Public Roads

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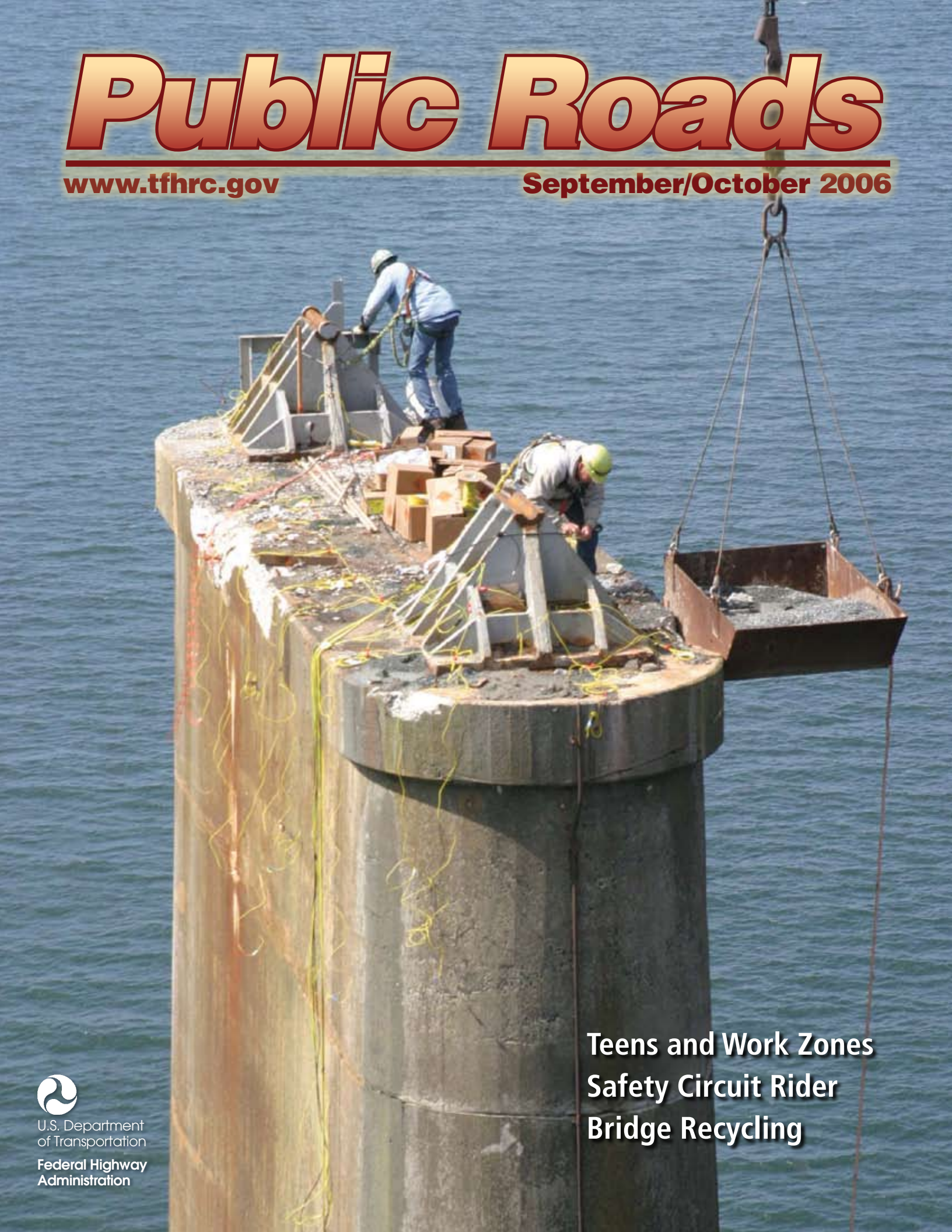
September/October 2006



