Pavement Preservation Journal

FALL 2013

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PAVEMENT PRESERVATION

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The National Center for Asphalt Technology (NCAT) study* on longitudinal joints has determined that Crafco Pavement Joint Adhesive is the winner for reducing longitudinal joint cracks and joint failure over all other joint sealant products and techniques tested.

Minnesota Transportation Board research report

- Simple, Fast Application
- No Special Preparation
- No Paving Operations Delay
- Reduces Costly Rehabilitation
- Reduces Road Closures

Crafco Pavement Joint Adhesive is a hot applied modified asphalt that effectively bonds paving passes together creating a flexible water tight seal.

NCAT confirms that Crafco Pavement Joint Adhesive is the performance leader.
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NCAT confirms that Crafco Pavement Joint Adhesive is the performance leader.
ALL STATES MATERIALS GROUP leads the industry with INNOVATIONS IN PAVEMENT PRESERVATION TECHNOLOGY.

With the substantial resources of ASMG behind them, our technicians are engineering the use of today’s resources to build and preserve an EFFICIENT, HIGH-QUALITY, SUSTAINABLE INFRASTRUCTURE FOR TOMORROW.

And, with ASMG’s extensive manufacturing, storage, and distribution network, these innovative solutions are delivered cost-effectively throughout the Northeast.

INNOVATION THROUGH LIQUID ENGINEERING

AHEAD OF THE CURVE
By Michael Buckingham  
President, FP² Inc.

Question: Just What is ‘Pavement Preservation’?

Without a doubt, pavement preservation, as our daughters might put it, is “hot”! By “hot” I mean it is popular, timely and stands in the public spotlight. It shares that spotlight with other exciting highway infrastructure themes such as low-energy mixes like warm mix asphalts, cold mix asphalts, and recycled materials like reclaimed asphalt pavement (RAP) in pavements and recycled concrete aggregate (RCA) in road structures.

Yet it is pavement preservation that seems to draw the most attention. Wouldn’t you know that now everybody and everything seems to want to jump on the bandwagon? There was a time when the magazine you hold in your hands was the only one that uttered the words “pavement preservation” in its pages, and covered the technology in detail. Now other worthy journals are saying “me too” and we are finding that in an effort to cast a broad net, some things are being called “pavement preservation” that don’t adhere to the definition that was established when the concept first came to the fore.

‘EXTEND SERVICE LIFE’

Every year FP² Inc. honors the memory of one of pavement preservation’s staunchest pioneers, FHWA’s Jim Sorenson, with its James B. Sorenson Award for Excellence in Pavement Preservation. There was not a greater friend to pavement preservation than Jim, who promoted the concept within the Federal Highway Administration until it thrived there. From FHWA the word was spread to the American Association of State Highway and Transportation Officials (AASHTO), state and local transportation agencies, and Jim was instrumental in the founding of FP²’s predecessor organization.

Say what you will about the profligacy of federal government, sometimes they get it right! Jim and the FHWA knew that the concept would succeed only by narrowing its focus, not by diluting the effort.

This was borne out in a Sept. 12, 2005 memo by David Geiger, P.E., FHWA director of asset management, which put the definition of pavement preservation succinctly: “For a treatment to be considered pavement preservation, one must consider its intended purpose . . . the distinctive characteristics of pavement preservation activities are that they restore the function of the existing system and extend its service life, not increase its capacity or strength.” To read the entire memo, visit www.fhwa.dot.gov/pavement/preservation/091205.pdf.

 Nonetheless, just about any pavement maintenance, rehabilitation or reconstruction process has tried to find its way into the pavement preservation “tent” or toolbox. Like the camel who first just puts its nose under the flap, then its neck, then its rump . . . well, you know the story. Before long everything is pavement preservation, and like the boy in the movie The Incredibles says, when everyone is special, nobody is special.

Well, we at FP² aim to keep pavement preservation special. That doesn’t mean that you won’t see processes peripheral to pavement preservation in our pages. Nor does it mean we are opposed to them. But we will support exclusively the narrow definition of pavement preservation, because that’s still the best one.

CLOSE WORK WITH FHWA

FP² works closely with FHWA and other pavement preservation stakeholders in other ways. For example, we maintain a very strong alliance with FHWA through the four regional pavement preservation partnerships that are coordinated by our comrades at the National Center for Pavement Preservation at Michigan State University.

Read about one of the participants in the Southeast PPP—Richard Turner, pavement manager for Charleston County—in the article on Charleston County, S.C., in this issue. He’s also a participant in the Georgia-Carolina Pavement Preservation Council. Other such councils are in the works. They’re just one more way we all are helping get the gospel of pavement preservation out to those who can benefit from it.
Although highways are highly durable and can last for decades, they deteriorate from traffic wear and tear, inadequate drainage, construction deficiencies, and weather.

Keeping them in good condition requires substantial resources: public entities spent more than $180 billion in 2008 on highways, with about $40 billion coming from the federal government.

Despite these outlays, the Federal Highway Administration (FHWA) estimates that these funding levels are insufficient to maintain or improve the condition of the nation’s highways through 2028. Further, the major source of federal surface transportation funding—federal motor fuel tax revenues deposited into the Highway Trust Fund—is eroding.

State highway agencies, the entities that are ultimately responsible for keeping most major highways in good repair, will need to develop strategies for doing so at reduced costs.

One potential strategy is using more cost-effective materials and practices. [In this report the Governmental Accountability Office identifies] selected materials and practices that states can use or are using to improve the performance of pavements, including what is known about their costs and benefits, if any, challenges, if any, to using these materials and practices.

Our literature review and discussions with stakeholders having relevant expertise resulted in the identification of 40 materials and practices that may contribute to improving the performance of pavements, extending service life, and reducing life-cycle costs. These materials and practices cover a range of uses and applications across the stages of a pavement’s life cycle, from initial design and construction through maintenance and preservation cycles, and at the time of reconstruction.

U.S. PAVEMENT INVENTORY

In the United States, state and local governments own about 96 percent of the more than 4 million miles of roads. State DOTs are responsible for constructing, repairing, and maintaining most major highways, including the Interstate Highway.
System. These agencies generally contract with private sector companies to perform these activities. The federal government provides funding to states through a series of programs collectively known as the federal-aid highway program. Each program that provides funding specifies how it can be used—such as for construction, reconstruction, and preventive maintenance activities—and specifies eligible project types. Highways supported by federal aid represent about one-fourth of all roads, but about 85 percent of all miles traveled annually occur on them (Table 1).

