

FOCUS

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A Guide to Cost-Effective Bridge Preservation

With an aging bridge inventory, increases in traffic and congestion, limited funding, and rising costs for labor and materials, State and local transportation agencies face significant challenges in addressing their bridge preservation and replacement needs. More than 30 percent of the Nation's bridges have exceeded their 50-year theoretical design life and are in need of various levels of repairs, rehabilitation, or replacement. This makes it more vital than ever for agencies to adopt strategic and systematic processes for bridge preservation as an integral component of their overall management of bridge assets.

A new *Bridge Preservation Guide* (Pub. No. FHWA-HIF-11042) available from the Federal Highway Administration (FHWA) provides a framework for implementing a preventive maintenance (PM) program. "The objective of a good bridge preservation program is to employ cost-effective strategies and actions that are aimed at maximizing the useful life of bridges. Applying the appropriate bridge preservation treatments and activities at the appropriate time can extend the useful life of a bridge at a lower lifetime cost," said Anwar Ahmad of FHWA.

In 2008 Congress changed the name of the Highway Bridge Replacement and Rehabilitation Program to the High-

way Bridge Program (HBP) and added systematic preventive maintenance as an eligible activity for Federal-aid funding. For more information on the use of Federal-aid funds for preventive maintenance, visit www.fhwa.dot.gov/preservation/100804.cfm.

A successful bridge program seeks a balanced approach that incorporates both preservation and replacement. Focusing only on replacing deficient bridges while putting off preservation needs will be inefficient and cost-prohibitive in the long term, as this will allow bridges in good condition to deteriorate. Preservation treatments often cost much less than major reconstruction or replacement activities. Delaying or foregoing warranted treatments will result in worsening

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www.fhwa.dot.gov/publications/focus/index.cfm



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Bridge deck repairs are performed prior to installation of a deck overlay, which can reduce the impact of aging and weathering.

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Cost-Effective Bridge Preservation,

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condition, often leading to more extensive work and higher costs.

The FHWA guide provides definitions for terms such as bridge preservation, preventive maintenance, rehabilitation, state of good repair, and structurally deficient, along with related commentary and examples. Also featured is a framework for establishing a Systematic Preventive Maintenance (SPM) program for bridges. As the guide notes, “An SPM program for bridges can be defined as a planned strategy of cost-effective treatments to existing bridges that are intended to maintain or preserve the structural integrity and functionality of elements and/or components, and retard future deterioration, thus maintaining or extending the useful life of the bridge.”

An SPM program can be implemented at the network-wide, highway system, area-wide, or regional level. Federal-aid funds may be used for SPM on highway bridges located on public roads regardless of whether a bridge is eligible for replacement or rehabilitation.

SPM programs should feature the following attributes at a minimum:

- *Goals and Objectives*—Clearly defined objectives and measurable goals. Goals and measures can also be developed for specific PM strategies.
- *Inventory and Condition Assessment*—Availability of tools and resources to conduct bridge inspections and evaluations.
- *Needs Assessment*—Documented needs assessment process that outlines how PM needs are identified and prioritized.
- *Cost-Effective PM Activities*—Ability to demonstrate that the proposed PM activities are a cost-effective means of extending the life of a bridge.
- *Plan for Accomplishing the Work*—Availability of tools and resources to accomplish the PM work.



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Top: Preparations are made to permanently close a bridge deck expansion joint to eliminate deterioration caused by a leaking joint.

Bottom: This bridge deck expansion joint has been permanently closed as a preservation measure.

- *Reporting and Evaluation*—Ability to track, evaluate, and report on the planned and completed PM work on a periodic basis. Expenditures should also be tracked over time, to ensure that the investment is providing the return expected.

Also highlighted in the guide are examples of PM treatments and activities that can extend the life of bridges when applied to the right bridge at the right time. For bridge decks, this can include installing

deck overlays to seal the deck surface and reduce the impact of aging and weathering, as well as using electrochemical chloride extraction (ECE) treatments to remove chloride ions and prevent corrosion of the bridge's reinforcing steel. Treatments for bridge superstructures include retrofitting fracture-critical members or fatigue-prone details and performing spot or zone painting to target areas where paint deteriorates the fastest and protect against corrosion.

Ultra-High Performance Concrete: New Solutions for Today's Highway Infrastructure



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Work is done on a bearing device to facilitate the proper expansion and contraction of a bridge.

For the bridge substructure, treatment options include using ECE to protect against corrosion and installing rip rap and other countermeasures to protect against bridge scour. Treatments that can be effective for all areas of the bridge include applying concrete sealants, coatings, and membranes to protect the surface of the concrete and stop or minimize the intrusion of water and chloride through the concrete, thus protecting the reinforcing steel from corrosion.

Included in the guide's appendices are National Bridge Inventory General Condition Rating Guidance and the American Association of State Highway and Transportation Officials' Bridge Element Condition State Guidance. Also included is FHWA's 2004 Memorandum on Preventive Maintenance Eligibility, as well as a list of resources.

