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On the Cover: Weighted trailers make pass on
National Center for Asphalt Technology Pavement Test
Track at Auburn University. For the first time, pavement
preservation techniques will be tested at NCAT; see
articles pp 10-13. Photo courtesy of NCAT.
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We have a new surface transportation bill, and pavement preservation is part of it! At press time at the end of June, with only hours to spare before the ninth extension of the federal surface transportation program expired, the Moving Ahead for Progress in the 21st Century bill (MAP-21) became law.

Thanks to the strong support of members of the U.S. House Transportation and Infrastructure Committee, pavement preservation in the final bill was stronger than it was in either the House or Senate versions. The concepts of asset management and preservation are widely used in MAP-21, which will bring great benefits to state and local government agencies, as well as industry.

The term asset management is included in the language and is defined to include “a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.”

The Maintenance Section of the law has been expanded to specifically define pavement preservation programs and activities. The final bill explicitly states that preservation activities are eligible for projects under the national highway and surface transportation programs. We’ll explore this new legislation in our next issue.

MORE MUST BE DONE

We at FP² are proud of the role that we and Williams & Jensen, our Beltway partners, played in making sure pavement preservation and asset management were explicitly included in MAP-21. A special “thanks” to all our members who traveled to D.C. for Capitol Hill visits, and who funded our efforts, and to Tracy Taylor of Williams & Jensen, who spearheaded our efforts. But much more needs to be done and our work is not over.

The immortal Socrates famously said “the unexamined life is not worth living.” Following his lead, earlier this year FP² leaders gathered in Chicago for a two-day jawboning session to examine our institution, look at why we do what we do, and look ahead to its future.

Nearly two dozen stakeholders—including representatives of founding organizations Asphalt Emulsion Manufacturers Association, Asphalt Recycling & Reclaiming Association, and the International Slurry Surfacing Association, along with officers and board of FP²—pondered FP²’s mission and how it should change as circumstances have changed.

FP² began as the Foundation for Pavement Rehabilitation and Maintenance Research (FPRMR) in 1992, as a non-profit public charity to pursue and encourage research in pavement maintenance. In 2000 we changed our name to the Foundation for Pavement Preservation, which was dissolved in 2009 to form FP² Inc., a non-profit trade association.

During those years we worked to found the National Center for Pavement Preservation, and worked with NCPP to support the establishment of four regional pavement preservation partnerships. We’ve supported and participated in pavement preservation and maintenance committees at TRB and AASHTO. We’ve served as a spur for FHWA and state DOTs in establishing pavement preservation as a defined category of pavement treatments. We’ve helped create national and international pavement preservation events, and publish the magazine you hold in your hands.

TOWARD THE FUTURE

In Chicago, we looked to the future and decided to continue our lobbying for pavement preservation on Capitol Hill. We will continue our support for the essential NCPP. We’re going to expand our membership for both current, association and private members, and expand awareness of pavement preservation through this magazine and other means.

And most of all, we are going to do our utmost to earn our place at the table as the National Center for Asphalt Technology tackles the performance of pavement preservation techniques in the field over the next three years. As the two lead articles in this issue illustrate, NCAT has provided industry—through FP² Inc.—an extraordinary opportunity to participate in this new study, which has the potential to scientifically quantify the life-extending benefits of pavement preservation for flexible pavements. To support this effort and secure this place at the table, we’ve launched a critical fundraising drive that we hope you will join.

For 20 years, FP² and its predecessor groups have been the industry catalyst in pavement preservation, and the voice of preservation philosophy in this country. We will hold that position as we create new programs while improving existing ones. Please join us as we move into our next decade of service.
For the first time, a formal pavement preservation study will take place at the NCAT Pavement Test Track.

The Pavement Test Track (Fig. 1) is a full-scale accelerated performance test facility managed by the National Center for Asphalt Technology (NCAT) at Auburn University. The project is funded and directed by a multi-state research cooperative program in which the construction, trafficking, and performance evaluations are carried out on 46 different 200-ft. test sections around a 1.7-mile oval test track.

Each test section utilizes the asphalt materials and design methods used by individual sponsors. A fleet of heavy trucks is operated on the track in a highly controlled manner in order to apply a design lifetime of truck traffic (10 million equivalent single axle loads, or ESALs) in two years.

Test sections are rebuilt every three years to provide experimental pavements for the next research cycle. The 2012 NCAT Pavement Test Track, which represents the fifth research cycle, is the first experiment that will include a formal pavement preservation study.

PRESERVATION GROUP EXPERIMENT

Referred to as the Preservation Group (PG) experiment, the PG study is designed to encompass multiple timely issues that are important to the entire pavement community.

State departments of transportation (DOTs)—beset by dwindling tax revenues and rising material costs—are being forced to do more with less like never before. Many DOTs either have a mandate to invest infrastructure dollars in pavement preservation, or have a strong interest to do so.

It is not uncommon for preservation treatments to be applied to roadways with incompatible pretreatment condition levels in a “reactive” rather than “proactive” manner. A great need exists to quantify the relationship between pretreatment condition and life cycle for all preservation alternatives so that DOTs and FP² can select those that provide the lowest possible life cycle cost.

The goal of the PG study on the 2012 NCAT Pavement Test Track is to provide sponsoring state DOTs with that relationship (i.e., the unique curve that defines the relationship between pretreatment condition and life cycle performance for each preservation treatment), which can then be programmed into decision trees that objectively select alternatives as a function of pretreatment condition.

Over time, feedback from pavement management systems will precisely calibrate these relationships to local materials, contractors and environmental conditions.

OFF-TRACK SECTIONS PLANNED

For the first time, off-track test sections will be used to conduct research at NCAT. A half-mile-long local county road (Fig. 2) that supports traffic to an aggregate quarry and HMA plant with a high percentage of truck traffic will serve as the host roadway for the off-track component of the 2012 PG study.
Relatively good condition pavement supports lighter traffic in the inbound lane, while generally distressed pavement supports heavier traffic in the outbound lane. In both lanes, performance will be differentiated between the wheelpaths because widening in the past history of the road (Fig. 3) has produced distinctly lower levels of pavement condition in the right (widened) wheelpaths.

Consensus treatments will be applied full lane width in 100-ft. test sections, producing 200 wheelpath-feet of experimental pavement surface. Each section will be further differentiated into 10-ft.-long test cells, producing 20 data points per treatment.

Instrumentation will document multi-depth pavement temperatures in each section, and records from the quarry will provide a comprehensive load history over the life of the experiment. Pavement condition will be monitored on a weekly basis in order to determine the time and traffic needed to reduce pavement condition back to the pretreatment level. Because a distinct value will be produced for each test cell, 20 data points will define the shape of the life cycle curve for each preservation treatment.

The PG study will also include select test sections on the NCAT Pavement Test Track that have survived from previous research cycles. All track PG sections are supported by the same subgrade and base, and the total thickness of all bituminous lifts is 7 in. This thickness was chosen when these sections were originally constructed at the beginning of the 2009 research cycle because in past studies 7-in. sections exhibited significant performance differences within the standard 10 million ESAL traffic cycle as a function of the differences in mix designs and materials. Several sections with dense mix surfaces from the 2009 Group Experiment (GE) survived the previous 10 million ESAL traffic cycle (e.g., hot virgin control mix, virgin warm mix, hot high RAP mix, warm high RAP mix, etc.). With funding provided by the 2012 PG study, traffic will be continued on these sections into the next research cycle until predetermined trigger distresses are observed.

IDEAL CONDITIONS FOR PG

Although continuing traffic on these sections will facilitate the completion of the 2009 GE study (fully connecting laboratory performance, material selection, field performance, and mechanistic-empirical pavement design methodologies), it will also provide ideal conditions for the 2012 PG experiment.