Highway pavement consists of several layers of durable material. Lower layers of a pavement typically consist of crushed, compacted rock (base or subbase) built on a compacted earthen roadbed (subgrade). The surface layer, upon which vehicles travel, is typically constructed of asphalt or concrete. According to FHWA, of all of the miles of roads supported with federal aid, about 91 percent have asphalt surfaces, about 5 percent have concrete surfaces, and 4 percent are unpaved.

All pavements deteriorate over time but numerous factors—including increased traffic, water intrusion into the pavement layers, freeze/thaw cycles or other weather events, and instability of the roadbed or base layers—can accelerate this aging process. Truck traffic, in particular, contributes to pavement deterioration, because heavier loads are many times more damaging than lighter loads. Evidence of deterioration may be apparent on the surface layer.

The activities performed by state and local governments, or their contractors, to build and keep pavements in good condition can be organized into four stages, corresponding to different points of a pavement’s life: (1) design, (2) construction, (3) maintenance and preservation, and (4) reconstruction (see Fig. 1).

Designs that appropriately consider factors specific to the highway, such as anticipated traffic

### Table 1: Ownership of U.S. Roads by Length in Miles and Vehicle Miles Traveled, 2008

<table>
<thead>
<tr>
<th>Owner</th>
<th>Miles supported with federal aid</th>
<th>Miles not supported with federal aid</th>
<th>Total miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>6,596</td>
<td>124,962</td>
<td>131,559 (3%)</td>
</tr>
<tr>
<td>State</td>
<td>562,170</td>
<td>222,141</td>
<td>784,311 (19%)</td>
</tr>
<tr>
<td>Local</td>
<td>418,564</td>
<td>2,667,888</td>
<td>3,086,452 (76%)</td>
</tr>
<tr>
<td>Other</td>
<td>7,188</td>
<td>49,832</td>
<td>57,020 (1%)</td>
</tr>
<tr>
<td>Total</td>
<td>994,518 (24%)</td>
<td>3,064,823</td>
<td>4,059,341 (100%)</td>
</tr>
<tr>
<td>Vehicle miles traveled (millions)</td>
<td>2,534,647 (85%)</td>
<td>458,058 (15%)</td>
<td>2,992,705 (100%)</td>
</tr>
</tbody>
</table>

Source: GAO analysis of FHWA data.

### Table 2: Pavement Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified asphalt binders</td>
<td>Synthetic or natural material added to asphalt to enhance pavement properties. Includes polymers, chemical modifiers, rubber, fibers, fillers, and biobinders/bioasphalt.</td>
</tr>
<tr>
<td>Reclaimed or recycled material</td>
<td>Re-use of materials into new pavements. Includes asphalt and concrete pavement, asphalt shingles, and ground tire/crumb rubber.</td>
</tr>
<tr>
<td>Blended or performance cements</td>
<td>Material added to the more typical portland cement to enhance concrete pavement properties or reduce costs. Includes pozzolans, slag cement, fly ash, and limestone.</td>
</tr>
<tr>
<td>Concrete curing compounds</td>
<td>Material applied to newly poured concrete to inhibit water evaporation and ensure proper concrete curing.</td>
</tr>
<tr>
<td>Geosynthetics</td>
<td>Synthetic polymeric materials used for a variety of purposes in pavement structures, such as reinforcement, separation, and drainage. Includes geotextiles, geomembranes, geogrids, geocells, and erosion control products.</td>
</tr>
<tr>
<td>Corrosion-resistant reinforcement for concrete pavement</td>
<td>Materials that resist corrosion and deter corrosion-related damage to concrete. Includes fiber-reinforced polymer bars, discrete fibers, stainless steel, and epoxy-coated steel.</td>
</tr>
</tbody>
</table>

Source: GAO.
levels, and construction that meets the design specifications are essential to ensuring long-lasting roads.

**PRESERVATION PROLONGS LIFE**

Likewise, maintenance and preservation activities can improve the performance of deteriorated pavements and prolong their life by preventing minor problems from getting worse and correcting major problems that accelerate deterioration. Over time, a pavement may undergo multiple cycles of maintenance and preservation before reconstruction is necessary.

Our review of existing literature and discussions with stakeholders having relevant expertise resulted in the identification of 40 materials and practices—six materials and 34 practices—that may contribute to improving the performance of pavements, extending service life, and reducing life-cycle costs.

Of the 40, six are materials that could be used in the construction, maintenance and preservation, or reconstruction stages of a pavement’s life.

Table 3 describes nine design and material testing practices affecting pavement performance that correspond to the design stage of the pavement life cycle. These include using different pavement types, such as the use of warm-mix asphalt (WMA) or two-lift concrete pavements, and tools that designers could use to predict pavement performance.

In reference to the practice of using WMA, FHWA included it as part of its Every Day Counts initiative to promote innovation; FHWA reported that, as of 2009, more than 40 states had constructed WMA projects.

In addition, according to FHWA, the use of precast concrete panels in highway projects may provide pavements in less time and at lower total cost—considering both construction and user costs—than using traditional cast-in-place concrete construction methods.

**EVALUATING PRESERVATION PRACTICES**

Table 4 describes 13 maintenance and preservation practices affecting pavement performance that could be used during the maintenance and preservation stage of the pavement life cycle. These practices include approaches to monitoring the condition of pavements and examples of specific maintenance and preservation treatments that can be used to cost-effectively sustain road networks.

In reference to maintenance and preservation practices, according to FHWA, applying treatments to roads in good condition is more economical than reconstructing them after they deteriorate: each dollar spent now on pavement preservation could save up to six dollars in the future.

However, FHWA reports that state DOTs have historically allowed pavements to deteriorate to fair or poor condition before taking steps to reconstruct them, a costly, time-consuming activity.

