to evaluate Perpetual Pavement technology. The Kansas Department of Transportation and the Asphalt Pavement Associations of Kansas, Arkansas, Missouri and Oklahoma, along with Dobson Brothers Construction Company and the Federal Highway Administration, hosted an open house in July 2005 to showcase a Perpetual Pavement installation. The pavement was constructed on U.S. 75 about 50 miles north of Topeka, Kansas, near Sabetha.

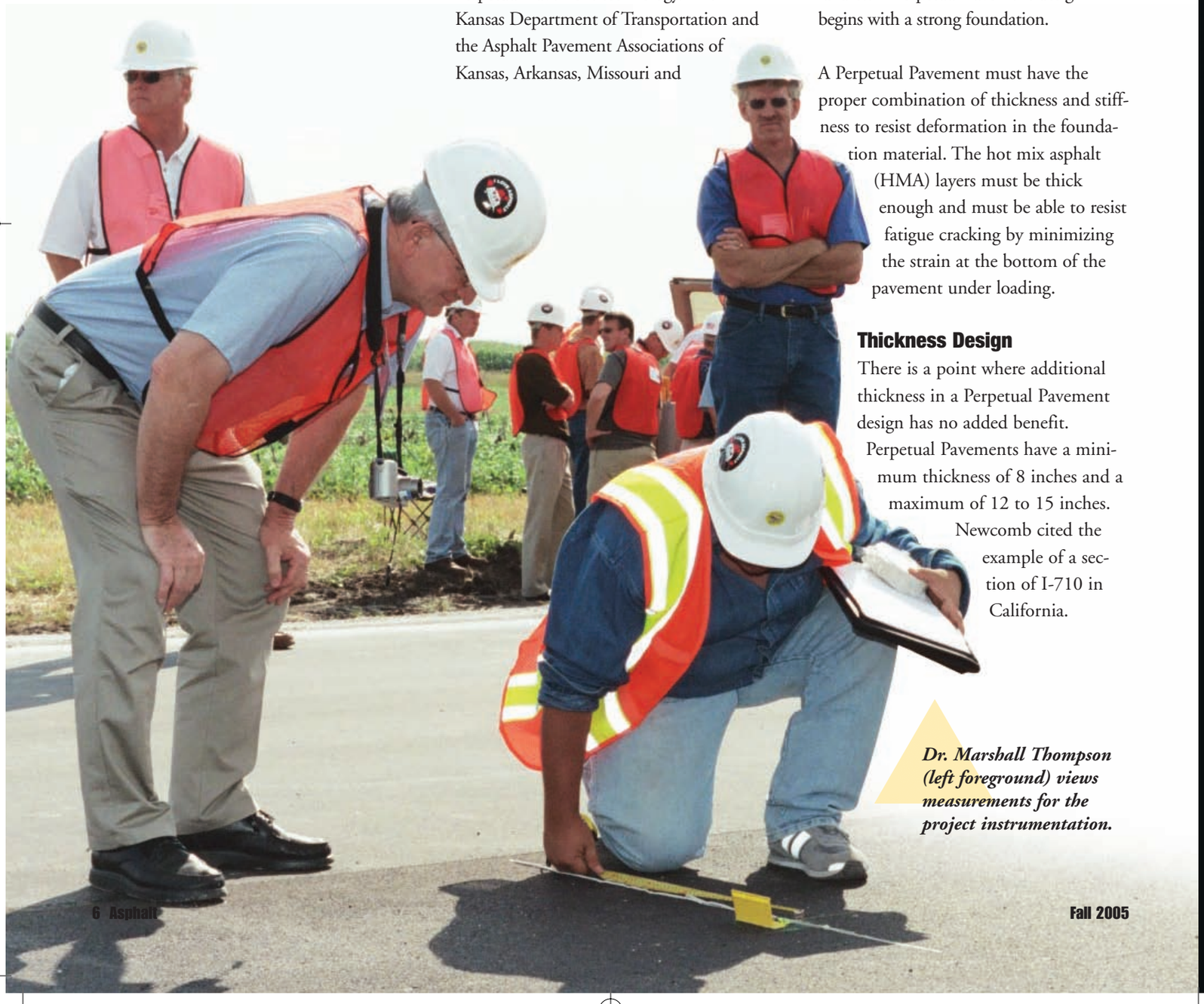
## Design Objectives

Workshop participants learned the basics of producing a long-lasting asphalt pavement. According to David Newcomb, Vice President for Research and Technology of the National Asphalt Pavement Association, a Perpetual Pavement is designed and built from the bottom up to eliminate structural failures. A Perpetual Pavement design begins with a strong foundation.

A Perpetual Pavement must have the proper combination of thickness and stiffness to resist deformation in the foundation material. The hot mix asphalt (HMA) layers must be thick enough and must be able to resist fatigue cracking by minimizing the strain at the bottom of the pavement under loading.

## Thickness Design

There is a point where additional thickness in a Perpetual Pavement design has no added benefit. Perpetual Pavements have a minimum thickness of 8 inches and a maximum of 12 to 15 inches. Newcomb cited the example of a section of I-710 in California.



***Dr. Marshall Thompson (left foreground) views measurements for the project instrumentation.***

**STATE ASPHALT PAVEMENT ASSOCIATIONS STAFF UPDATE**

Longtime Plantmix Industry of Kentucky (PAIKY) Executive Director, **Dean Blake**, has accepted the position of Deputy Executive Director. **Brian Wood,** who has been PAIKY's Assistant Executive Director and Engineer for the last five years, is the new Executive Director.

