Accelerating Infrastructure Innovations

FOCUS

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INSIDE

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U.S. Department of Transportation

Federal Highway Administration

RAP: The State of the Practice

Everything old is new again as State transportation departments look at increasing their use of reclaimed asphalt pavement (RAP), optimizing the use of natural resources while saving money. A new report from the Federal Highway Administration (FHWA), *Reclaimed Asphalt Pavement in Asphalt Mixtures: State of the Practice* (Pub. No. FHWA-HRT-11-021), highlights RAP use across the United States, as well as best practices for increasing the percentage of RAP used in hot-mix asphalt (HMA) pavements while maintaining high-quality infrastructure.

As stated in FHWA's 2002 recycled materials policy, "The same materials used to build the original highway system can be re-used to repair, reconstruct, and maintain them. Where appropriate, recycling of aggregates and other highway construction materials makes sound economic, environmental, and engineering sense." To view the policy, visit www.fhwa.dot.gov/legsregs/directives/policy/recmatmemo.htm.

Use of reclaimed asphalt pavement (RAP) conserves natural resources while saving money.

The use of RAP reduces the need for virgin aggregate, which is a scarce commodity in some areas of the United States. It also reduces the amount of costly new asphalt binder required in the production of asphalt paving mixtures. "The use of RAP conserves natural resources, lowers transportation costs required to obtain virgin aggregate, and decreases the amount of construction debris placed into landfills," said Audrey Copeland of FHWA. While RAP is most commonly used as a virgin aggregate and asphalt binder substitute, it can also be used as a granular base or subbase, stabilized base aggregate, and embankment or fill material.

A survey of FHWA's Long-Term Pavement Performance (LTPP) program test sections containing at least 30 percent RAP showed similar performance and pavement life when compared to virgin asphalt sections. These LTPP test sections were located throughout the United States and Canada. An analysis of Florida pavements also showed similar pavement life for sections containing no RAP and sections containing 30 percent RAP.

Recycling asphalt pavement first became popular in the 1970s, due to the high cost of crude oil. In the early 1990s, FHWA and the U.S. Environmental Protection Agency estimated that more than 82 million metric tons (90 million tons) of asphalt pavement were reused each year, making asphalt the most frequently recycled material in the country. Use slowed with the introduction of the Superpave mix design system in the

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RAP: The State of the Practice,
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Top: Milled RAP at a project in Kansas.

Bottom: About half of all States increased RAP usage from 2007 to 2009. At this asphalt plant in Minnesota, RAP is processed and new asphalt mixtures containing RAP are produced.

1990s, as guidance originally was not provided for the use of RAP with Superpave pavements. The Superpave mix design system also encouraged the use of coarse-graded mixtures, which in some cases limited the amount of RAP that could be used in the mix. However, guidelines in recent years have addressed the use of RAP in the Superpave mix design method, including the National Cooperative Highway Research Program's (NCHRP) Research Results Digest 253, *Guidelines for Incorporating RAP in the Superpave System,* and NCHRP Report No. 452, *Recommended Use of Reclaimed Asphalt Pavement in the Superpave Mix Design Method: Technician's Manual.* Increases in asphalt binder costs and diminishing supplies of quality aggregate, along with a new emphasis on green technologies, are now prompting greater interest in using RAP.

In 2007, FHWA created the RAP Expert Task Group (ETG) to advance the use of RAP in asphalt paving applications. ETG members include representatives from FHWA, State transportation departments, the American Association of State Highway and Transportation Officials (AASHTO), National Asphalt Pavement Association, National Center for Asphalt Technology, industry, and academia.

A 2009 survey conducted by the North Carolina Department of Transportation on behalf of AASHTO and the RAP ETG found that about half of all States increased RAP usage from 2007–2009. Twenty-three States reported experimenting with or routinely using high RAP (25 percent or more RAP in an asphalt mixture). In 2007, average RAP use was estimated at 12 percent in HMA mixtures in the United States. Concerns that limit the use of high RAP cited by States in the 2009 survey include the quality of the blended virgin and RAP binder and potential stiffening of the mix from high RAP quantities, leading to premature cracking.