When consensus trigger distresses are observed, an assortment of carefully selected “reactive” pavement preservation treatments will be applied. Truck traffic will continue, and performance will be precisely monitored in order to quantify the life cycle of various preservation alternatives as a function of pretreatment condition.

Results from this experiment will provide a rational starting point for the implementation of a life cycle-based preservation treatment selection process contingent upon pretreatment condition that can be refined over time with state-specific pavement performance histories. Also, an array of laboratory testing will facilitate the identification of reliable predictive tools that will aid DOTs in implementation.

SUGGESTED TREATMENTS

The following is a list of treatments have been suggested for inclusion in the 2012 PG study, with the actual treatments determined by consensus among states that choose to participate:

- Chip seals (single, double, triple, cape and various aggregate sizes, designs, tack rates)
- Scrub seals
- Micro surfacings
- Thin-lift HMA (inlays vs. overlays, conventional vs. low cost)
- HMA cape seals
- Fog seals (with and without rejuvenator)
- Cold “in-place” recycling (foamed using a central mixing plant)

Buzz Powell, P.E., Ph.D., is assistant director, National Center for Asphalt Technology (NCAT), Auburn, Ala.
You can be part of the new research on pavement preservation planned for 2012 at the National Center for Asphalt Technology at Auburn University.

We invite you to join FP2 in an extraordinary opportunity to have a say in this new research in the NCAT Pavement Preservation Group experiment.

The preceding article by Dr. Buzz Powell, P.E., Ph.D., NCAT assistant director, outlines NCAT’s rationale and preliminary plan for executing the Preservation Group (PG) work. But much remains to be done and you can have an impact on how the project is shaped, unfolds and is managed.

STAKEHOLDERS TAKE NOTE

If you are a stakeholder in the pavement preservation community, please join with FP2 as we underwrite new research on pavement preservation at the National Center for Asphalt Technology.

Nowhere is there a more respected testing facility for bituminous pavements than NCAT, the National Center for Asphalt Technology at Auburn University. For over a quarter of a century, research at NCAT has blazed new trails in asphalt science and pavement performance.

Now—for the first time—pavement preservation techniques will have their day at the NCAT Pavement Test Track as FP2 and its partners document performance there of these techniques in a new NCAT Pavement Preservation Effectiveness Study, to start in 2012—and we want you to be part of it.

NCAT has provided industry—through FP2—an extraordinary opportunity to participate in this new study, which has the potential to scientifically quantify the life-extending benefits of pavement preservation for flexible pavements. It’s designed to evaluate the benefits of a comprehensive list of pavement preservation treatments, and the results of the study should provide highly valuable, measurable data that are not currently available.

According to NCAT, the product delivered to state DOTs at the conclusion of the experiment will be the quantified relationship between pretreatment pavement condition and the time/traffic needed to return to pretreatment condition. A unique life cycle curve will be defined for each preservation treatment. This approach will avoid any bias in the outcome that would have resulted from directly comparing the performance of treatments on underlying pavement surfaces of varying condition. State DOTs can drop these curves directly into decision trees to objectively select the most cost-effective treatments on their own networks solely as a function of measured pretreatment condition.

Pavement management feedback could then be used to calibrate these curves for local climate, materials or contractors, NCAT says. By comparing each unique treatment curve to the deteriorating curve of an untreated control section, the second implementable finding will be to quantify the life extending benefit of proactively applied preservation treatments. This second finding will be a valuable tool for
CONFIRMING ‘RIGHT TREATMENT’

The essence of pavement preservation is the application of the right treatment, to the right pavement, at the right time to save or delay future expenditures.

Pavement preservation makes scarce dollars go farther in keeping roads in top shape, providing a great return on investment. Experience shows that every $1.00 spent on pavement preservation will save from $6.00 to $10.00 or more in future rehabilitation or reconstruction costs.

On average, pavement preservation projects support approximately 25 percent more jobs on a dollar-for-dollar basis, compared with new construction or rehabilitation projects.

Pavement preservation is socially responsible and ecologically sustainable. It utilizes up to 80 percent less of the earth’s non-renewable resources than do conventional highway rehabilitation and reconstruction programs.

Pavement preservation improves efficiency and safety, reducing motorist delays by using techniques that complete road work faster, with less traffic disruptions.

For all these reasons, FP2 Inc. supports the spread of pavement preservation practice and techniques throughout the United States.

A good highway system is a critical component of a healthy economy and essential for global competitiveness. Our country’s economic vitality depends on its highways to move people, goods and services, 24 hours a day, seven days a week.

To serve its purpose, our road system must be in good physical condition and provide a high degree of connectivity and efficiency. Pavement preservation provides the best way of maintaining road system integrity and longevity.

The U.S. highway system—an asset valued at over $1.75 trillion in total—is steadily deteriorating. For a variety of reasons, expenditures are not keeping pace with proven needs. There are never enough resources to build and rebuild roadways and bridges. With constrained resources causing roadways to deteriorate to the point of no return, we need to get serious about preserving and maintaining this fundamental investment.

Pavement preservation fills that gap, but not everyone knows or believes that. Research undertaken at the NCAT Test Track will help solve that problem.

PUBLIC, PRIVATE SECTORS TOGETHER

The NCAT study was initiated—and is being sponsored—primarily by seven state DOTs, but the private sector can and must have a place at this table as well.

But participation in this essential study of this scale is a tremendous financial undertaking, and FP2 needs your help to make industry participation a reality. Frankly, the project’s funding requirements are on a par with FP2 Inc.’s current project budget, so we are redoubling our efforts to meet our contribution goal.

Your pledged contribution to this effort is essential and will ensure that you and your business have a voice in the development and execution of this experiment. That’s because FP2 will be a full partner with funding state DOTs if our funding goal is met.

With full participation by FP2, your industry will be represented in all aspects of the testing, including conceptual development, application and data gathering methods. Industry also will be represented in the data review process prior to the study’s publication.

We need your help to make full private sector participation a reality. We are asking for your pledge and commitment to ensure our industry’s voice is heard and acted on in this study.

Your pledge goes farther because it also qualifies you for membership in FP2 if you are not now a member! You will be afforded membership to FP2 Inc. for a three-year period at the level corresponding to one-third of your total pledged contribution. You can contribute the entire amount at once, or in equal installments on the following dates: July 1, 2012, Oct. 1, 2012, and Oct. 1, 2013. Your full amount pledged is requested before the October 2013 deadline.

Your support is essential to this study’s success. We believe the results ultimately will boost your business by objectively quantifying the benefits of pavement preservation treatments in practical findings that will be implemented by state DOTs.

For more information please contact FP2 executive director Jim Moulthrop at (512) 977-1854 or jimmoulthrop@gmail.com. And please accept our sincere “thanks” for considering participation in this important undertaking at the NCAT Pavement Test Track.

Mike Buckingham is president, and Jim Moulthrop executive director, of FP2 Inc.
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Virginia DOT Combines FDR, Cold In-Place, Cold-Central Plant Recycling in I-81 Project

By Brian K. Diefenderfer, Ph.D., P.E., and Chaz B. Weaver, P.E., P.E.M.

In the first U.S. highway reconstruction combining three pavement recycling processes in one project, the Virginia Department of Transportation (VDOT) rehabilitated a section of Interstate 81 in the shadow of the Blue Ridge Mountains during the 2011 construction season.

VDOT rehabilitated a 3.7-mile section of I-81 southbound near Staunton using cold in-place recycling, cold central-plant recycling and full-depth reclamation. The high-profile project used cold milling machines, a reclaimer, a portable cold-mix plant and a cold recycler, in addition to rollers and asphalt pavers.

The processes were performed both “in place” within the roadbed and adjacent to the highway, and they reused existing material from the underlying road structure. The driving surface received a new overlay of hot-mix asphalt.