Pavement management/preservation systems can help states monitor the condition of their roads and make decisions to optimize the use of resources by applying appropriate preservation treatments.
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Learn more at basf.com/asphalt or call 1-800-395-5152.
Table 4: Pavement Maintenance and Preservation Practices

<table>
<thead>
<tr>
<th>Practice</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluating pavement condition using non-destructive technology</td>
<td>Using tools such as deflection testing devices (e.g., falling weight deflectometer), ground penetrating radar, ultra-sonic and impact echo devices, and other nondestructive testing devices that can be used to noninvasively evaluate the condition of pavements.</td>
</tr>
<tr>
<td>Pavement management/preservation system</td>
<td>A network-level, long-term strategy that uses an integrated, cost-effective set of pavement maintenance and preservation practices.</td>
</tr>
<tr>
<td>Thin or ultra-thin asphalt overlay on asphalt pavement</td>
<td>Applying a thin (generally 1.5 inches or less) layer of asphalt over an existing asphalt pavement.</td>
</tr>
<tr>
<td>Mill asphalt pavement and resurface with asphalt overlay</td>
<td>Removing the surface layer of an existing asphalt pavement and replacing it with a new layer of asphalt.</td>
</tr>
<tr>
<td>Cold in-place recycling of asphalt pavement</td>
<td>Removing existing asphalt pavement, mixing it with new asphalt, and placing the re-mixed material as a base layer for a subsequent asphalt overlay.</td>
</tr>
<tr>
<td>Surface preservation treatments for asphalt pavement</td>
<td>Various thin surface treatments applied to asphalt pavement, involving the application of liquid asphalt and, in most cases, aggregate.</td>
</tr>
<tr>
<td>Microsurfacing for asphalt pavement</td>
<td>Spreading a thin mixture of polymer-modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives on an asphalt pavement.</td>
</tr>
<tr>
<td>Diamond grinding for concrete pavement</td>
<td>Removing surface imperfections of a concrete pavement using diamond saw blades.</td>
</tr>
<tr>
<td>Dowel bar retrofit for concrete pavement</td>
<td>Installing metal reinforcing bars across joints or cracks that exhibit poor load transfer.</td>
</tr>
<tr>
<td>Partial-depth repair for concrete pavement</td>
<td>Removing and replacing small, shallow areas of a concrete pavement to restore localized areas of deterioration.</td>
</tr>
<tr>
<td>Full-depth repair for concrete pavement</td>
<td>Removing and replacing a segment of concrete pavement through the depth of the concrete slab to restore areas of deterioration.</td>
</tr>
<tr>
<td>Joint sealing for concrete pavement</td>
<td>Applying sealant material to the spaces between jointed concrete pavement sections.</td>
</tr>
<tr>
<td>Crack sealing for asphalt and concrete pavements</td>
<td>Applying sealant material to cracks in asphalt or concrete pavements.</td>
</tr>
</tbody>
</table>

at the proper time. Several states we spoke with (Georgia, Utah and Washington State) are expanding their use of lower-cost surface preservation treatments.

Georgia, for example, began using a preservation practice involving thin asphalt overlays in 2007. Georgia DOT officials refer to their practice as “micromilling”—that is, removing a thin layer of asphalt from a road and replacing it with a new, thin layer of asphalt. According to Georgia officials, the cost of this practice is significantly less than the cost of a thicker asphalt overlay that they would otherwise place.

In addition, Washington has begun using an asphalt pavement surface preservation treatment typically used on low volume highways to maintain higher volume asphalt highways. The treatment—known as a “chip seal,” in which liquid asphalt sprayed on a pavement is covered with aggregate and rolled to embed it—generally provides less additional service life to a pavement than milling and replacing the asphalt surface.

However, the life-cycle cost of a chip seal treatment is about one-third that of milling and replacing the asphalt surface, according to state officials, and the treatment’s use should result in lower maintenance and preservation costs over the life of the pavement.

Some of the materials and practices described in the preceding tables offer additional benefits, beyond improving pavement performance, for example:

- Incorporating reclaimed or recycled materials (see Table 2) into highway pavements provides an environmental benefit by making use of a material that might otherwise be disposed of and reducing the amount of new material needed.
- Using precast concrete panels (see Table 3) can provide a benefit to users of the road under repair. Concrete that is placed on-site may take several days to cure, and during that time, affected lanes must remain closed to traffic. Conversely, precast panels may be driven on immediately, thereby reducing the inconvenience to drivers.
- Following the principles of a pavement management/preservation system (see Table 4) can provide sustainability benefits because these tools seek to minimize the amount of natural resources used over a pavement’s life cycle.
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Geosynthetic-Reinforced Double Chip Seal Tames Troubled Streets

By Norman “Skip” Brown

In 2008, the City of Williams, Calif., had a problem: How to prudently spend money (from State Proposition 1B) that was earmarked for streets and roads.

A considerable portion of city streets was in poor condition due to a lack of funding for maintenance on decades-old pavement situated over clay, with free water no more than 24-36 in. below surface. This lack of adequate structure on the saturated clay had resulted in heavily cracked and deteriorated asphalt streets.

The City of Williams responded by issuing a contract for chip sealing and hot mix asphalt (HMA) overlays on fabric. Gutters were to be matched by key-cut, cold plane grinding on the HMA portion.

Delta Construction Company, Inc. was the low bidder for the project, which involved repair of 33,000 sq. yd. of pavement. As president and owner of this over-65-year-old family business, I was concerned that this grind/overlay would fail the existing pavement, and the project as designed could not successfully be constructed due to an obvious lack of competency of the existing subsurface structure.

Removing portions of the existing asphalt surface by grinding on failed pavement where there is “no bottom” could result in huge...
expenses to attempt to stabilize the subgrade if equipment fell through. This proved to be correct as one truck subsequently fell through the existing surface while implementing a different process.

Subgrade failure then could also result in serious issues with underground utilities. It became obvious that we needed to leave whatever was there alone and build on top with a flexible surface that would take movement under traffic loading without cracking. The contractor, Delta, proposed a double-chip seal process it had been developing over the past 25 years that clearly represented “out of the box” thinking.
Subgrade in Williams so saturated that trucks could not negotiate streets

BREAKING THE SPEC

This double-chip seal process is called a Geosynthetic Reinforced Chip Seal (GRCS), a surface treatment using the standard pavement fabric under a double chip seal. This highly flexible surface wears well under traffic and has proven to preclude over 90 percent of reflective cracking for over 20 years. The method used at Williams was the same used by Delta for over 25 years in northern California and Nevada.

GRCS will not “improve the ride” of existing pavement. It applies an even thickness throughout. If there are potholes or depressions, they should be filled with HMA prior to the installation of the GRCS.

If the failed asphalt was not vertically deflecting under loads both down and up, Delta did not remove it. Where the traveling surface was too irregular to leave as is, a thin blanket overlay was placed with HMA to build a better ride and provide a smoother surface on which to place the surface treatment.