**Deanna Loveland** is the new Executive Director of the Oklahoma Asphalt Pavement Association. She replaces Dr. Pat Jaynes.

**UPCOMING EVENTS**

**Alabama Rubblization Workshop** will be held December 5 – 6, 2005 in Montgomery, Ala. For more information, contact Mel Monk of the Alabama Asphalt Pavement Association at www.alasphalt.com or (334) 834-5314.

**The National Pavement Expo 2006** will be held in Charlotte, NC, on February 15 – 18, 2006. For more information, visit www.nationalpavementexpo.com.

The second Asian bitumen conference, **Asian Bitumen 2006**, will be held in Singapore, February 23 – 24, 2006. For more information, visit www.cconection.org/asianbitumenflyer.pdf.

**The World of Asphalt 2006 Show and Conference** will be March 13 – 16, 2006, in Orlando, Fla. For more information, visit www.worldofasphalt.com and see the ad on page 40.

**PAVEMENT PRESERVATION ACTIVITIES**

The AASHTO Standing Committee on Highways and the AASHTO Board of Directors has approved a three-year technical services program for pavement preservation. The program will be operated by the **National Center for Pavement Preservation** located at Michigan State University. An oversight group from the AASHTO Subcommittee on Maintenance will develop a specific work plan for the three-year effort.

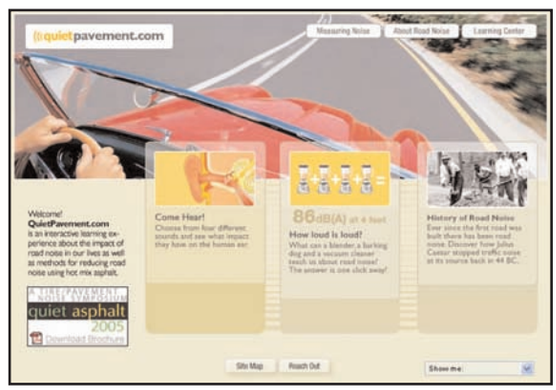
Over the next two years, the **FHWA's Office of Asset Management** and their local Division Offices will offer state highway agencies the opportunity to have their pavement preservation program reviewed at no cost. The National Center for Pavement Preservation will conduct a program review and interviews with key personnel for each State Highway Agency that accepts FHWA's invitation. FHWA will then identify opportunities and make recommendations for improvements in the State's program. For more details on FHWA's involvement with pavement preservation, see the related article on page 18.