To address these concerns, *Reclaimed Asphalt Pavement in Asphalt Mixtures* presents best practices for increasing RAP use. "Several different options are available to address potential concerns, and the most appropriate option will depend on various factors such as material properties, plant type, and production rate," said Copeland. Among the issues to be considered when increasing RAP use are the need for additional processing and quality control (QC), sources and categories of RAP, selection of the virgin binder grade, preparation of materials for mix design, blending and comingling of the virgin and RAP binders, and performance.

Best practices detailed in the report cover RAP processing, RAP percentages and binder grade selection, mix design considerations, plant production, and placement of RAP mixes. As the report notes, "Performing QCs throughout the entire processing and production process is critical." The use of performance tests to evaluate asphalt mixtures containing RAP is also recommended.

> "The same materials used to build the original highway system can be re-used to repair, reconstruct, and maintain them."

To download a copy of *Reclaimed Asphalt Pavement in Asphalt Mixtures: State of the Practice*, visit www.fhwa.dot.gov/publications/research/infrastructure/pavements/11021/index.cfm. For more information on RAP, visit www.fhwa.dot.gov/pavement/recycling/index.cfm, or contact Audrey Copeland at FHWA, 202-493-3097 (email: audrey.copeland@fhwa.dot.gov). ✻

FHWA Offers New Guidance on Hollow Bar Soil Nails

Guidance for mitigating corrosion in hollow bar soil nails is presented in a new Federal Highway Administration (FHWA) report, *Hollow Bar Soil Nails: Review of Corrosion Factors and Mitigation Practice* (Pub. No. FHWA-CFL/TD-10-002).

Hollow bar soil nails (HBSNs) have been used in temporary applications for earth retaining structures in the United States for more than 10 years, providing an alternative to solid bar soil nails when the solid bar installation would require casing of the hole. The use of HBSNs reduces the steps needed for installation, which can accelerate construction and increase work zone safety. When using soil nailing, the existing ground is reinforced and strengthened by installing closely-spaced steel bars, known as "nails," into a slope or excavation as construction of a retaining wall proceeds from the top down. This creates a reinforced section that is stable and able to retain the ground behind it.

A 2006 FHWA report, *Hollow Core Soil Nails: State of the Practice,* identified areas of further research that would help transportation agency personnel and design professionals understand the potential of HBSNs as a mainstream technology for permanent soil nail applications. One of the areas identified was corrosion mitigation guidance. To view the 2006 report, visit www.cflhd.gov/programs/techDevelopment/geotech/hollowcore.

A subsequent FHWA questionnaire sent to transportation agencies, consultants, manufacturers, trade associations, and contractors found that a lack of guidance on corrosion protection is limiting the use of HBSNs in corrosive environments. The new FHWA report identifies contributing factors that may lead to corrosion of HBSNs and reviews the current guidance on corrosion mitigation. "The hollow bar soil nails are a valuable technology. This study's goal was to further the knowledge base about the technology," said Justin Henwood of FHWA.

Factors affecting corrosion of HBSNs examined in the report include soil corrosivity, coatings, soil abrasiveness, grout properties, grouting procedures and equipment, stress in steel, and metallurgy.

Existing corrosion mitigation guidance is also discussed, including both U.S. and international (primarily European) guidance. Most of the existing guidance pertains to assessing the corrosion potential of the soil and then selecting an appropriate corrosion protection system. The U.S. and international guidance both recognize the importance of assessing the soil corrosivity using a suite of electrochemical tests. As the report notes, however, the level of testing and the assessment of corrosivity are different. The U.S. guidance is based on comparing the measured value of each electrochemical property, such as pH, resistivity, chlorides, and sulfates, with a certain threshold value for that property. The European practice is to assign a numerical rating to a variety of parameters, including electrochemical properties, and then assess the corrosivity of the soil based on the value of the cumulative ranking.

Recommendations for next steps outlined in the report include that studies be performed to assess the factors influencing the development of cracks in grout when using HBSNs. Also included in the report are copies of the FHWA questionnaire and a summary of responses received.