Following this HMA “skin patching,” Delta filled all existing cracks wider and deeper than 1/4-in. The preferred material is a hot-pour, polymer modified asphalt sealant. Any cracks already filled were not addressed unless the “fill” consisted of weeds. The main reason to fill the cracks is to ensure the fabric binder is available to saturate the fabric and not disappear down the crack.

Next, Delta placed a 4.1 oz. pavement fabric into a hot oil binder followed by pneumatic rolling.

Delta prefers to use PG 70-10 binder below 4,000 ft. in elevation, and PG 64-10 or PG 64-16 above that elevation, unless in desert areas, where it’s best to stay with PG 70-10. Although typical fabric applications under HMA overlays usually specify 0.22-0.26 gal. per sq. yd. (G/SY) of binder, this process demands much more. I typically recommend 0.30-0.40 G/SY, depending on a number of different conditions, including type of fabric applicator used, pavement texture, amount of cracking, ambient temperatures, future traffic loading and contractor ability to provide full saturation of the fabric by the binder. The Williams project was shot at a range of 0.30-0.33 G/SY.

FULL SATURATION OF FABRIC

Fabric placed under HMA should always be “fully saturated.” This has not been an issue under HMA overlays, as the hot asphalt placed on top of newly installed fabric will draw the binder up through the fabric and “saturation” will not be an issue when proper amounts of binder are present.

That may change under the new warm mix asphalt (WMA) processes now becoming popular, as the fabric manufacturers are now recommending rolling the fabric with pneumatic tired rollers prior to WMA overlays.

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This complete saturation is mandatory under chip seals. If the fabric is not completely saturated with the hot asphalt binder, some of the following application of PMCRS-2h emulsion binder for the chips will be absorbed into the fabric, resulting in the loss of the necessary film thickness to properly hold the chips. The addition of extra binder along with the use of pneumatic rollers working closely behind the fabric laydown machinery will achieve this best. Several passes of these rollers are necessary while periodically using a “parting agent” (sparingly) on the roller tires to prevent adherence to the surfacing binder.

Longitudinal joints were lapped 1 to 3 in., and transverse joints were butt joints. On streets with a painted center line, temporary raised markers were installed on top of the fabric. To assist them in holding their position under traffic, they were nailed down through large washers.

The fabric was then evenly sanded at a rate of 2 to 3 lbs. per sq. yd., and re-rolled for a minimum of one complete coverage.

**SANDING MANDATORY**

Sanding is mandatory prior to allowing any public traffic on the fabric. This sand remained in place until immediately prior to the application of binder for the chips. All loose sand was then swept clean prior to this application. Only brooms with nylon bristles were used. Excess pieces of fabric not attached to the binder were trimmed off.

The first of two chip seal applications was performed within 72 hours of the placement of the fabric. The bituminous binder used for the chip seal was polymer modified PM CRS-2h. The application rate used was 0.32 G/SY over the installed fabric. The determination of application rate depends on the relative success of complete saturation of the fabric into the paving asphalt (fabric inadequately saturated will need more binder) and the nominal height of the chips used. 3/8 x No. 6 chips were placed at the rate of 22 to 24 lbs. per sq. yd. using a self-propelled spreader.

Three pneumatic tired rollers were used to set the chips. Five coverages were maintained at a maximum roller speed of 5 mph. Cul-de-sacs, dead end streets, bicycle lanes or parking areas along roads wider than 26 ft. received an additional five coverages. The reason for this is to help compensate for the lack of traffic on these surfaces prior to sweeping.

The second chip seal was placed within 48 hours of the first chip seal on most of the streets. Loose chips were swept off with brooms using only nylon bristles prior to the application of the emulsion. The same emulsion used on the first application above was applied at a rate of .38 G/SY. 5/16 x No. 8 chips were then placed at a rate of 22 lbs. per sq. yd. Rolling then proceeded as described above.

Initial sweeping was delayed for three days to allow traffic to continue to “set” the chips. Final sweeping
Where the traveling surface was too irregular to leave as is, a thin blanket overlay was placed with HMA ahead of surface treatment.

was performed three weeks after the initial sweeping.

FIVE-YEAR RESULTS

The five-year results speak for themselves. Due to the savings of placing a GRCS in lieu of a HMA overlay on fabric, the contract was increased from 33,000 to 56,000 sq. yd. for the same price. The city was so impressed with the initial procedures and results it increased the project to 75,000 sq. yd. After five years, the 75,000 sq. yd. placed are functioning well without any major failures.

In December of 2008, Delta received an award from the California Chip Seal Association for the annual Chip Seal Innovation Project of the Year. For more information on this project, visit Delta’s website at www.DeltaConstructionInc.com.

Delta has been performing this GRCS process for 30 years to-date. Projects have ranged from Clear Lake, California to Lake Tahoe, Nev. (at 6,000 feet in elevation) on pavements that were reaching the “end of their useful life” and were scheduled for complete replacement.

GRCS has extended this “useful life” to a point yet unknown at a cost representing around 10 percent of replacement and 40 percent of the typical fabric/HMA overlay now used.

Additionally, due to the total lack of voids allowing air and water into the surface, subgrades dry up and pavement oxidation consequences are reduced dramatically. The subgrade then regains strength to carry the traffic loads. The high amount of binder (16-18 percent by total weight of the process) allows a surface that survives for decades without additional sealing.

Preservation treatments are best applied when pavements are in serviceable condition. Opinions expressed are those of the author. Brown is affiliated with Asphalt Consulting Services, Sacramento.

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The word is out, and governments across the country see pavement preservation as a crucial component of modern pavement management systems (PMS).

Charleston County, which encompasses the City of Charleston, is located in eastern South Carolina and is following this trend, adopting a proactive preservation approach to maintain and advance its PMS.

This preservation through PMS activity complements one of the largest and most underfunded road systems in the country, that of the South Carolina Department of Transportation, and will spend county taxpayer dollars more wisely.
As a rookie in the field of pavement preservation, Charleston County sees education as the key to the successful implementation of its pavement preservation program.

REALLOCATING FUNDS

Richard Turner, pavement manager for Charleston County Transportation Department, advocates this movement. Pavement preservation is only one of three categories of funding within the PMS, but by reallocating some money from the Rehab and Reconstruction funds, the county will be able to improve more miles of roadway for the same amount of money, this according to the Charleston County Transportation Committee’s website www.charlestonctc.org.