The project also employed a novel traffic-management plan that detoured passenger cars onto U.S. 11 away from the construction; large trucks used one lane on I-81 while the other lane was under construction. VDOT alerted motorists to the construction several hundred miles from the project via on-road, web, radio and other communication tools.

The high-profile project was so successful that in early 2012 it received a national award from the Asphalt Recycling & Reclaiming Association (ARRA) and Roads & Bridges Magazine. VDOT was presented with ARRA’s 2012 Recycling Award in the Cold In-Place category at its annual meeting in
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late February. The awards recognize the top asphalt road recycling projects in North America, and winners are selected based on the amount of recycled pavement material used, cost savings and project challenges.

The three specialized processes have the potential to revolutionize how aging roads are rehabilitated via pavement recycling. Roanoke-based Lanford Brothers Co., Inc., was the prime contractor for the I-81 In-Place Pavement Recycling Project. VDOT awarded the contract for $7.6 million.

**FOAMED ASPHALT BASE COURSE**

After rebuilding the shoulders to accommodate work zone traffic, Lanford first milled the top 10 inches of asphalt from the right-hand lane, using two large cold mills, and brought it to a mobile cold recycling plant near the interstate, adjacent to the work zone. There the materials were stabilized with a combination of foamed asphalt and portland cement, using cold central-plant recycling (CCPR). After paving the CCPR material using a conventional paver, both a 12-ton and a 14-ton double-steel-drum vibratory roller were used with a 10-ton pneumatic tire roller to compact the mixture.

Meanwhile, a subcontractor, Slurry Pavers, Inc., of Glen Allen, Va., stabilized the revealed, existing aggregate subbase—which had deteriorated to the point of causing damage to the overlying bound layers—with 3 percent lime kiln dust, a reclaimed industrial byproduct, to a depth of 12 inches, using a reclaimer. The stabilized materials were compacted in place with padfoot and smooth drum rollers.

The milled, recycled materials from the mobile cold-recycling plant then were used to pave a new base course over the stabilized aggregate subbase to a 6-in. compacted depth. This later was topped with a 4-in. intermediate course of conventional hot-mix asphalt and a 2-in. surface course of stone-matrix asphalt.
The challenge: rehabilitating the complete pavement structure of a 3.7 mile section of I-81 in Virginia. The solution: two project phases involving the use of as many as three different recycling methods. The result: REVOLUTIONIZING ROAD REHABILITATION!
In the second phase of the project, subcontractor Reclamation, Inc., of West Hurley, N.Y., used a larger cold recycler to perform cold in-place recycling (CIR) in the left-hand passing lane. For this work, the top 2 inches of the pavement was milled and the next 5 inches was recycled in situ using foamed asphalt and portland cement as the stabilizing agents.

The cold recycler was equipped with an onboard paving screed so the machine was able to mill, stabilize, and repave the roadway in one pass. The CIR layer then was compacted using a pair of 16-ton double steel-drum vibratory rollers and a 25-ton pneumatic tire static roller. The left lane was then topped with a 2-in hot-mix asphalt intermediate course and a 2-in. surface course of stone-matrix asphalt.

The actual reconstruction portion of this project was completed during five separate, five-and-a-half-day, single-lane closures over a two-month period. All other work was completed using standard 8 p.m.-to-7 a.m. allowable lane closures.

VDOT maintained a project website with explanatory downloads, project schedules and maps. Public affairs staff conducted media outreach and visited schools to explain what would happen. VDOT was so successful at “branding” this project as a recycling effort—instead of a mere construction project—that local traffic reporters came to refer it as the “I-81 recycling project” in their traffic updates.

DETERIORATED SUBGRADE PROMPTS REBUILD

This particular section of I-81 was constructed in the late 1960s. VDOT routinely maintained the surface.

MORE ONLINE

I-81 Recycling Project:
Read about the I-81 Recycling Project at: www.virginiadot.org/projects/staunton/augusta_county_8211_i-81_southbound_paving.asp
Or simply Google “Virginia I-81 Augusta”

Benefits of full-depth reclamation:
VDOT’s research division, the Virginia Center for Transportation Innovation and Research (VCTIR), analyzed the performance of full-depth reclamation and recommended the process to restore the substructure in the I-81 project. Full-depth reclamation strengthens the underlying foundation by mixing additives in with the existing material and recompacting it. The 2011 VCTIR report is at: http://vtrc.virginiadot.org/PUBDetails.aspx?Id=298149
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asphalt with periodic patching and overlays. However, the original foundation of compacted stone aggregate and soil had weakened to the point that it no longer provided a stable base for the overlying asphalt layers.

Fatigue cracking, caused by years of heavy traffic loads, had deteriorated the pavement structure from bottom to top. The symptoms of this deterioration could have been addressed by traditional “mill and overlay,” but the underlying condition would have remained. The cause of this extensive wear could only be remedied by reworking all the material down to the subgrade in the right lane. A forensic investigation before construction confirmed the location of the deterioration within both lanes of the pavement structure.

VDOT's Staunton District had found maintenance cycles were averaging two to four years, with patching in between. VDOT needed a process that could go in very deep, fix the entire pavement structure and get out very quickly. With the mobile recycling equipment and portable cold-mix plant, VDOT could do that efficiently and accelerate construction as much as possible.

The reconstruction work also included the addition of prefabricated edge drains on both sides of the roadway. The product used was pre-wrapped with a geotextile filter and brought to the site on rolls which also accelerated construction to get workers in and out as fast as possible.

The existing subgrade had been built on top of impervious, plastic clayey soil and did not have drains built alongside. There were no underdrains or subgrade drainage in the original design and thus the original pavement structure was like a bathtub. Because of this, pumping of water and fines coming up through the surface had been observed.

A WIN-WIN SOLUTION

The project was a win-win for several groups. The pavement designers appreciated it because it repaired those deep failures, fixing the entire pavement structure, as opposed to putting a bandage overlay on top requiring continual maintenance. The recycling process is also “green” so fewer materials were trucked in and out of the site.

But the accelerated construction was very important because it allowed the contractor to get in, fix the deep problems and get out very quickly. It eliminated, as much as possible, the inconveniences to motorists of a lengthier construction process. VDOT probably would not have been able to do the one-lane closure with detour if not for this sequence of construction. The accelerated construction was a huge advantage.

Brian K. Diefenderfer, Ph.D., P.E., is a senior research scientist at the Virginia Center for Transportation Innovation and Research (VCTIR, formerly the Virginia Transportation Research Council), VDOT’s research division, and Chaz B. Weaver, P.E., P.E.M., is the District Materials Engineer for VDOT’s Staunton District.

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Scorched vegetation and contractor mistakes were among the reasons the City of Fort Worth stopped using hot in-place recycling (HIR) as a pavement preservation process back in the 1990s. But now, in the 21st century, HIR has returned to the city’s “toolbox” of pavement preservation techniques.

Today, Fort Worth utilizes a one-pass, hot-on-hot repaving process in which the existing, deteriorated pavement is heater-scarified to a depth of 1 in., and mixed with a rejuvenating agent prior to being placed as a leveling course. This 100 percent-recycled leveling or base course then is topped with 1 in. of virgin hot-mix asphalt—placed simultaneously by the same machine—which achieves a thermal bond between the lifts.

“The HIR process is a good product,” said George Behmanesh, P.E., assistant director, Fort Worth Transportation and Public Works Department. “Otherwise we would not be using it. It’s a quick process that permits the contractor to get in and out of the right-of-way very quickly. Compared to standard overlays, we get a good quality riding surface that is bonded well to the base course. Overall it’s a good product at a reasonable price.”

But adoption of the HIR process took place only after the city rebuilt its confidence in HIR. The city had a HIR program in the late 1980s into the early 1990s, but suspended it due to some bad experiences.