Additional information on HBSNs is provided in the 2010 FHWA publication, *Hollow Bar Soil Nails: Pullout Test Program* (Pub. No. FHWA-CFL/TD-10-001), which looks at bond strengths and load testing procedures. Included in the publication are details pertaining to an FHWA field study and analysis program and its test results. To download a copy, visit www.cflhd.gov/programs/techDevelopment/geotech/HBSN.

Hollow Bar Soil Nails: Review of Corrosion Factors and Mitigation Practice is available online at www.cflhd.gov/programs/techDevelopment/geotech/corrosion. For more information on HBSNs, contact Justin Henwood at FHWA, 720-963-3362 (email: justin.henwood@fhwa.dot.gov). *

FHWA's Central Federal Lands Highway Division used hollow bar soil nail technology for a project on South Fork Smith River Road in California.

Intelligent Compaction: One Giant Step Forward in Quality Control

Take a giant step forward in quality control (QC) for paving projects with the use of intelligent compaction (IC). With transportation agencies nationwide sharing the goal of producing quality projects that meet the public's expectations for performance, high quality compaction of the pavement subgrade and materials is key to long-life performance of the roadway. In the past, a lack of technology made it difficult to perform QC and evaluate compaction operations. The quality of the compaction operation could only be assessed after completion by looking at whether the results complied with the specifications for the project. "Today, IC can provide better control and oversight of the compaction process, resulting in improved and more uniform compaction and increased productivity," said Lee Gallivan of the Federal Highway Administration (FHWA).

Development and implementation of the IC technology has been advanced through a 3-year pooled fund study launched by FHWA and the Transportation Pooled Fund Program in 2007, "Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base, and Asphalt Pavement Materials" (Project No. TPF-5(128)). As part of the study, 16 IC demonstrations were conducted in 13 States across the country. Field reports on the demonstrations are available at www.intelligentcompaction.com. Two FHWA Tech Briefs, *Intelligent Compaction for Asphalt Materials* and *Intelligent Compaction for Soils and Subbase Materials*, are also available on the site or at www.fhwa.dot.gov/pavement (click on "Publications" and then search under "TechBrief").

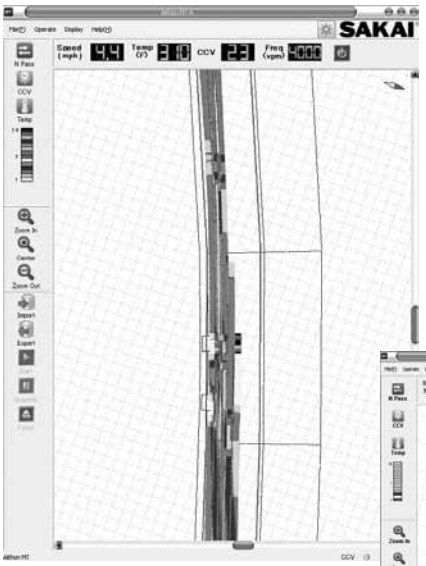
"Today, IC can provide better control and oversight of the compaction process, resulting in improved and more uniform compaction and increased productivity."

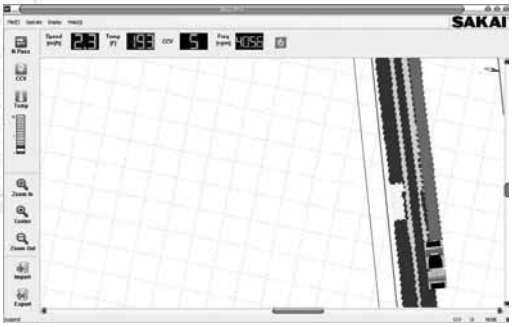
IC for hot-mix asphalt (HMA) is a process that uses a self-propelled double-drum vibratory roller equipped with new technology, including accelerometers mounted on the roller, an onboard computer to evaluate pavement response to the applied compaction effort, pavement surface temperature sensors, and color-coded display units. This accelerometer-based measurement system is known as intelligent compaction measurement values (IC-MV). The vibratory roller is also equipped with global positioning system (GPS) technology that monitors the operation of the roller and its location. Through a correlation process that uses pavement cores from a test section, the roller operator, quality control technician, and field superintendents can evaluate the quality of the compaction operation in real time.