“Choosing the right treatment for the right road is what we are learning now by completing pilot projects and meeting with vendors and industry professionals,” Turner said. “One fuels the other; by meeting with industry leaders, we learn what techniques could be successful in the Charleston area.”

Engineers then design pilot programs that put these techniques to use in Charleston’s uniquely structured system. What might work on high-volume roads may not be the answer for the county’s mostly low-volume road system.

The right treatment on the right road at the right time can be a fine line to walk, said Turner. “If you place a preservation treatment on a road that is a little too far down its life cycle, then the treatment will not last very long, and the effectiveness will not be realized,” he said.

Pilot programs help identify the right tool to use for a particular project. By continually evaluating techniques and products, the county will stock its “tool box” with cost effective practices for pavement preservation.

EVALUATING TECHNIQUES

Among the techniques recently evaluated for integration within the PMS are ultrathin lift asphalt overlays, crack sealing, asphalt rejuvenation, fog sealing and micro surfacing.

The trials do not get a pass or fail mark, but rather are used to test the limits of a particular treatment given different variables such as age, service load and pavement distresses.

For instance, Charleston County cut maintenance costs for some of its low-volume, weathered roads by using a combined treatment of crack sealing with an ultrathin overlay instead of the typical 1.5-in. layer. After crack sealing using a liquid rubberized asphalt material, it applied an ultrathin, warm mix asphalt overlay.

Though the cracks reflected through the surface after a few months, the project was considered a success in that the combined treatment effectively sealed the

South Carolina DOT staff observes placement of Reclamite rejuvenator in Charleston County
cracks and the surface from harmful elements, and provided a new, smooth and quiet wearing surface. The engineers learned that the combined technique provides a good quality treatment, but has its limits and may be better suited for roads with less cracking.

**REJUVENATOR TESTED FOR FIRST TIME**

In another pilot program, Charleston County partnered with SC DOT to test, for the first time on Palmetto State public roads, Reclamite asphalt rejuvenator. Testing began in October 2012 on five test sections throughout Charleston County. Pavement Technology, Inc is the authorized contractor for Reclamite and John Schlegel, the operations manager, was onsite for the demonstration.

“Reclamite is a maltene-based pavement rejuvenator that actually combines with the asphalt cement in the pavement and changes the chemical properties in that asphalt...
cement, giving it a higher penetration number and lower viscosity number,” Schlegel said. “This is a chemical treatment of the asphalt road which reconstitutes the binder that is in the top quarter-inch of that pavement, to help seal it against the oxidation and the elements it’s exposed to, and maintain the fines and the gravel that’s in the roadway.”

The product basically gives the asphalt a new lease on life, and testing confirmed the assertion; Reclamite asphalt rejuvenation is a fast and affordable way to delay the aging process of a road.

**FOG SEAL TOOL OF CHOICE**

For roads between five and 10 years old, fog seals have become Charleston County’s tool of choice for pavement preservation.

In May 2013, the county completed a test section utilizing Tire Rubber Modified Surface Seal (TRMSS) by Wright Asphalt Products. The project was a success and provided a great learning opportunity for both the county and local contractor, Truluck Construction Co., which is exploring opportunities of a pavement preservation service line.

Research and analysis established that the TRMSS is an acceptable method to seal roads. By using recycled tire rubber, engineers can seal a road providing resistance to weathering, UV degradation and oxidation. Additionally, for every lane mile of the TRMSS placed, approximately 18 tires are recycled. Moving forward, the county will pursue opportunities to further explore the use of fog seals and complete the first fog seal contract in the Charleston County.

Benefits abound for testing modern approaches to pavement preservation, and the new Pavement Preservation Certification Program offered at Tri County Technical College, near Anderson, S.C., ensures
engineers can identify the appropriate preservation treatment for a particular road. It’s the first course of its kind in the United States, according to the National Center for Pavement Preservation.

It’s a part of the SC DOT’s Technician Certification Program, and Charleston County is the first municipality in the state to certify engineers in pavement preservation.

“With pavement preservation finally in the spotlight, we cannot afford to have failures,” said Jim Feda, PE, director of maintenance for the SC DOT. He’s a huge proponent of certification and indicates that by July 2013 all preservation projects were to require a certified technician on-site.

“It is good to see that Charleston County is taking the initiative to have its employees complete the pavement preservation certification, but this does not really surprise me because I have always thought that Charleston County had a good pavement management and preservation program,” Feda said. The college currently offers three certifications in preservation, through which Charleston County has certified four employees.

**STAYING ON CUTTING EDGE**

Turner believes that knowing what other industry professionals are up to allows Charleston County to stay on the cutting edge. As a member of both the Georgia-Carolina Pavement Preservation Council and the Southeast Pavement Preservation Partnership, he is able to keep the county in the conversation. “Sharing ideas, successes, failures and new products are all part of learning more and becoming more effective and efficient,” Turner said.

Though the county’s Pavement Preservation Program is in its beginning stages, the condition of the pavements in Charleston County roads are still above average for the state of South Carolina.

In fact, the American Public Works Association (APWA) just awarded Charleston County’s Transportation Department accreditation for going above and beyond requirements for public service.

The county intends to lead the way in innovation when it comes to pavement management and pavement preservation. As pilot programs continue, the county will compile an arsenal of preservation techniques to combat the inevitable effects of aging and service on all types of roads before the road requires rehab or reconstruction.

Currently, 27 miles of roadway are marked for micro surfacing for 2013, and the county is currently working on a project for asphalt rejuvenation on 20 miles of roadway. The county hopes to have pavement preservation fully integrated into the PMS for the fiscal year of 2014.

Payne is principal of FBC Editing.com. All images courtesy Charleston County, S.C.

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Asphalt Recycling, Warm Mix Use Show Major Gains

THANKS TO BROAD adoption of sustainable construction practices, the asphalt pavement industry saved taxpayers more than $2.2 billion dollars during the 2011 paving season through the use of recycled materials and energy-saving warm-mix technologies.

According to a survey conducted by the National Asphalt Pavement Association (NAPA) in partnership with the Federal Highway Administration (FHWA), about 66.7 million tons of reclaimed asphalt pavement (RAP) and 1.2 million tons of reclaimed asphalt shingles (RAS) were collected in the United States during 2011 for use in new pavements. Also, about 19 percent of all asphalt produced in the country that year was made using warm-mix asphalt (WMA) technologies.