**FOUNDATION FOR PAVEMENT PRESERVATION NEWS**

The **Foundation for Pavement Preservation** ($FP^2$) held their **first annual meeting** in Austin, Texas, on October 4, 2005. The meeting preceded the Associated General Contractors Trade and Equipment Show. The seminar had approximately 100 attendees who heard about the various methods used to extend pavement life.

One of the highlights of the meeting was the recognition of the City of Los Angeles for Excellence in Pavement Preservation. Nazario Sauceda, Assistant Director, and Bill Robertson, Director of LA's Department of Public Works, gave a presentation on their program.

The Foundation is committed to promoting pavement preservation activities and bringing together industry leaders and organizations to increase support and share technology. $FP^2$ invites TRB participants to their hospitality suite in January.




**Quietpavement.com a Winner**

The Asphalt Pavement Alliance web site *Quietpavement.com* continues to win major awards. In September, the site was named "Outstanding Web Site" by the Web Marketing Association, and in October, the Construction Writers Association gave the site an award for "Special Recognition for Website Interactivity." Earlier this year, *Quietpavement.com* was distinguished as "Webby Worthy" by the International Academy of Digital Arts and Sciences in the 2005 Web Awards.

*AI Field Engineer Mark Blow (right) shares the latest quality construction techniques with Elmendorf AFB personnel in Alaska.*

## NEW AI STAFF APPOINTMENTS

**Alexander (Sandy) Brown** is the new AI Canadian Field Engineer. A life-long resident of the Toronto area, Sandy's 30 years of asphalt experience includes extensive knowledge of pavement materials, asphalt mixes, road design, construction and evaluation. Sandy's office is located in Ontario. His position is shared with the Ontario Hot-Mix Producers Association.

The Institute welcomes **Jacqueline Goins** as AI's new Library Services and Resources Specialist. With extensive experience, as well as a degree in Library and Information Science, Jacqueline leads a variety of initiatives in the management and retrieval of AI resources.

**Jonathon Oepping** is AI's Division of Research and Laboratory Services' new Asphalt Materials Technician. He works in all aspects of the AI Laboratory with a focus on mix testing and analysis.

**Becky Boston-Sharron** is the new Communications Specialist in AI's Marketing Department. Becky works with AI's publications, seminars, promotional mailings and trade shows.

**Barbara Day** joins the AI staff as the new Asphalt Pavement Alliance Coordinator and Administrative Assistant in the Finance Department.

## AI RESEARCH

**AI and the University of Kentucky Transportation Center** were recently awarded a federal research grant to study the relationship between good construction practices and the long-term durability of asphalt pavements. "This will be an applied research study that will produce results that can be practically and directly used at all levels of the road transportation system," said AI President Pete Grass.

**The Airfield Asphalt Pavement Technology Program**, which is administered by Auburn University in partnership with the Federal Aviation Administration, recently awarded the Asphalt Institute a research project to develop state-of-the-art guidelines for rubblization. The research team is composed of AI's Mark Buncher and Gary Fitts, along with consultants Roy McQueen and Tom Scullion.

## WELCOME NEW AI MEMBERS

**Asphalt Operating Services, LLC**

**Flint Hills Resources, LP**

**Lunday-Thagard Refining**

**Peoria River Terminal, Inc.**

*AI Field Engineer Bob Humer, AI Director of Research and Lab Services Mike Anderson, and AI Lab Technicians Mike Beavin and Shay Emmons recently conducted a training session for the California Department of Transportation (Caltrans) in Sacramento on asphalt binder technology. Caltrans is implementing PG binder specifications and asked AI for training.*

# Asphalt

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*Laura Doolittle, Designer*



*Cover photo courtesy of expresswaysonline.com.*




*For the latest information from the Asphalt Institute, visit the Institute's website at www.asphaltinstitute.org*

Features







# President's Message

## PRESIDENT'S MESSAGE

Bill Haverland, Manager, Asphalt Sales and Marketing, of ConocoPhillips is Chairman of the Asphalt Institute this year — noteworthy in that this is his *second* time in that position. Bill first served as our Chairman in 1996. He is the only individual that has come back for a second term. That invites some comparisons.