“We had some issues with the previous contractor, who became careless and began burning shrubs,” Behmanesh said. “We decided to shut the program down. But Cutler Repaving, Inc., came along almost a decade later, and was so persistent that we decided to visit one of their jobsites in University Park [Dallas suburb]. I went once and spoke with the contractor on the job. The second time I went without being seen, just to see how the process was applied without a customer being around. We decided to give Cutler one contract to see how it would go prior to expanding the program. And so far, based on what I have seen and what the staff has reported, I’m pleased with the work.”

ONGOING PRESERVATION PROGRAM

Fort Worth has a very aggressive pavement management and preservation program and HIR is a major part of it, Behmanesh said.

“We started our current pavement management system in 2002 and have been using it to analyze the cost-effectiveness of our major maintenance program,” he said. “We have shared the information with our elected officials in numerous workshops and showed them that the result of spending...
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“Our elected officials have been great, after seeing the numbers and understanding the extent of the problem,” Behmanesh said. “They also understand the importance of our pavement management and preventive maintenance programs, and have responded well by increasing our maintenance program budget. And they have increased our major maintenance program funding fivefold over the last decade.”

Fort Worth’s pavement management system inventories all 7,300 lane miles of pavement in the city, said Najib N. Fares, P.E., infrastructure manager, Transportation and Public Works Department, Infrastructure Group. His crew of three uses a van equipped with a computerized system to collect information on pavement conditions and ride index.

“It’s all about optimizing the funds we have,” said Andy Anderson, P.E., RPLS, assistant director, Transportation and Public Works Department, Infrastructure Design and Construction Group, City of Fort Worth. “The elements of pavement preservation are part of an overall strategy of how we deal with the condition of our streets. We’re constantly upgrading the sufficiency rating of our streets, which gives us a clue to which reconstruction or maintenance approach is necessary to bring it to a condition that we want it to be. And the more heavy maintenance we can do, the more cost-effective our dollars are, because you are preserving the pavements.”

REPAVING UNIVERSITY DRIVE

The repaving process keeps traffic moving and road user disruptions to a minimum, Anderson said. “We need for our contractors to get in and get out,” he said. “We need to be minimally disruptive to traffic, and to other institutions. Our University Drive repaving project (2010) went right through the heart of the TCU [Texas Christian University] campus, so we had to keep the disruption to traffic and TCU students and staff to an absolute minimum, as well as the neighborhood there in and around the campus.”

But for University Drive there was more to deal with than just the TCU campus. It is the main thoroughfare accessing some of Fort Worth’s more important institutions and tourist attractions, such as the Fort Worth Zoo, famous Forest Park, Will Rogers Complex, and the Fort Worth Botanical Gardens right across the street.

“University Drive is one of our highest-traveled thoroughfares,” said David W. Bowers, construction
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inspector II, Transportation and Public Works Department, Infrastructure Design and Construction Group. “It connects downtown with the southeast part of Fort Worth, connects TCU campus, a major golf course, the zoo, and major condominium projects and shopping malls. It’s also one of the prettiest thoroughfares and is very aesthetically pleasing.”

Given these local conditions, the City of Fort Worth pays particular attention to the disruption road work in the area might have on the surroundings. Yet Cutler’s one-pass HIR process was ideally suited for minimal disruption to traffic flow and local institutions. “I did not hear one complaint, and I saw the progress each day,” Anderson said.

The University Drive project in Fort Worth ran three and a half lane miles from I-30 on the north and Berry St. on the south, approximately 320,000 sq. yd. of HIR. The pavement suffered from rutting, cracking and other surface distresses, said Rick Hatcher, senior construction inspector, Fort Worth Construction Services Division.

On University Drive, the city was seeing separation of layers of conventional hot-mix asphalt. “The lifts start to move on you, and that creates cracking and a lot of damage to pavements,” Hatcher said. “There will be a lot of shoving at intersections, and as the pavement heats up in the summer, the traffic will rut the pavement. But the hot-on-hot repaving process and added rejuvenator from Martin Asphalt breaks through the independent layers and makes for a revived pavement.”

ONE-PASS PROCESS

The fast-moving, one-pass repaving process expedited renewal of University Drive. “As fast as this process moves, it allows for the least amount of inconvenience for motorists,” Bowers said. “As the process moves forward we just move the traffic control so traffic can go in and out.”

“We like the single-pass procedure of repaving,” Fares said. “When you go in with your paving train, you start and you finish and you get out. After you heat the pavement you don’t have to wait for another machine to overlay it; repaving is completed by one machine, with the pavement opened to traffic in an hour. It impacts less traffic with less inconvenience, and the thermal bond between the recycled and virgin layer creates a homogenous lift of asphalt without seams. And it’s about $25,000 to $35,000 cheaper per lane mile than mill-and-overlay. You also are recycling the existing pavement 100 percent, so that’s good for the environment.”

REPAVING AN HIR PROCESS

The Cutler Repaving process takes place in one pass, in one continuous train, eliminating continuous lane closures and construction traffic. Residents may leave home in the morning on a decayed pavement and return from work on an entirely new pavement.

With repaving, the existing pavement is heated to 300 deg F. Once it reaches a softened, pliant condition, the pavement is scarified to a depth of 1 in., and in the mobile repaving unit, a recycling agent that restores the viscosity of the aged asphalt is mixed into the scarified, reclaimed asphalt. This reclaimed material then is reapplied and distributed with a screed as a 1-in. leveling course. While that material remains at a minimum 225°F, a virgin hot-mix asphalt overlay is placed over the recycled leveling course.

Cutler’s repaving machine scarifies, applies recycling agent, places the leveling course, and applies the new overlay simultaneously in one pass. That benefits road users because there is no delay between the time the pavement is recycled and the time a riding or friction course is placed, resulting in a safer work zone for road users and for contractor personnel.

To place a final friction or driving course, other hot in-place processes use a separate paver following the heater/scarification process. But Cutler uses a screed at the rear of the repaver and thus is able to eliminate an entire machine.

“From an engineering point of view, there is no delamination between the recycled layer and the new overlay,” said Cutler vice president John Rathbun. “The recycled and virgin courses bond to become a monolithic overlay. That’s very important in predicting life cycle performance. The same heat that’s used to take the road apart is used to put it back together, and the two layers are effectively compacted into one lift.”

The process also does not use a tack coat, which can be tracked by tires and shoe soles into parking lots, businesses, vehicles and homes.

Edited from material contributed by Cutler Repaving, Inc.
Pavement recycling is a viable pavement preservation option, as it can accrue substantial savings in energy and nonrenewable natural resources, and pavement in-place recycling has been demonstrated to be an environmentally friendly pavement preservation technique.

Selection of the appropriate pavement and choice of recycling technique are influenced by available materials, geometric constraints, construction practices, traffic loads, environmental needs and the contractor’s technical capabilities.

Highway agencies are experiencing tremendous pressures, as they have limited resources to meet increasing traffic growth and high rates of road deterioration. Pavement recycling is one of the most cost-effective and environmentally friendly forms of flexible pavement preservation available today.

Preservation Options

These preservation options include hot in-place recycling (HIR), cold in-place recycling (CIR), and in-plant recycling. Each recycling preservation alternative is applicable to certain pavement conditions which must be evaluated prior to selecting the preferred type. The advantages of asphalt pavement surface recycling methods include:

Conservation of natural resources. For example, CIR requires the addition of only about one to three percent of fresh asphalt binder compared to about 5 to 6 percent for a new asphalt concrete pavement. This amounts to savings of about 10 gallons of asphalt binder per ton of asphalt mix.