“Asphalt pavements are the sustainable option for paving our nations’ roads and highways. With warm mix, we can use less energy to produce high-quality pavements, and RAP and RAS allow us to reuse liquid asphalt, saving costs and preserving natural resources,” said NAPA chairman John Keating, president and COO East of Oldcastle Materials Inc. “While use of these technologies has increased dramatically, there is room to do more, and the asphalt pavement industry is ready to reach even higher levels of sustainability in road construction.”

The use of RAP and RAS during the 2011 paving season translates to a saving of 21.2 million barrels of liquid asphalt binder, saving taxpayers some $2.2 billion. When reclaimed asphalt pavement and shingles are reprocessed into new pavement mixes, the liquid asphalt binder in the recycled material is reactivated, reducing the need for virgin asphalt binder. Using reclaimed materials also reduces demands on aggregate resources. Warm-mix asphalt technologies allow asphalt pavements to be produced at lower temperatures, which means reduced energy demands, as well as fewer emissions during production and paving.

“The asphalt pavement industry has a long history of adapting new technologies and innovations to make a better product,” said NAPA president Mike Acott. “This survey reflects that and demonstrates how asphalt producers are at the forefront of ensuring that our roads are built in an economical and sustainable manner.”

Compared to a previous survey of the 2009 and 2010 construction seasons, the use of these sustainable practices has continued to increase. In 2011, RAP usage reached 66.7 million tons, a 7 percent increase from 2010 and a 19 percent increase from 2009. More than 99 percent of asphalt pavement reclaimed from roads went back into new pavements. In the survey, 98 percent of producers reported using RAP in their mixes for new construction, pavement preservation, rehabilitation, and other projects.

RAS usage also continued to climb, increasing to 1.2 million tons in 2011—an 8 percent increase over 2010, and a 52.5 percent increase since 2009. Since 2009, RAS usage has been reported in 36 states. RAS includes both manufacturers’ scrap shingles and post-consumer roofing shingles.

The survey was conducted in mid-2012. Results from 203 companies with 1,091 plants in 49 states and Puerto Rico, along with data from 32 State Asphalt Pavement Associations, were used to calculate industry estimates for total tonnage. A slight variation from the previously reported 2010 results is due to changes in survey design to ensure greater accuracy. A copy of the full survey, including a state-by-state breakdown of the data, is available at www.asphaltpavement.org/recycling.

Preservation Alliance to Hold First Meeting

PLAN NOW TO attend the first meeting of the Pavement Preservation & Recycling Alliance (PPRA), which will be held Nov. 10-13 at the Dallas Marriott City Center hotel.

PPRA is a partnership of leading industry associations – the Asphalt Emulsion Manufacturers Association (AEMA), the Asphalt Recycling & Reclaiming association (ARRA), and the International Slurry Surfacing Association (ISSA) – the goal of which is to advance sustainable, eco-efficient, and innovative pavement applications.

This event will combine many aspects of what has been the AEMA Emulsion Technologies Workshop and the ARRA semi-annual meeting, and it will be a new event for ISSA.

The next two days will consist of a pavement preservation and recycling meeting geared heavily towards the interests of agency personnel and consulting engineers. Topics will include asphalt emulsions in pavement preservation, composition and classification of emulsions, variables affecting quality, and selecting the right type and grade; technical details of full-depth reclamation/soil stabilization, cold in-place, hot in-place recycling and cold planing, getting more done with fewer resources, and innovative and cost-effective pavement solutions; and slurry and micro systems.

For more information visit http://ppralliance.org/index.php/upcoming-meetings/2013-ppra-fall-meeting.
New Spec for Quiet Bridge Decks

IN APRIL 2013 the International Grooving & Grinding Association reported California has instituted a new specification to reduce noise from concrete bridge decks.

Most states use sound walls; with approximately 400 miles of sound walls along its highways, California has the most in the United States. But Caltrans has determined that it’s more economical to control the problem at its source, and reduce the amount of noise generated when tires interface with a bridge surface. Working in conjunction with the FHWA, the department has begun a major program to reduce bridge deck noise.

Prior to 2012, it was common practice in the state to transversely tine bridge decks. The Caltrans Division of Environmental Analysis found they have noise levels that are generally greater than 105 dB, with some measuring as high as 110 dBA. Tining the surface longitudinally, as well as using a longitudinally tined polyester concrete surface, bring dBA levels down into the 103-105 range. Longitudinal textures created by dragging will achieve surface noise levels of 101-102 dBA. The recently implemented Standard Specification 51-1.03F(5)B requires that all bridges outside of freeze-thaw zones and within a Noise Sensitive Area have a grinding and grooving finish, which results in a 100-103 dBA level.

Grinding and grooving are accomplished by adding an additional ¼-inches of concrete thickness to the top of the deck, and then grinding it off to achieve a level, longitudinally grooved surface. For California bridges, this means that the initial clear cover to the top of the rebar will increase from 2- to 2.25-inches.

“For years, motorists and nearby residents have suffered with unwanted tire/pavement noise generated from heavily tined bridge deck surfaces,” said John Roberts, executive director of the International Grinding & Grooving Association. “Caltrans is once again leading the way to a more sustainable transportation network by employing environmentally-friendly, saw-cut surface textures such as diamond grinding and grooving to reduce noise, while increasing safety and smoothness at a competitive cost.”
Contribute Your Technical Paper to Pavement Preservation Journal

PROSPECTIVE AUTHORS ARE invited to present articles on original research on any topic relevant to pavement preservation, such as preservation techniques, materials, construction, testing, performance, recycling and pavement management to Pavement Preservation Journal.

Papers discussing best practices for pavement preservation treatments, including asphalt overlays, scrub and fog seals, crack sealing, chip seal, hot in-place recycling, micro surfacing, and slurry seals, would be welcome as well.

Authors must prepare their manuscripts in accordance with the guidelines outlined by the Pavement Preservation Journal. All articles should be submitted as an e-mail attachment to Dr. Yetkin Yildirim, P.E., at yetkin@mail.utexas.edu.

For more information, including style guidelines, please visit the Pavement Preservation Journal’s home page at www.fp2.org.
Gary Allan Billard

GARY ALLAN BILLARD, 69, a longtime resident of Norwalk, Ohio, and formerly of Bellevue, Ohio, died May 14, 2013 at his home.

Mr. Billard was well known to the pavement preservation community in that in recent years, he was president of Skidabrader LLC, an airport and highway pavement texturing contractor. Before that, for many years, he was president of Northern Ohio Stone in Flatrock, Ohio, a family owned business.