In 1997, the Asphalt Institute had 60 members; today we enjoy 85 as we go to press and I've no doubt we'll actually finish this year higher. In fact, during the last 12 months, we've added 12 percent to our membership rolls. Why? We deliver value to our members for their investment, and perhaps unlike 1997, we are more focused on solving industry problems than ever before.

Based on 2004 reported numbers, U.S. markets alone reflected total sales on the order of 36.1 million tons of liquid asphalt. Compare that to 32.9 million tons in 1997. That is a 1.4 percent annual increase, about what we'd expect over this eight year time period — given the turbulent economic conditions.

Looking back to 1997, the FHWA expected to have all states using the then new Superpave specifications. In 2006, California is now the final state to adopt Superpave — in fact, AI staff recently conducted two Asphalt Binder Technology (ABT) courses in California in late September. These courses were requested to help California with their transition to PG asphalt binders beginning next year.

Bill's first round as Chairman was while he served with Shell Oil; then it was bought by Tosco Refining and then by Phillips 66 who merged to become ConocoPhillips. We're glad he is still with the industry. He is the uncontested champion of the "most membership plaques hanging on one wall" contest and while the extreme case, Bill demonstrates that the business isn't static. Mergers and acquisitions are part of the reality of the oil business.

Our industry owes a debt of gratitude to Bill and people like him. They definitely have a day job, but somehow find time to give back to the industry in a significant and appreciated way. Whether it is serving on a committee, taking a leadership role or supporting the collective efforts of the industry by joining the association—contributing today ensures a bright future for our markets tomorrow.

Peter T. Grass, President

## FROM THE CHAIRMAN

Along with changes within our industry, the leadership and staff of the Asphalt Institute has also changed. There is a different feel within the staff and in the way they conduct their work. The dedication and resourcefulness of the staff has allowed us to make the great strides noted above. We are financially stable once again, have a dominant voice in industry activities, and take proactive approaches to challenges as they develop. It has been through their hard work and creativity that the Asphalt Institute is recognized as the refining industry's voice in the business. We, as members, owe them well deserved thanks for bringing us where we are today.