The roller's color-coded display units show where the roller is located and where it has been to ensure that compaction is achieved over the full pavement area. The technology also provides the roller operator with information about when the individual rolling zones meet the specified compaction requirements, ensuring full coverage. This real-time display is particularly

An intelligent compaction (IC) roller is used to place a hot-mix asphalt lift on U.S. 219 in Springville, NY.

A thin lift of hot-mix asphalt is compacted with an IC roller on U.S. 52 in West Lafayette, IN.





Left: The color-coded IC roller display screen allows agencies and contractors an opportunity to locate and evaluate the stiffness of pavement sections, so that they can address areas that are too soft or not uniform.

Bottom: The IC roller display screen can also indicate where the roller is located and where it has been, showing pavement areas that have received overlapping passes and areas that have not had the target number of passes applied.

important during night paving, as it helps the roller operator to know the individual start and stop locations of each roller pass. The temperature sensors, meanwhile, continuously monitor the surface temperature of the HMA to ensure that compaction operations are conducted at optimum temperatures.

"Agencies have gone to great lengths to define the quality of the end product primarily based on the quality of the materials going into the mixtures. Most agencies include specifications designed to target densities as part of the compaction process, but few have defined quality as part of roadway operations," said Gallivan. "IC technology provides the opportunity to include compaction as part of the project's overall quality operations. The IC technology does not replace the roller operator, but it gives the operator the ability to more effectively use the equipment."

The availability of real-time information on compaction and pavement surface temperatures allows contractors and agencies to make adjustments to compaction operations as they go. Productivity is also improved by the ability to apply the proper number of rolling passes uniformly across the pavement, thus avoiding over-rolling or under-rolling. Additional quality improvements resulting from use of the IC technology include:

- Mapping of the underlying materials or paving surfaces either with or without milling can identify weak areas and facilitate timely remediation.
- Enhanced training of roller operators will lead to their increased ownership of the success of compaction operations.
- Improved compliance with density specifications will both produce a better pavement and benefit contractors as their pay and bonuses are determined.

Ultimately, quality compaction operations will result in improved pavement performance.

When using IC technology, the first step in evaluating quality is to develop target values. A new IC data management tool, Veda, can be used to create a "compaction curve" that plots IC-MV against roller pass counts. The compaction curve can be used to determine target IC-MV and optimal roller passes for a paving project. IC technology also provides contractors and agencies the opportunity to identify and evaluate the stiffness of pavement sections. They can then address areas that are too soft or not uniform, which can potentially create problems during the remaining construction operations or after the project is completed. These evaluations can be conducted on the existing subgrade or base materials, pavement, shoulders, or milled surfaces.

Developed through the pooled fund study and a collaboration with the Minnesota Department of Transportation (Mn/DOT), Veda also provides the ability to view and analyze geospatial IC data from multiple roller manufacturers. "The software can easily be used to perform standardized data processing and reporting, providing contractor and transportation agency representatives with summary results quickly in the field," said Gallivan.

"The full potential of IC technology as a quality control tool could not be determined without a program such as Veda that can organize, analyze, and provide plan-view plots and information on the immense amounts of data collected during construction activities," said Rebecca Embacher of Mn/DOT. Veda is currently being used in several IC demonstration projects around the country to further the development of the software as a quality control tool. To download Veda and the accompanying user's guide or to learn more about IC technology, visit www.intelligentcompaction.com.

For more information on using IC, contact Lee Gallivan at FHWA, 317-226-7493 (email: victor.gallivan@fhwa.dot.gov), or George Chang at the Transtec Group, 512-451-6233 (email: gkchang@thetranstecgroup.com). *

Highway Technology Calendar

The following events provide opportunities to learn more about products and technologies for accelerating infrastructure innovations.

Second International Conference on Warm Mix Asphalt
October 11–13, 2011, St. Louis, MO

Sponsored by the National Asphalt Pavement Association and the Federal Highway Administration (FHWA), the conference will provide a progress report on the implementation of warm-mix asphalt. Featured topics will include mix design, long-term performance, accelerated performance testing, effects on binder properties, and innovative temperature reduction processes. The conference will be of interest to engineers, researchers, contractors, and transportation agency personnel.