In that occupation he served on the board of ASTM International and vice chairman of the E17 committee. ASTM International is one of the largest voluntary standards development organizations in the world; and a source for technical standards for materials, products, systems and services.

He was also a board member of the committee on skid resistance of highways and airports for Transportation Research Board of the National Academy of Sciences. He also served as a director of the Texas Pavement Preservation Center of the University of Texas-Austin.

At August 2012 National Pavement Preservation Conference field demonstration in Nashville, Mr. Billard (at left, with microphone) narrates demonstration of concrete texturing using Skidabrader equipment.

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Heat energy behaves differently depending on the color of the surface that it comes into contact with. Light, white colored surfaces tend to reflect heat energy, while dark, black-colored surfaces absorb much of this energy. The degree to which a surface reflects this energy is called its albedo, which can be expressed as a numerical value from 0 to 1 (where 1 means 100 percent reflectance, and 0 means total absorption).

Asphalt materials have traditionally been black, and thus, the majority of our world’s roadways are dark in shade. As a result, the earth’s natural surface has become extensively covered by dark roadways. The solar reflectance of a freshly installed asphalt pavement is about 0.05; this means that fresh asphalt absorbs 95 percent of the sun’s energy. Slightly lighter, aged asphalt pavements have a solar reflectance between 0.10–0.18, depending on the type of aggregate used in the asphalt mix.

URBAN HEAT RETENTION

As pavements cover approximately 35-40 percent of populated areas, this process of heat retention has contributed to an increase of urban temperatures relative to rural areas in the same climatic zone. The resulting temperature-increasing phenomenon has been coined the Urban Heat Island (UHI) effect.

Growing UHIs made by covering the earth’s surface in heat-absorptive structures is said to contribute to presumed...
global warming. Heat that would otherwise be reflected is instead being stored on the earth’s surface, only to be later released as a form of energy that gets trapped in the earth’s atmosphere.

**HIGHER ALBEDO = LOWER TEMPS**

There are many factors that contribute to a pavement’s heat-retention properties, including pavement thickness, pavement density, and type of material used. However, the most influential factor on a surface’s temperature is its albedo. All else being equal, a surface with a low albedo will absorb far more heat than a high albedo surface.

Independent of the type and thickness of the pavement, it is clear that a higher albedo results in a lower maximum daily surface temperature, as well as a lower minimum daily temperature. Regardless of the thickness or density of a pavement, increasing surface reflectance will result in less heat absorption.

Approximately 2.4 percent of the earth’s surface is covered by urban areas. If all of the black surfaces in these areas were turned white, it’s calculated that it would result in 0.03 percent more of the sun’s energy being reflected, rather than being absorbed. This number may appear negligible, but this seemingly small change results in enough UHI reduction to account for 44 billion tons of CO₂.

It is difficult to imagine how much of an impact such a huge amount of CO₂ offset would bring, but there is a more relatable way to conceptualize these calculations: if the albedos of all urban surfaces are raised to offset 44 billion tons of CO₂, the impact would be equivalent to removing all cars from the entire globe for 11 years.

**PERFORMANCE BENEFITS**

Not only can increasing roadway albedo have positive environmental effects, but more reflective roadways also can be less costly and more durable than their black-colored counterparts.

Flexible pavements are constructed using elastic materials that are susceptible to temperature changes. The structural capacity of a flexible pavement decreases as the temperature of the pavement increases. Laboratory and field testing has shown that the resilient modulus of an asphalt pavement increases as a result of lower pavement temperature.

The more resilient a pavement, the better the pavement is at resisting gradual deformation such as rutting. Because a higher albedo results in a lower maximum pavement temperature, light-colored pavements can be thinner than dark-colored pavements while achieving the same durability. A higher albedo means that less material is necessary for construction which translates into lower material costs.

Yildirim is director, Texas Pavement Preservation Center. Opinions expressed are those of the author.
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For preserving pavements, highway agencies may seek the participation of the private sector in order to raise revenue, share risks and reduce project delivery costs.

Public-private partnerships (PPPs) are an increasingly common approach for project delivery. To address the lack of a rational decision-support structure for choosing between PPP and traditional contracting approaches for a specific pavement preservation project, we demonstrate a framework that assesses the relative performance of PPPs.

In this context, performance is expressed in terms of the likelihood and amount of cost savings associated with the PPP.

**CONTRACT WORK DEFINED AS PPP**

A public-private partnership (PPP) [here] is generally defined as a contractual agreement formed between public agencies and private sector entities to allow for greater private sector participation in the delivery of transportation projects. We consider any pavement preservation activity that is delivered by any approach besides in-house is considered to be a PPP.

PPPs can help public agencies accelerate project delivery by utilizing private sector strengths in packaging and procuring services in innovative ways, and in providing specialized skills, equipment, and processing. PPPs allow public agencies to reduce their size or to function effectively with a dwindling workforce, particularly in the current era that is characterized by incipient retirement of the baby boomer generation.

A framework would help the agency identify the most cost-effective contracting approach for a given pavement preservation project on the basis of the project characteristics; predict/quantify the consequences of any contracting option in terms of the cost savings or other agency-specified performance criteria; and to identify/quantify the influence of project attributes such as the expected project duration, work type, and project size on the performance of each contracting type.

**PROJECT DELIVERY APPROACHES**

Fig. 1 presents a few of the contracting approaches that can be used for the delivery of highway preservation projects.

The work completed during the in-house project delivery approach for preserving highway pavement is carried out by the agency’s in-house personnel using the agency’s equipment and materials on a force-account basis.
In the traditional contracting approach, the facility design phase is carried out independently of the construction phase. The contract is awarded to the best qualified bidder.

Cost-Plus-Time (A+B Bidding, or Multi-Parameter Bidding), is a contracting approach that not only considers the initial construction cost in the bidding process, but also takes into account the time needed to complete the project. In order to estimate the cost of time, a road-user cost ($/day) is determined and multiplied by the required number of days for completion. The contract is then awarded on the basis of the combined cost of time and construction material and services. Safety, quality, social impacts, and other factors can be incorporated into the cost-plus-time contracts to form multi-parameter contracts.

Other contract permutations include Cost Plus (Cost Reimbursement) contracts, Incentives/Disincentives, Lane Rental, and Performance-Based Contracts.