Bill Haverland, Chairman

# AI Members

**as of 11/1/2005 (* – Affiliate Member )**

*** Akzo Nobel Surface Chemistry LLC**, Willowbrook, IL
**All States Asphalt, Inc.**, Sunderland, MA
**Alon USA**, Dallas, TX
*** Andrie Inc.**, Muskegon, MI
*** ARR-MAZ Custom Chemicals, Inc.**, Winter Haven, FL
**Asphalt Materials, Inc.**, Indianapolis, IN
* **Asphalt Operating Services, LLC,** Bartlett, IL
**Asphalt Processors Incorporated**, BARBADOS
**Asphalt Refining & Technology Company**, Douglasville, GA
**Associated Asphalt, Inc.**, Roanoke, VA
* **Astaris LLC**, Saint Louis, MO
**Bitumar Inc.**, Montreal, QC, CANADA
* **Bouchard Coastwise Management Corp.**, Melville, NY
**BP Bitumen**, Whiting, IN
**Calumet Lubricants**, Indianapolis, IN
**Canadian Asphalt Industries Inc.**, Markham, ON, CANADA
*** Canadian National Railway**, Montreal, QC, CANADA
**Chevron Corporation**, San Ramon, CA
**Chevron – Asia Pacific Africa and Pakistan Region (Caltex)**, Sydney, AUSTRALIA
**CITGO Asphalt Refining Company**, Plymouth Meeting, PA
**Coastal Energy Corp.**, Willow Springs, MO
**Colas, S.A.**, Paris, FRANCE
**ConocoPhillips Company**, Houston, TX
*** Dexco Polymers LP**, A Dow/ExxonMobil Partnership, Houston, TX
*** DuPont**, Wilmington, DE
*** Dynasol L.L.C.**, Houston, TX
**EMCO Building Products Corp.**, LaSalle, QC, CANADA
**Ergon Asphalt & Emulsions, Inc.**, Jackson, MS
**ExxonMobil Lubricants & Specialties Company**, Fairfax, VA
**ExxonMobil Lubricants & Specialties Company, International**, Fairfax, VA
**Flint Hills Resources, LP**, St. Paul, MN
**GAF Materials Corporation**, Wayne, NJ
**The Hudson Companies**, Providence, RI
**Hunt Refining Company**, Tuscaloosa, AL
**Husky Oil Marketing Company**, Calgary, AB, CANADA
**IKO**, Chicago, IL
**Imperial Oil**, Toronto, ON, CANADA
*** Innophos, Inc.**, Cranbury, NJ
**Irving Oil**, Saint John, NB, CANADA
**Isfalt A.S.**, Uskudar, TURKEY
**Jebro Inc.**, Sioux City, IA
**Kokosing Materials, Inc.**, Fredericktown, OH
*** Kolbeck Petroleum, Inc.** , Wichita, KS
*** KRATON Polymers**, Houston, TX
**Lafarge Asphalt Engineering**, A Division of Lafarge Construction and Materials, Inc., Mississauga, ON, CANADA
**Lunday-Thagard Refining**, South Gate, CA
**Marathon Petroleum Company, LLC**, Findlay, OH
**E. A. Mariani Asphalt Co., Inc.**, Tampa, FL
**Mathy Construction Company**, Onalaska, WI
**McAsphalt Industries Ltd.**, Scarborough, ON, CANADA
**McCall Oil and Chemical Corp.**, Portland, OR
*** MeadWestvaco Corporation Asphalt Innovations**, Charleston, SC
**Murphy Oil USA, Inc.**, Superior, WI
**Nynäs Bitumen**, Zaventem, BELGIUM
**Oldcastle Materials Group**, Washington, DC
**Paramount Petroleum Corporation**, Paramount, CA
* **Penn Maritime, Inc.**, Stamford, CT
**Peoria River Terminal, Inc.,** Fort Lauderdale, FL
**Petro-Canada Inc.**, Mississauga, ON, CANADA
**Petroleo Brasileiro, S.A. – Petrobras**, Rio de Janeiro, BRAZIL
*** Pioneer Oil LLC**, Billings, MT
*** Ponderosa Petroleum Company**, Parker, CO
**RECOPE**, Cartago, COSTA RICA
**REPSOL YPF**, Madrid, SPAIN
*** Safety-Kleen Systems, Inc., Oil Recovery Division**, Plano, TX
**San Joaquin Refining Co., Inc.**, Bakersfield, CA
**Sargeant Marine, Inc.,** Boca Raton, FL
**SemMaterials, L.P.**, Tulsa, OK
**Seneca Petroleum Co., Inc.**, Crestwood, IL
**Shell Canada Products**, Montreal, QC, CANADA
**Shell International Petroleum Company Limited**, London, UNITED KINGDOM
**Shell Oil Products US**, Houston, TX
**Shelly & Sands, Inc.**, Zanesville, OH
**SK Corporation**, Seoul, KOREA
*** Sprague Energy Corp.**, Portsmouth, NH
**Suit-Kote Corporation**, Cortland, NY
*** TAMKO Roofing Products, Inc.**, Joplin, MO
**Terry Industries, Inc.**, Hamilton, OH
**Total Petrochemicals USA, Inc.**, Houston, TX
**Trumbull Asphalt, A Division of Owens Corning**, Toledo, OH
* **Ultrapave Corporation**, Resaca, GA
**United Refining Company**, Warren, PA
**U.S. Oil & Refining Company**, Tacoma, WA
**Valero Energy Corporation**, San Antonio, TX
**Vance Brothers Inc.**, Kansas City, MO