The *Bridge Preservation Guide* is available online at www.fhwa.dot.gov/bridge/preservation/guide/index.cfm. For more information on bridge preservation, contact Anwar Ahmad at FHWA, 202-366-8501 (email: anwar.ahmad@fhwa.dot.gov).

Bridge preservation will also be one of the featured topics at the National Bridge

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Say hello to superior strength and durability with ultra-high performance concrete (UHPC). A new TechNote released by the Federal Highway Administration (FHWA), *Ultra-High Performance Concrete* (Pub. No. FHWA-HRT-11-038), provides transportation agencies with an introduction to UHPC and discusses its applications and capabilities. "The mechanical and durability properties of UHPC make it an ideal candidate for developing new solutions to pressing concerns about highway infrastructure deterioration, repair, and replacement," said Ben Graybeal of FHWA.

UHPC is an advanced cementitious composite material first developed in the 1990s and commercially available in the United States since 2000. Compared to more conventional concrete materials,

UHPC exhibits superior properties such as exceptional durability, high compressive strength, usable tensile strength, and long-term stability. It generally contains high cementitious material contents, low water-to-cementitious material ratios, compressive strengths above 21.7 ksi (150 Mpa), and sustained tensile strength resulting from internal fiber reinforcement. These properties can be used to enhance bridge durability and develop new structural forms that will facilitate accelerated bridge construction.

The TechNote highlights the various applications of UHPC to date. Also covered are such topics as mixing and casting the concrete; curing procedures; testing procedures; sample preparation and extraction; structural design, analysis, and modeling; and inspection.

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Ultra-high performance concrete pi-girders were used in the construction of the Jakway Park Bridge in Buchanan County, Iowa.

Ultra-High Performance Concrete,

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Ultra-high performance concrete connections are tested at FHWA's Turner-Fairbank Highway Research Center in McLean, VA. These connections can link prefabricated bridge girders to precast concrete bridge decks.

In the United States, UHPC has been used in both Iowa and Virginia to build prestressed concrete girder simple-span bridges. UHPC girders can allow for longer spans or shallower girder depths, and enable the enhanced durability of the structure. Researchers have also developed an optimized bridge redecking system that uses UHPC. The two-way ribbed precast slab system, known as a waffle slab, uses the mechanical and durability properties of UHPC to create a resilient, lightweight deck.

The Iowa Department of Transportation (DOT) deployed the technology this year for the construction of the Little Creek bridge in Wapello County. With a waffle slab designed to be composite with the girders, the bridge is 18-m (60-ft) long and just over 10-m (33-ft) wide. Iowa DOT will continue to conduct field testing of the bridge's performance to evaluate use of the waffle slab as a precast deck alternative for new bridges and to replace deteriorated decks on existing bridges.

In New York, meanwhile, two bridges using field-cast UHPC to create deck-level

connections between precast concrete elements were constructed in 2009. An ongoing FHWA Transportation Pooled Fund project being conducted in partnership with the New York State Department of Transportation (NYSDOT) and the Iowa DOT is evaluating the performance of field-cast UHPC connections that link prefabricated bridge girders to precast concrete bridge decks. While the use of modular bridge deck components can produce higher quality, more durable bridge decks, the required connections have often been lacking in the past, diminishing the overall bridge system performance. The new UHPC connection eliminates the conflict points between the deck reinforcing bars and the girder shear connectors, allowing for easy field assembly. NYSDOT plans to use the concept in a highway interchange reconstruction project this year.

UHPC is also being investigated for use in such applications as precast concrete piles, seismic retrofit of bridge substructures, thin-bonded overlays on deteriorated bridge decks, and blast mitigation.

Buy America provisions are relevant to the steel fiber reinforcement used in UHPC. States planning to use UHPC in projects should work with their FHWA division office early in the design process to request a Buy America project waiver.

To download the TechNote, visit www.fhwa.dot.gov/publications/research/infrastructure/structures/11038/.

More details on UHPC are available in two Tech Briefs previously released by FHWA. *Field-Cast UHPC Connections for Modular Bridge Deck Elements* (Pub. No. FHWA-HRT-11-022) describes FHWA's ongoing Transportation Pooled Fund project. As the study has demonstrated, UHPC can exhibit an exceptional bond when cast against previously cast concrete. The use of UHPC can also significantly shorten the development length of embedded discrete steel reinforcement. These properties allow the modular component connection to be redesigned, simplifying construction and enhancing long-term system performance. The Tech Brief is available online at www.fhwa.dot.gov/publications/research/infrastructure/structures/11022.

Structural Behavior of a 2nd Generation UHPC Pi-Girder (Pub. No. FHWA-HRT-09-069) looks at FHWA's evaluation of a second generation UHPC pi-girder cross-section developed for use in short- and medium-span highway bridge applications. To download the Tech Brief, visit www.fhwa.dot.gov/publications/research/infrastructure/structures/09069.