Better pavement performance. A hot-mix asphalt (HMA) overlay over a recycled asphalt base yields better performance than a HMA overlay over an existing pavement surface.
Generally, in-place recycling (i.e., HIR and CIR) can be adopted to fix functional and surface distresses. Typically, HIR can be used to address the surface deficiencies in the top 2 in., while CIR can be used as a treatment to fix the top 3 to 5 in. of the surface. Limited geometric adjustments (i.e., crown and cross fall) can be made with HIR.

Evaluation of a pavement preservation recycling option for flexible pavements should consider the following systematic approach: (1) pavement evaluation; (2) pavement structure and material designs; (3) economic evaluation of alternatives; and (4) field control of the construction process.

**Reduced traffic disruption.** In-place recycling can maintain pavement geometrics and thicknesses without the necessity of a road closure.

Project experience across the country shows that recycled asphalt pavements either perform better than, or are comparable with, conventional asphalt pavements. However, good pavement performance is a function of proper pavement selection, a good design and sound construction practices. The guidance document for asphalt recycling is the *Basic Asphalt Recycling Manual* (BARM), produced by the Asphalt Recycling & Reclaiming Association (ARRA). Many highway agencies have used the BARM to develop specifications that fit their local situation.

Evaluation of a pavement preservation recycling option for flexible pavements should consider the following systematic approach: (1) pavement evaluation; (2) pavement structure and material designs; (3) economic evaluation of alternatives; and (4) field control of the construction process.

**PAVEMENT EVALUATION**

The first step in any pavement preservation project is the evaluation of the existing pavement condition and underlying structure. As outlined in Fig. 1, pavement evaluation entails several activities.

Surface condition should be reviewed from both a structural and functional perspective. Distress types, such as fatigue cracking and often rutting, indicate a structural inadequacy, while poor ride quality depicts one of the functional deficiencies of the pavement surface.

The severity and extent of all types of distresses should be recorded. This information, along with the knowledge of the mechanism and causes of the distresses, assists in the selection of an appropriate fix for the problem. Fig. 2 presents the general strategy to select the most appropriate technique among several asphalt recycling methods based on the distress severity.

**IN-SITU STRUCTURAL EVALUATION**

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valuable engineering tool in assessing uniformity and structural adequacy of an existing pavement. The deflection data can be used for several purposes, including estimation of the engineering properties of the individual pavement layers, and identifying the locations of weak layers.

The information is vital in the selection of an appropriate asphalt recycling technique. For example, in the case of a weak upper pavement layer (asphalt surface course), in-place recycling can be used, while if poor strength properties of the base/subbase or subgrade are indicated, surface recycling should not be considered as an option. In the latter case, in-plant recycling can be considered appropriate after milling the existing asphalt layer and reworking the unbound pavement layer to achieve the desired properties.

Within the proposed pavement project, destructive samples can be acquired to ascertain the layer thicknesses and for laboratory testing. The main purpose of this material evaluation is to investigate the physical material properties (e.g., binder content, aging, grade and HMA gradations, etc.), to determine the type and amount of rejuvenating agent or other additives (i.e., lime or cement), and to improve the gradation of HMA with reclaimed asphalt pavement (RAP) material during the recycling process.

Future traffic levels in terms of axle loads and repetitions need to be estimated. The purposes include: (1) determination whether or not the pavement cross-section is adequate; and (2) selection of recycling type.

One of the major causes of pavement distress is the presence of water in the pavement system. Therefore, to determine the actual causes of distresses, pavement drainage on the proposed project site should be examined. This should include both in-pavement and surface drainage.

It should be recognized that if the subgrade or base layers have moisture-related problems, any surface recycling alternate will offer diminished benefits, without addressing the problem inherent in the respective layers. Therefore, both external (climatic conditions) and internal (roadway geometry and material properties) drainage factors should be evaluated for any project considered for asphalt recycling.

It should be noted that based on the results of the pavement evaluation process, a number of feasible preservation alternatives, including pavement recycling, may be indicated for a particular pavement project. Only the most practical or suitable options should be considered at this stage.

**STRUCTURE AND MATERIAL CHARACTERIZATION**

Considering the local environment conditions, traffic demands and construction practices, one can design pavement structures and pavement materials, for different alternatives, to meet the future performance requirements.

While mechanistic-empirical design procedures can be adopted initially, there exists a need to characterize materials, especially with RAP in the HMA mixture, and performance models need to be calibrated to local conditions.

It would be prudent to define the short- and long-term research goals for developing design guidelines. For example, the material characterization can be considered as a first step, while calibration of performance models would be needed for the long-term.

After the initial guidelines (material characterization and design criteria), assessment of the long-term observed performance would be required to ascertain any further need to improve the developed set of criteria.

Many recent research studies have focused on the material characterization of HMA mixtures involving RAP using simple performance tests. However, no universal guidelines currently are available to control the quantity of RAP in an asphalt mixture. The main reason is the gap between technical design and common practices.

Hence, it would be useful to develop design guidelines based on the state-of-the-art knowledge in material characterization, and the local constraints such as climate, material and construction practices.

In addition, the guidelines should also address expected material durability and expected field performance. Different pavement preservation alternatives can produce pavements with variable expected service lives and costs; for example, mill and fill, CIR and thin asphalt overlay. Therefore, to make a choice for the most cost-effective alternative among a list of mutually exclusive alternatives, economic analysis should be a part of the overall process.

**ECONOMIC EVALUATION OF ALTERNATIVES**

Life cycle cost analysis should be performed on all feasible preservation options. This includes agency direct cost and user delay.

Such analysis can be performed using (1) present worth (PW); and (2) equivalent uniform annual costs (EUAC). Based on the results of the analysis, the most economical alternative can be selected. In addition, the available technology and the construction practice should be considered in the final selection.

**FIELD CONTROL OF CONSTRUCTION**

Construction quality is an important factor affecting pavement performance. If the construction practices or the technology used in the construction process are not adequate, the end product may never meet the expected thresholds.

Therefore, quality control (QC) and then quality assurance (QA) during construction are critically important. The QC/QA program must assure that the quality of the materials and construction practices are satisfactory.

Syed Waqar Haider, Ph.D., P.E., is assistant professor, civil and environmental engineering, Michigan State University, and Larry Galehouse, P.E., is director, National Center for Pavement Preservation, Michigan State University.
Implementing In-Place Recycling Technologies

By Shakir Shatnawi, Ph.D., P.E.

In-place recycling technologies—when designed and constructed properly—are environmentally friendly and cost-effective preservation and rehabilitation alternatives.

These technologies are known as hot in-place recycling (HIR), cold in-place recycling (CIR), and full-depth reclamation (FDR). In-place recycling strategies remove, recompile, and place existing materials on site. A comprehensive Canadian study that investigated the environmental impact of various pavement strategies found recycling strategies are those with the least amount of energy consumption.

HIR TECHNOLOGIES

HIR technologies are aimed at heating the existing distressed asphalt concrete pavement surface, and then restoring it to a good condition. There are three different processes that are commonly used in HIR, including surface recycling (heater scarification), repaving and remixing.

HIR recycled pavement may not require an overlay or a seal coat. The process includes the following steps:

- Heating and milling the existing asphalt surface to depths of 1 to 2 in.
- Sizing the reclaimed asphalt pavement, mixing with recycling additives, and then relaying the mix
- Adding virgin aggregates or hot mix asphalt, when required, before remixing, and replacement

HIR is a cost-effective and viable pavement preservation strategy that has been used successfully by many agencies. For example, the Province of British Columbia uses HIR as a mainstream alternative strategy to conventional mill and fill with great satisfaction. Data show that from an energy standpoint, HIR has the least energy consumption in comparison with hot-mix asphalt (HMA) overlay, and mill- and-fill strategies.