For the probability that a given type of PPP approach would yield cost savings (or cost loss) vis-à-vis the in-house approach, the binary probit model was used. All model variables are statistically significant at the 90 percent level of confidence, and the signs are intuitive.

**DATA COLLECTION, ANALYSIS**

This study used data from 138 pavement preservation contracts that were let or completed in the United States and abroad (Africa, Asia, Europe, North and South America, and the Pacific) between 1996 and 2007 inclusive. The data were collected from internet resources and a number of transportation agencies in the United States and abroad.

The results suggest that the A+B+I/D and PBC contracts for pavement preservation generally have a greater probability of cost savings compared to the traditional contracts.
The results also showed that the warranty contracts for pavement preservation generally have a lower probability of cost savings compared with their traditional counterparts. This is consistent with expectation: Anastasopoulos et al. (2011) and Singh et al. (2007) found that in the short term, warranty contracts are generally more costly, per lane-mile, than otherwise similar traditional contracts.

Also, it is seen that pavement preservation contracts that are less than 10 miles in length generally have a higher amount of cost savings compared to those that are over 10 miles in length. Also, pavement preservation contracts that are let using PBCs were generally found to yield higher amounts of cost savings compared to other contracting approaches; the contrary effect was observed for similar work done through warranty contracting approaches. Also larger contracts (size exceeding $1 million) were found to be associated with higher amounts of cost savings relative to smaller contracts (smaller than $1 million).

**CONCLUSIONS AND RECOMMENDATIONS**

This study carried out econometric analyses to identify the factors that influence the likelihood and amount of cost savings associated with PPPs relative to the in-house approach for pavement preservation projects.

Unlike past, similar research, cost savings is defined in this paper not in relation to lowest bid costs but as the percent cost difference between the PPP contracting approach and its in-house counterpart.

The developed models can be used in a PPP evaluation and decision-support framework to predict the performance (such as the cost savings likelihood and amount) of alternative contracting approaches. This would benefit highway agencies and international organizations who seek to identify the superior contracting option (PPP or otherwise) for a given pavement preservation project on the basis of the project characteristics, and to quantify the consequences of such choices in terms of the cost savings or other agency-specified performance criteria.

However, final recommendations for a given project should only be made after weighing carefully other considerations such as local site conditions or social and political culture. Through such a tool, agencies’ public accountability could be enhanced as the consequences of alternative contracting options could be more clearly communicated to the general public, taxpayers or to sponsoring institutions.

Anastapoulos is with the Department of Civil, Structural and Environmental Engineering, State University of New York-Buffalo, and Voloski and Labi are with the School of Civil Engineering, Purdue University. Edited by Pavement Preservation Journal from the original paper. Bold face emphasis added. For the full paper, contact Dr. Anastasopoulos at panasas@buffalo.edu.
FHWA Moves Forward with Management Road Map

Through a variety of initiatives, the Federal Highway Administration is moving forward with implementing its 2010 pavement management road map.

In 2010, FHWA published the Pavement Management Roadmap (Google FHWA–HIF–11–011). As described in these pages, the PM road map is a long-term vision for pavement management and the research, development, and technology transfer initiatives needed to help transportation agencies achieve that vision.

Asset management provides a coordinated approach to managing infrastructure assets over the course of their life cycle, thereby improving performance, increasing safety, and providing greater value to the community, FHWA says. A new emphasis on asset management in recent years has also meant a new role for pavement management.

“Today asset management managers rely on pavement management data to develop a strategic program of projects that will make progress toward achieving the state’s targets for asset condition and performance of the National Highway System,” says FHWA’s Nastaran Saadatmand.

To help agencies more fully utilize their pavement management systems (PMS), the road map identifies the steps needed to address current gaps in pavement management and establish research and development initiatives and priorities.

FHWA developed its road map through three regional workshops held in Phoenix, Dallas and McLean, Va., in 2010. Stakeholders participating in the workshops included representatives from state and local highway agencies, Canadian government agencies, metropolitan planning organizations, academia, and private industry.

ROAD MAP IMPLEMENTATION

Implementation activities include setting up a network of road map research sponsors, which held an initial meeting in October 2012. Participants included representatives from state transportation agencies, academia, and FHWA. This network will share information, pool resources to advance the needs and projects outlined in the road map, and prevent duplication of effort.

FHWA has also launched a Pavement Management Roadmap web site. Visitors...
to the site can download the road map and related documents, including project reports and a marketing plan. Also featured are updates on road map goals and activities, information on how states are implementing PMS, and links to related publications and web sites.

Visitors have the opportunity to submit questions and comments about the road map and how they can be involved in implementing its goals. To start using the site's many resources, visit www.fhwa.dot.gov/pavement/management/roadmap.

Research projects being conducted across the country are helping to achieve the road map's vision and advance pavement management. Results from these initiatives are being shared nationwide through the road map network and web site.

Projects include the Development of Cost–Effective Pavement Treatment Selection and Treatment Performance Models, sponsored by the Louisiana Department of Transportation and Development (LADOTD) and Louisiana Transportation Research Center. Conducted by researchers at the University of Louisiana at Lafayette and funded at $267,395, the study's goal is to develop pavement treatment performance models to support the cost–effective selection of pavement rehabilitation and maintenance treatments. These treatments include chip seals, crack seals, micro surfacing, and both thin and thick overlays.

"Pavement performance models for each distress type have been developed based on each pavement type and for each pavement treatment. Pavement treatment trigger values are also being calibrated based on the optimum time for treatment application," said Mohammad Jamal Khattak of the University of Louisiana at Lafayette. Once these analyses are completed, a comprehensive software package will be developed and integrated into LADOTD's existing PMS. This new software will assist highway engineers in determining the optimum treatment type and timing based on life-cycle cost analyses.

Advancing the road map's goal of showcasing best practices for pavement management, a new Pavement Management Guide was developed under NCHRP Project 20–07, replacing a 2001 version of the guide. Updates include an increased emphasis on using preventive maintenance treatments as part of a pavement preservation program. Advances in technology that have improved data quality and integration are also featured in the guide, as well as information on performance management and asset management principles.

More information on these and other research projects is available at www.fhwa.dot.gov/pavement/management/roadmap. As additional project results are available, they will be added to the road map web site at www.fhwa.dot.gov/pavement/management/roadmap/activities.cfm.

Adapted by Pavement Preservation Journal from an article in FHWA's FOCUS newsletter.
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