Information on UHPC is also available by contacting Ben Graybeal at FHWA, 202-493-3122 (email: benjamin.graybeal@fhwa.dot.gov). To learn more about FHWA's structures research, visit www.fhwa.dot.gov/research/tfhrclabs/structures/index.cfm. To download recordings from two FHWA Webinars on UHPC, visit www.nhi.fhwa.dot.gov/about/innovationseries.aspx and select the November 18, 2010, Webinar or the April 21, 2011, session. *

FHWA Launches Construction Peer Network

Share your transportation construction best practices, identify proven solutions to project challenges, and learn from your peers as the Federal Highway Administration (FHWA) launches its Construction Peer Network (CPN) this fall. Using regional peer exchanges and new products such as a Program Information Tool (PI Tool), the CPN will bring States together to discuss benefits realized and lessons learned as they implement more effective construction practices.

“The information exchanged will establish a baseline of construction delivery processes and procedures, as well as highlight the state of current practices and identify state-of-the-art construction methods,” said Chris Schneider of FHWA.

The CPN’s goals are to:

- Find and share exemplary construction processes and practices.
- Provide options to State transportation agencies for maximizing limited resources.
- Widely deploy proven practices and innovations across the Nation.
- Promote ways to use construction funding more effectively, resulting in a positive impact on quality, cost, time, and other important project delivery metrics.
- Determine national baselines for critical construction processes to guide information sharing, research, and training.

“The ultimate result is to learn what works so that advancements and proven processes can be disseminated more rap-

idly across the country, enhancing highway infrastructure performance and safety and decreasing costs,” said Schneider.

CPN focus areas include:

- Project supervision and staffing.
- Construction quality.
- Construction administration.
- Construction safety.
- Innovation.
- Communications/Data/Information Sharing.

FHWA will host the first peer exchange workshop in February 2012, with more information on the event to be available later this fall. An estimated four additional regional peer exchange work-

shops will be held in 2012 and 2013. Prior to the workshops, FHWA and participating State agencies and contractors will gather data on construction best practices using the PI Tool, which is an electronic survey tool.

Additional expected products resulting from the CPN will include reports, case studies, and new or improved specifications and guidance.

For more information on the CPN, contact Chris Schneider at FHWA, 202-493-0551 (email: christopher.schneider@fhwa.dot.gov), or David Unkefer at the FHWA Resource Center, 404-562-3669 (email: david.unkefer@fhwa.dot.gov). *



The Construction Peer Network will bring States together to discuss benefits realized and lessons learned as they implement more effective construction practices.

FHWA’s new Construction Peer Network will identify and share transportation construction best practices.

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.

Precast/Prestressed Concrete Institute 57th Annual Convention and National Bridge Conference

October 22–26, 2011, Salt Lake City, UT

Focusing on the theme “Shape Your Future,” attendees will learn about new products and technologies and expand their knowledge of precast concrete structures. Event cosponsors include FHWA.

Contact: Raj Ailaney at FHWA, 202-366-6749 (email: raj.ailaney@fhwa.dot.gov), or visit <http://pciconvention.org/2011/index.html>.

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.

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.

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

GPS and You: Putting the Technology to Work

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.

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. *

Learn how global positioning system (GPS) technology can be used to improve transportation construction operations and quality with the Federal Highway Administration's (FHWA) free Web-based course, GPS Technology (Course No. FHWA-NHI-134078). Developed by the Transportation Curriculum Coordination Council (TCCC), the course is available through FHWA's National Highway Institute (NHI).

The 1-hour introductory course will provide participants with a general understanding of GPS, which is becoming a commonly used tool for highway construction and maintenance. GPS can be used, for example, in surveying, rough and fine grading, determination of utility locations, excavation and grading, and paving.

"Awareness of emerging GPS-based applications and equipment modifications is essential to technicians today when performing inspection and maintenance job functions," said Christopher Newman of FHWA.

Upon completion of the course, participants will be able to define GPS, describe the levels of GPS accuracy, and

understand how GPS is used in highway construction today. The training is designed for representatives from FHWA, State, and local agencies, as well as industry.

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 online training courses developed by the TCCC are available from NHI. In addition to basic training for transportation workers, many of the TCCC courses can help with implementation of emerging technological advances.

For additional information on the course or to register, visit www.nhi.fhwa.dot.gov. Details on other online TCCC training opportunities can be found at www.nhi.fhwa.dot.gov/training/course_search.aspx (click on "View All Available Web-Based Training Courses"). Information on the GPS technology course is also available by contacting Douglas Townes at the FHWA Resource Center, 404-562-3914 (email: douglas.townes@fhwa.dot.gov). *



GPS technology can be used in a range of highway construction practices, including paving.

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Its primary mission is twofold: (1) to serve the providers of highway infrastructure with innovations and support to improve the quality, safety, and service of our roads and bridges; and (2) to help promote and market programs and projects of the various offices of FHWA's Office of Infrastructure.

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Management, Inspection, and Preservation Conference. Scheduled to be held October 31–November 4, 2011, in St. Louis, Missouri, the conference is sponsored by FHWA and the American Association of State Highway and Transportation Officials' Transportation System Preservation Technical Services Program. The event will feature separate tracks for bridge management, inspection, and preservation topics. For more information, visit www.tsp2.org/bridge. *

To learn more about FHWA's structures preservation resources, including publications, memos, and other guidance, visit www.fhwa.dot.gov/bridge/preservation.

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