CIR TECHNOLOGIES

CIR technologies are aimed at removing a portion of the existing asphalt pavement to a specified depth by milling, and then recycling it back, using the following steps:

- Milling the existing asphalt layers to a specified depth
- Crushing and screening the reclaimed asphalt, mixing with additives, and then repaving
- Adding virgin material, if necessary, before relaying the recycled mix
CIR is a more cost-effective pavement strategy over conventional (remove-and-replace or overlay) strategies. As CIR is performed only on the asphalt concrete layers; the candidate project must have a sound subgrade and aggregate base. Based on the structural capacity of the project or the intended use, either a preservation treatment or an overlay is placed over the stabilized base.

The benefits of CIR include reduction in construction cost, conservation of materials, preservation of existing pavement geometrics, preservation of environment, and conservation of energy. Fig. 1 shows a comparison between various paving techniques in terms of energy consumption.

**FULL-DEPTH RECLAMATION (FDR)**

FDR is a cost-effective and environmentally friendly alternative to costly roadway reconstruction that may involve removing the entire pavement, including the base and subgrade, and then replacing it with a new structure.

The traditional reconstruction technique is costly, as it requires transporting the milled materials off-site and replacing them with new materials. This lengthy process with noise, fumes and dust can result in major traffic disruption, and requires constructing detours. Obviously, this process is not environmentally friendly as it results in the greatest negative environmental impacts in terms of high energy consumption, lower air quality and depletion of natural resources.

FDR allows complete reconstruction and can utilize the entire pavement materials, including the base and the subgrade—while correcting grade, cross slope, and underlying pavement problems—without changing the geometry of the pavement or the need for shoulder reconstruction.

This process results in a strong stabilized base with depths ranging from 4 to 12 in. This strategy results in structural improvements, restoration of the desired profile, and elimination of cracks and deep ruts while addressing base and subgrade problems. Typically, a preservation treatment or an overlay is placed over the stabilized base. FDR uses the following steps: pulverization, introduction of additive, shaping and grading, compaction and application of a preservation treatment or an overlay.

Fig. 2 shows a comparison between FDR and reconstruction with a new base. This comparison shows significant energy savings when using FDR. Based on information obtained from the State of Nevada, up to 50 percent savings can be realized with FDR.

**BARRIERS TO IMPLEMENTATION**

Although in-place recycling technologies are environmentally sound and cost-effective, their implementation has not been accepted widely due to lack of knowledge and awareness of their benefits, as well as hesitation on the part of some agencies to try new strategies.

In some cases, improper design and construction techniques that resulted in premature failures impeded the
progress of these technologies. The sidebar on this page lists barriers that have impeded the implementation of in-place recycling.

Training, promotional efforts and incentive programs can result in expanding the use of these technologies. For example, in 2009, Caltrans dedicated $15 million from its pavement preservation budget for in-place recycling, which was an incentive to the districts to apply more in-place recycling techniques. Agency commitments to recycling will provide incentives to industry to invest more in recycling technologies and improvements.

One of the barriers to implementing HIR is the initial emissions produced during construction in some of the processes, which may not pass air quality standards of some agencies. A priority for those processes is obviously to reduce emissions to acceptable levels.

Another significant issue is that CIR and FDR recycling analysis and structural design procedures have relied on assigning structural values such as structural coefficients and gravel factors that are one-size-fits-all.

For example, a gravel factor of 1.5 may be given to CIR regardless of what type of mix used in a project. The amounts of additives and their types can significantly influence the engineering properties of the mix and its ultimate field performance. Rational approaches based on actual material properties—rather than on empirical values—must be developed to account for the actual structural capacity of a particular mix and to quantify the cost-benefits of these recycling techniques.

In-place recycling is the way of the future, and it is clear that a concerted effort must be taken to overcome the barrier.

Shakir Shatnawi, Ph.D., P.E., is president of Shatec Engineering Consultants, LLC. For more information, contact Shakir sshatnawi@shatec.net or (916) 990-6488.

BARRIERS TO IMPLEMENTATION OF IN-PLACE RECYCLING

- Lack of experience and technical expertise
- Nonavailability of local contractors
- Lack of local support from the asphalt industry
- Difficulties in leaving the comfort zone
- Biases and misconceptions
- Past premature failures
- Poor strategy selection that resulted in poor performance
- Lack of clear guidance on proper usage and process control
- Inconsistent specifications
- Lack of awareness to cost-effectiveness and significant environmental benefits
- Air quality concerns regarding HIR
- Large expense of recycling equipment
- Concerns regarding structural capacity

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Slurry Seals as Much as Triple DeSoto County Pavement Life

By Russell Heritage

In DeSoto County, Miss.—one of the fastest growing counties in the United States—three identifiable components have led to what is arguably the best road infrastructure in the state of Mississippi: a good tax base, forward-thinking road and engineering departments, and committed support for a pavement preservation program from the county’s Board of Supervisors.

For a jurisdiction expanding at DeSoto’s rate, road managers must constantly remain on the lookout for any deficiencies that may crop up on the county’s pavements. “The supervisors and road department have an aggressive inspection procedure that we go through every year,” said Bill Russell, supervisor, DeSoto County District Three. “We’ve found that addressing distressed areas quickly—and applying a preservation treatment soon after—will double and sometimes triple the normal life expectancy of an asphalt pavement.”

PROACTIVE PRESERVATION

To maintain a healthy balance between restoring older roads and maintaining those that are in good condition, the county relies on a combination of techniques: hot-mix asphalt overlays for areas with significant levels of distress, and pavement preservation treatments for roads in need of less extensive proactive maintenance. This strategy provides a great amount of flexibility, as it is not 100 percent dependent on one method to do all of the heavy lifting.

DeSoto uses pavement preservation techniques to keep healthy roads in excellent condition. “They’re using our products in a more proactive fashion than most agencies, which allows them to realize the full benefit of pavement...”
preservation treatments,” said Tim Harrawood, southern regional general manager of Vance Brothers, Inc. “If they have some isolated deficiencies on a roadway, they go out and address those prior to us coming in and resurfacing that road. That’s tremendously important in terms of the quality and longevity of the roadway once it has been treated.”

“If you let a road deteriorate too much, it’s not just a case of overlaying the road, it’s a case of digging it up and performing a lot of reconstruction,” said Russell. “We try to avoid that as much as possible.”

By proactively treating their roads, the county is able to maintain high-quality transportation infrastructure for a fraction of what it would cost to wait until more extensive repairs are needed.

THE RIGHT TREATMENTS AT THE RIGHT TIME

The concept of preserving infrastructure before it reaches a state of disrepair sounds simple, but it is not always standard practice. In some instances, preservation treatments are used incorrectly on roads that are in need of pre-treatment, or on those that require more extensive repair. In other areas around the country, they are not utilized at all. DeSoto County’s Board of Supervisors has shown forethought and innovative thinking by supporting a proactive pavement preservation program, and its constituents are reaping the benefits as a result.

Because DeSoto prides itself on smooth roads, microsurfacing, scrub seals and slurry seals are the county’s pavement preservation treatments of choice. These methods are a great fit for their roads because they result in smooth, aesthetically pleasing surfaces that protect the underlying pavement. There is no loss of curb reveal, no utility casting adjustments and few traffic delays—all of which make the treatments well-liked by the county’s constituents. Vance Brothers, Inc., headquartered in Kansas City, Mo., is the applicator for all pavement preservation treatments in DeSoto County. Ergon Asphalt & Emulsions, Inc., and Vulcan Materials are material suppliers.

The road department’s quick response time further strengthens public support for proactive treatments. “If a citizen calls and says there’s a problem with a road, that becomes the road department’s No. 1 priority,” Russell said. “We don’t let problems fester. The citizens are aware of that. They know they can make one call to a supervisor and get the problem fixed. And we receive compliments on that all the time.”