Contact: Matthew Corrigan at FHWA, 202-366-1549 (email: matthew.corrigan@fhwa.dot.gov), or visit www.warmmixasphalt.com.

Fifth Asphalt Shingle Recycling Forum
October 27–28, 2011, Dallas, TX

Organized by the Construction Materials Recycling Association, the forum will cover all aspects of the opportunities offered by shingle recycling. Using recycled asphalt shingles in hot-mix asphalt and other construction applications can save money and conserve natural resources while maintaining quality.

Contact: Audrey Copeland at FHWA, 202-493-3097 (email: audrey.copeland@fhwa.dot.gov), or visit www.shinglerecycling.org.

National Bridge Management, Inspection, and Preservation Conference
October 31–November 4, 2011, St. Louis, MO

Building upon FHWA's successful 2007 National Bridge Preservation Workshop, the conference will feature separate tracks for bridge management, inspection, and preservation topics. "Making the Case for Bridge Preservation" and "Next Generation Bridge Inspection" will also be featured themes. The conference is sponsored by FHWA and the American Association of State Highway and Transportation Officials' (AASHTO) Transportation System Preservation Technical Services Program (TSP•2).

Contact: Shyan-Yung Pan at FHWA, 202-366-1567 (email: shyan.pan@fhwa.dot.gov). Information is also available at www.TSP2.org/bridge.

Industrial Byproducts Conference
November 1–2, 2011, Austin, TX

Sponsored by FHWA, the Industrial Resources Council, and the Rubber Manufacturers Association, the conference will highlight the use of industrial byproducts in road construction.

Contact: Jason Harrington at FHWA, 202-366-1576 (email: jason.harrington@fhwa.dot.gov), or visit www.RMA.org.

Second Road Dust Best Management Practices Conference
November 7–9, 2011, Las Vegas, NV

Best practices in road dust management and lessons learned will be featured at the conference, which addresses environmental compatibility and sustainability, general and international best practices, and unique and extreme conditions. Sponsors include Montana State University; the University of Nevada, Las Vegas; Transportation Research Board (TRB); and FHWA.

Contact: For more information, visit http://roaddustinstitute.org/conference.

TRB 91st Annual Meeting
January 22–26, 2012, Washington, DC

More than 10,000 transportation professionals from around the world will gather at the meeting to share perspectives on current developments in transportation research, policy, and practice. The meeting will feature more than 4,000 presentations in nearly 650 sessions and workshops covering all transportation modes.

Contact: For information, visit the TRB Web site at www.trb.org (click on "Annual Meeting"). Questions about the meeting can be emailed to trbmeetings@nas.edu.

Ninth National Conference on Transportation Asset Management: Making Asset Management Work in Your Organization
April 16–18, 2012, San Diego, CA

Sponsored by TRB, AASHTO, and FHWA, conference topics will include asset management implementation, pavements and bridges, beyond pavements and bridges, and transit state of good repair. Abstracts for conference presentation proposals are being accepted until September 15, 2011.

Contact: To learn more, visit www.trb.org/conferences/assetmanagement2012.

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Pipe Installation, Inspection, and Quality: What You Need to Know

Find out what you need to know and look for when installing and inspecting pipes on highway construction projects with the Federal Highway Administration's (FHWA) free Web-based course, TCCC Pipe Installation, Inspection, and Quality (Course No. FHWA-NHI-134105). Developed by the Transportation Curriculum Coordination Council (TCCC) in partnership with State transportation agency personnel, the course is available through FHWA's National Highway Institute (NHI).

The self-paced, 7-hour course is designed for field personnel involved in all aspects of highway construction, from engineers to technicians. The guidance will also be useful for project managers or resident engineers. Course modules focus on the three basic pipe materials: concrete, metal, and plastic. Included is information on foundation work, bedding selection, placement, joint sealants, backfilling, and documentation for all three types of pipe. Upon completion of the course, participants will be able to:

- Identify basic types of pipe.
- Understand proper foundation and bedding requirements for pipes.
- Link different types of pipe with their required specifications for installation.
- Identify common errors to avoid when dealing with pipe placement, joints, and backfilling.
- Understand the importance of accurate records and reporting.