DeSoto’s proactive maintenance strategy has paid off, not only in the quality of its roadways, but in cost savings as well. This 2012 season, the county is using microsurfacing, slurry seals and cape seals to restore and protect close to 26 miles of roadway for approximately $570,000. These treatments are used in combination with 26 miles worth of HMA overlays, which will cost the county approximately $2.2 million. Without an aggressive proactive maintenance
policy, these numbers could be much higher.

“We’ve learned that when you maintain your roads on the front end, it more than makes up for it on the back end,” said Russell. “Once you get into the cycle of consistently preserving your pavements, it helps for years to come.”

**HIGH FRICTION VALUES**

Because of the consistent application of preservation treatments, friction values on the county’s roads are through the roof. High friction values ensure that vehicles stay adhered to the pavement, especially in wet weather.

“One of our first successes in DeSoto County came from using microsurfacing on a road that had lost all friction values,” said Harrawood. “Because of low friction values, there was a significant increase in accident rates, especially during rain events. We used microsurfacing on a little over one mile of that pavement, and those sort of wrecks stopped completely.”

The county’s efforts have paid off. During an informal tour of the county’s preservation projects completed since 2005, Mississippi DOT chief engineer Mark McConnell remarked, “DeSoto has some of the best county roads in the state.” Obvious to constituents and experts alike, DeSoto County’s road maintenance efforts are a remarkable success.

How has the county’s support of its transportation infrastructure contributed to DeSoto’s growth? In part by making a great impression on prospective businesses considering a move to the area.

“When industrial prospects come in, they look at your community, and they look at the condition of your roads, bridges and infrastructure. And when they see DeSoto’s, they know they’re coming to a place that cares, a place that’s going to treat them well. It’s good advertisement,” said Russell.

As DeSoto County’s Board of Supervisors continues to invest in the county’s roadways, it ensures that the area remains a haven for businesses, local and otherwise. By exercising an eye for safety and sustainability while expanding to accommodate one of the nation’s fastest growing populations, the Board is driving DeSoto’s economy forward. This is no small feat for any agency, but it is a task that DeSoto County has purposefully sought and achieved.

In recognition of that achievement and the outstanding success of DeSoto’s pavement preservation program, the county’s Board of Supervisors was nominated this year for the James B. Sorenson Award for Excellence in Pavement Preservation, presented by FP2 Inc. The award recognizes agencies for pavement preservation programs that have excelled in four categories: public and official support, tangible improvement to transportation infrastructure, public notification, and uniqueness.

Russell Heritage is a staff writer with Ergon, Inc.
Honor Student Krcmarik Wins Sorenson Scholarship

Senior engineering student Michael Krcmarik is the 2012 recipient of the James B. Sorenson Memorial Pavement Preservation Scholarship, presented by the National Center for Pavement Preservation (NCPP).

Krcmarik, a National Civil Engineering Honor Society student currently completing his Bachelor’s Degree in Civil Engineering, will receive the award, which is given annually to a student accepted into the pavement engineering graduate program at Michigan State University.

With an overall academic GPA of 3.82/4.0 and ongoing participation in several extracurricular activities, Krcmarik already has been able to draw on his experience, which includes working as a technician in MSU’s Advanced Asphalt Characterization Laboratory, and as an engineering co-op student working to digitize county drain engineering plans.

In addition, he has a Bachelor’s Degree in Crop and Soil Science, which he received in 2010. He intends to pursue a Master’s degree and undertake research within Michigan State University’s geotechnical/pavement engineering program.

The James B. Sorenson Memorial Pavement Preservation Scholarship, worth $1,500 per semester, is intended to encourage students interested in pavement preservation who have demonstrated the capacity and motivation to achieve educational and professional goals, and who possess the initiative to seek opportunities to further those goals.

The Sorenson family and friends established this scholarship in honor of James B. Sorenson, a noted leader and dedicated advocate in the field of pavement preservation.

Jim devoted his entire life to service—first as a Vietnam veteran—and then for several decades in the Federal Highway Administration. His passion for preservation left a lasting mark both nationally and internationally. Jim was instrumental in the landmark establishment of the National Center for Pavement Preservation, before which there was no single academic center promoting pavement preservation.

Please contact the NCPP at ncpp@egr.msu.edu or (517) 432-8220 for more information about the scholarship. Please consider supporting this worthy cause with a contribution. To contribute to the James B. Sorenson Memorial Pavement Preservation Scholarship, please send your donation to:

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Pavement Friction Restoration Using High-Velocity Impact

By Yetkin Yildirim and Umid U. Azimov

A workshop—Pavement Friction Restoration Using the High Velocity Impact Method—took place at the Center for Transportation Research at the University of Texas on May 2, 2012, and was sponsored jointly by Skidabrader and the Texas Pavement Preservation Center.

The workshop featured presentations by Gary Billiard, president of Skidabrader, titled Friction and Texture Enhancement, by Thomas Yager from NASA Langley Research Center titled Current Status of Roadway and Runway Friction Evaluations, and by Dr. Yetkin Yildirim, director of the TPPC, titled Pavement Preservation and Texture.

Yildirim commenced the workshop by outlining the importance of pavement preservation and resurfacing techniques. While proper maintenance practices encourage cost-efficient preservation, the primary goal of maintaining healthy pavements is that of safety.

Roadway safety can be enhanced by applying the right preservation treatment at the right time, thus preserving structural integrity, enhancing pavement performance, retarding progressive failures, and improving ride quality. However, safety standards and remedial actions can be established only with education and training of industry professionals and policy makers.

In his presentation Friction and Texture Enhancement, Gary Billiard shared the Skidabrader surface re-texturing process. Sufficient roadway friction is an important factor for both highway and runway safety. Skidabrader provides a time- and cost-efficient resurfacing process.

The Skidabrader machine is equally efficient on PCC and asphalt surfaces, and its bi-directional texturing process produces a level of surface uniformity which has proved effective in accident reduction. Additionally, the process is environmentally clean and self-contained, resulting in an ability for day or nighttime operations and few traffic disruptions.

During his presentation, Yager shared his many years of experience in improving the safety of runway and highway surfaces. The presentation explored the development of friction evaluation methods and techniques throughout history, the current and newly developed equipment used in conducting these evaluations, the classification of pavement surfaces in terms of friction levels, and the treatments available to increase pavement friction performance.

Billiard provided the National Aeronautics and Space Administration’s perspective on friction and skid resistance. Current friction measurements make use of a number of different vehicles and trailers. NASA’s Mobile Tire Test Facility has replaced the older Instrumented Tire Test Vehicle while Runway Friction Tester, Airport Surface Friction Tester, and the Canadian Electronic Recording Decelerometer Vehicle have replaced the Diagonal Braked Vehicle.

NASA’s correlation of over 10,000 data sets on nearly 100 wet pavement surfaces reveals an inversely proportional relationship between the pavement friction coefficient and the speed of the vehicle. The data suggests that the slope of the graph is a function of the macrotexture of the pavement while the magnitude of the friction coefficient is a function of the microtexture.

Pavement surfaces are classified into five categories according to the probability of hydroplaning, which is evaluated using the grease sample and sand patch techniques, in addition to the outflow meter measurements. The deeper the macrotexture of the pavement as measured by the two techniques, the lower the chance of hydroplaning.

In order to improve the friction performance of the pavement, different treatments may be applied. These include shot-abrading, grooving, grinding, and overlays. Overlays are further divided into microsurfacing, slurry seals, rejuvenators and porous friction courses.

Yetkin Yildirim is director, Texas Pavement Preservation Center, and Umid U. Azimov is graduate research assistant at the University of Texas at Austin, affiliated with the TPPC.
Bonded Concrete Overlays as a Pavement Rehab Technique

By Manuel Trevino and Yetkin Yildirim

Bonded concrete overlays (BCOs) represent an economical and technical solution to the problem of concrete pavement deterioration in heavy-traffic roads.