"This course will help transportation professionals improve their understanding of the factors that contribute to high-quality pipe installations. The instructional materials and guidance highlight best practices from various agencies," said Christopher Newman of FHWA.

> "This course will help transportation professionals improve their understanding of the factors that contribute to high-quality pipe installations."

Launched in 2000, the TCCC is a partnership that includes representatives from FHWA, NHI, regional State training and certification groups, several American Association of State Highway and Transportation Officials subcommittees, and industry associations. More than 100 Web training courses developed by the TCCC are available from NHI.

To register for TCCC Pipe Installation, Inspection, and Quality or for more information on other available TCCC training opportunities, visit www.nhi.fhwa.dot.gov. Information is also available by contacting Christopher Newman at FHWA, 202-366-2023 (email: christopher.newman@fhwa.dot.gov). ✻

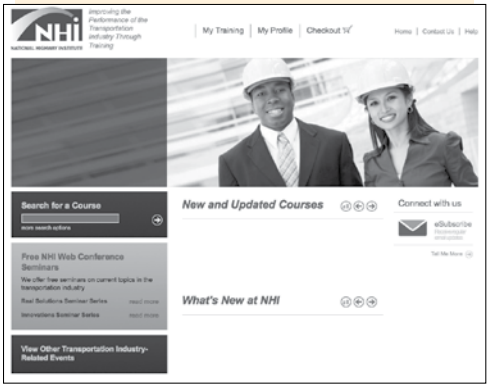
Annual Report Provides a Snapshot of NHI

Learn more about the work of the Federal Highway Administration's (FHWA) National Highway Institute (NHI) with its new 2010 annual report. The *National Highway Institute Year End Report: Fiscal Year 2010* opens with a look at the history of NHI, from its commissioning by Congress in 1970 to develop and deliver high-quality training for the transportation workforce to its ongoing innovations in training today. NHI now offers more than 300 courses across 15 program areas.

NHI's 2010 highlights include the launch of its redesigned Web site (www.nhi.fhwa.dot.gov), which provides an improved hub for all NHI training information. New features include the "My Training" section, where customers can view their course history, obtain unofficial transcripts for Web-based training courses and conferences, request official transcripts from the NHI Registrar, and download electronic materials from the NHI Store.

Also highlighted are NHI's many partnerships, including new collaborations with the American Society of Civil Engineers' Geo-Institute and the Deep Foundations Institute to assist in the delivery of geotechnical training.

For more information about NHI training opportunities or to download a copy of the 2010 report, visit www.nhi.fhwa.dot.gov. ✻



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Highway Technology Calendar,

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Seventh RILEM International Conference on Cracking in Pavements

June 20–22, 2012, Delft, Netherlands

Conference topics will include the detection, prediction, and mitigation of cracking in pavements; laboratory and field model validation; and accelerated pavement testing. Organized by RILEM (the International Union of Laboratories and Experts in Construction Materials, Systems, and Structures), conference partners include FHWA and AASHTO.

Contact: Katherine Petros at FHWA, 202-493-3154 (email: katherine.petros@fhwa.dot.gov), or visit www.rilem2012.org.

International Conference on Long-Life Concrete Pavements

September 18–21, 2012, Seattle, WA

Organized by FHWA, in partnership with the National Concrete Pavement Technology Center, the conference will address various aspects of concrete pavement design, construction, and materials technologies that result in long life, sustainable concrete pavements. A mini-symposium on concrete paving durability will be held the last day of the conference. The event is targeted at pavement, materials, and geotechnical engineering professionals, including Federal, State, and municipal engineers; consulting engineers; contractors; materials suppliers; and members of academia. Abstracts for conference presentation proposals are due by October 1, 2011.

Contact: Shiraz Tayabji at Fugro Consultants, Inc., 410-997-9020 (email: stayabji@aol.com), or Sam Tyson at FHWA, 202-366-1326 (email: sam.tyson@fhwa.dot.gov). Conference information is also available at www.fhwa.dot.gov/pavement/concrete/2012conf.cfm. *