This rehabilitation strategy consists of the placement of a layer of concrete on top of the existing pavement that restores and increases its structural and functional capabilities. With the placement of a BCO, the existing pavement will not only recover from the faulty conditions, but will also gain additional service life.

The materials and aggregates of the BCO have to be compatible with those of the existing pavement. For material compatibility, use aggregates for the BCO concrete that produce moduli and thermal coefficients lower than those of the materials in the existing slab, which will result in lower stresses at the interface, regardless of the season of placement.

If the pavement in question has been overlaid with asphalt concrete (AC) layers, these layers should be milled prior to BCO placing, and prior to surface preparation and repair of distresses. Remnants of AC will hinder the bonding of both portland cement concrete (PCC) layers and are likely to trigger delaminations, because AC works as a bond-breaking layer between PCC layers. Complete milling of these layers will ensure that all surface contaminants such as oil, carbonates and acids are removed.

All the major distresses present in the existing pavement should be repaired prior to the overlay placement. The main guideline to follow when performing this work is to assess whether the distress is likely to affect the performance of the overlay within a few years. If that is the case, the distress has to be fixed before the BCO is built.

Spalled cracks, opened cracks, delaminations, punchouts, and deteriorated patches must be repaired. Most distresses require full-depth repairs, which have to be continuously reinforced with steel bars to ensure continuity between the repair and the existing pavement. This will preserve the load transfer capability of the slab, for which the bars must be properly tied or welded to the reinforcing steel in the existing concrete. Partial-depth repairs, in which the distressed concrete is removed by a combination of sawing and chipping, or by cold milling, are suitable only when the deterioration is limited to the surface of the concrete.

Surface preparation encompasses operations conducted on the existing substrate to roughen its texture in such a way that the new concrete layer becomes bonded to it as if both strata were a single structure. There are several surface preparation methods to achieve a roughened substrate. The most common are shotblasting, sandblasting, and cold milling.

Steel reinforcement bars can be placed directly over the surface of the existing pavement, rather than at mid-depth of the overlay. The performance of the steel has been demonstrated to be the same, but placing it on top of the substrate saves construction time and costs, since it is much easier and economical to lay it over the surface than to place it on chairs at mid-depth.

Surface cleaning refers to the removal of dust and debris after the surface preparation is complete and prior to the placement of the BCO, to ensure that no foreign elements interfere with the achievement of bonding between both concrete layers.

Once the surface has been cleaned, it is ready to be overlaid. Customary concrete placement procedures for new pavement apply for placement of BCOs. Special attention should be given to adverse environmental conditions during paving. Hot, dry climates pose the most problematic setting for BCO placement, because these conditions favor the loss of moisture from fresh concrete.

Curing is a key component for the preservation of satisfactory moisture content and temperature in the concrete during its early stages so that desired properties may develop. Curing can be accomplished by a variety of methods, which include the use of a curing compound, membrane curing, curing blankets, evaporative retardants and burlap.

An expedited BCO can be opened within 6 to 24 hours after placement. To make this possible, normally the BCO is constructed with a high-early-strength PCC mix, which is attained by using Type III cement, as opposed to the normal cement (Type I). In general, if Type III cement is not utilized, the mix is supplemented by the use of superplasticizers. Another type of admixture that may be added is an air entrainment agent to increase workability.

Manuel Trevino and Yetkin Yildirim are affiliated with the Center for Transportation Research, University of Texas at Austin.

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Diamond-Ground PCC
Smother than SMA on Ike

By John Roberts

High-speed pavement testing indicates diamond-ground portland cement concrete is smoother than stone matrix asphalt in adjacent sections on I-290, the Eisenhower Expressway on Chicago's West Side.

In September 2011, Ames Engineering of Ames, Iowa, conducted profile testing of three lanes in both directions of I-290, the “Ike” between Austin Ave. and Sacramento Blvd. The profile testing was conducted to compare the SMA ride qualities with those of the CDG.

In summer 2010, on this section of roadway, both a stone matrix asphalt (SMA) overlay and a conventional diamond-ground (CDG) surface were constructed. The project, which extended for approximately 3.8 miles, consisted of overlay of three to four lanes of the existing plain-jointed portland cement concrete (PCC) pavement roadway in each direction with SMA from Austin to Kostner Ave., and from Homan Ave. to Sacramento Blvd.

Conventional diamond grinding was used to retexture the existing continuous reinforced concrete pavement (CRCP) between Kostner and Homan avenues. This diamond grinding was begun in July 2010 by a joint venture of Quality Saw and Seal and Safety Grooving and Grinding.

Evaluating Noise

In 2010, shortly after completion of the diamond grinding, the project was evaluated for tire/pavement noise using an on-board sound intensity noise measurement device. The CDG and SMA surfaces were comparable in noise level, with the CDG registering at 103.7 dBA and the SMA at 103.4 dBA.

The diamond grinding on this project received an award for its ride quality, which prompted the International Grooving & Grinding Association (IGGA) to conduct profile testing of both the SMA and CDG surfaces to enable a comparison of the ride characteristics. Ames Engineering was hired to conduct profile testing of the project.

In September 2011, Ames Engineering began the profile testing on I-290 in the target area between Austin and Sacramento. Both the eastbound and westbound directions were tested to compare the smoothness levels of a diamond ground section to the SMA overlay, both of which were constructed at the same time in summer, 2010.

Testing was completed during a single night. The outside lanes were tested in both directions. The westbound testing was initiated at the Sacramento Blvd. overpass and terminated at the new overlay terminus just east of the Austin Ave. overpass. The eastbound testing commenced at the Austin Ave. overpass and terminated at the Sacramento Blvd. overpass.

Specialized Equipment

The Ames Engineering profile van measured the profile in each wheel path simultaneously. Two RoLine sensors were mounted on a cross member which attaches to the front bumper. The RoLine sensors were positioned approximately 12 in. above the pavement, and simultaneously the RoLine footprints were positioned 72 in. apart (center-to-center).

At the same time that profile measurements were obtained, still photos were taken at approximate 150-ft. intervals, allowing correlation between the profile results and a roadway image. The image was captured using a camera mounted to the windshield just below the rear view mirror. Both the images and profile data were linked to GPS coordinates.

“Ames tested with a state-of-the art wide band profiler, which is the most accurate method of testing,” said Scott Eilken, Owner, Quality Saw & Seal. “It doesn’t get any better than that.”

The research found that the diamond-ground surface had an overall average profile index (zero blanking band) of 20 in./mile with a standard deviation of 3.9 in./mile. While the SMA exhibited an overall average of 23.1 in./mile and a standard deviation of 6.3 in./mile. While 90 percent of the CDG surface exhibited a profile index of 25 in./mile or less, only 61 percent of the SMA surface achieved this. Additionally, while 100 percent of the CDG surface can meet a requirement of 30 in./mile, 10 percent of the SMA surface still would exceed this limit.

The results indicate that the CDG surface was smoother than the SMA overlay by approximately 3 in./mile, and that the smoothness variability was approximately half that of the SMA surface.

With the increased emphasis worldwide toward safe, smooth and low noise pavement surfaces, CDG has proven to be an economical and environmentally safe choice for today’s roadway specifiers. The traveling public and surrounding communities will notice the reduction in tire/pavement noise, while the transportation authorities will benefit from the safe, smooth and long-lasting pavement surface provided by CDG.

“This testing proves what this industry has known for a long time. A 20- to 25-year-old concrete pavement can be made smoother for less money using diamond grinding when compared to an asphalt overlay, and avoids the never-ending cycle of milling and overlay brought on by covering a structurally sound section of concrete pavement,” said Eilken.

John Roberts is executive director, International Grooving & Grinding Association.
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