Teens and Work Zones
Safety Circuit Rider
Bridge Recycling

U.S. Department of Transportation
Federal Highway Administration

Public Roads

—featuring developments in Federal highway policies, programs, and research and technology—

September/October 2006 www.tfhrc.gov Vol. 70, No.2

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Front cover—In Rhode Island, the Old Jamestown Bridge over an inlet of Narragansett Bay is undergoing demolition for beneficial reuse as an artificial reef. All structural steel was salvaged and recycled, and the concrete debris is being transported by barge to create the reef. Here, workers ready one of the piers for demolition. *Photo: RIDOT.*

Back cover—During the various demolition stages of the Old Jamestown Bridge, girder spans that were dropped in the second controlled explosion on May 18, 2006, are visible in the background. The new span, the Jamestown-Verrazzano Bridge, that replaced the old one in 1992 is visible on the right. *Photo: RIDOT.*

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The Secretary of Transportation has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this department.

Guest Editorial

Taking Safety One Step at a Time

Look both ways before you cross. Buckle up. Slow for work zones. Guardrails. Traffic lights. Rumble strips. Roadside shoulders. Signs. Pedestrian crossings. Bicycle paths. Comprehensive safety plans.

All of these innovations and thousands of other successful solutions help keep users of the Nation's transportation system safe while they travel for business and recreation. Yet, despite these safety measures, more than 42,000 road users lose their lives each year. What a challenge for the Nation to move the safety numbers in a positive direction!

The Federal Highway Administration is working on several projects with State departments of transportation, through the National Cooperative Highway Research Program, and with other organizations and programs to address this challenge through improved data and analysis tools, better estimates of the effectiveness of certain programs and projects, and identification of innovative treatments. For States, counties, metropolitan areas, and cities, the task of increasing safety, while also decreasing congestion, requires vigilance in applying new (and sometimes not-so-new) safety solutions. It takes patience, perseverance, keen investigative skills, and the ability to examine solutions and try new countermeasures and methods that the practitioner has never used before—one at a time until a successful one is found.

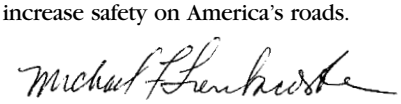
This issue of PUBLIC ROADS features four very different articles that provide ideas on how to tackle all sorts of safety problems. One article reports on a new outreach campaign to help young drivers learn to identify and navigate work zones safely. A second article covers intersection improvements that help address the limitations of older drivers and the mobility issues they face. A third pertains to pedestrians and the challenge of finding where and why roadway crashes involving them occur, and then implementing appropriate solutions at a time when local governments, cities, States, and the Federal Government are encouraging people to walk to improve their health and reduce the number of cars on the road. The fourth safety-focused article reports on low-cost solutions to improve safety on rural roads in Kentucky under its Safety Circuit Rider program.

Many transportation agencies are faced with multiple problem areas and need to search through various countermeasures to find the most appropriate approaches. These articles call to mind

two popular sayings that sum up the tenacity needed to implement solutions that improve highway safety. The first is from the soccer player Mia Hamm about success: "Factors like opportunity, luck, and timing are important. But the backbone of success is usually found in old-fashioned, basic concepts like hard work, determination, good planning, and perseverance." What does this have in common with highway safety? Achieving the national safety goal of reducing fatalities to 1 per 100 million vehicle miles traveled will require hard work, a mix of many different measures, and perhaps—a little luck.

The second quote comes from an old E.F. Hutton commercial about providing financial service the "old-fashioned way—one customer at a time." This is similar to the challenge of highway safety. By itself, no one solution can achieve a major improvement in the safety numbers. Several nationwide initiatives, such as increasing the use of safety belts, are critical to making progress. However, to achieve double-digit improvements in safety—to improve driver behavior, vehicles, and roadway infrastructure—the transportation community will need to implement safety "the new-fashioned way—one *action* at a time."

In the transportation community, everyone needs to keep working on the problems and solutions one at a time, finding what works one at a time, evaluating improvements one at a time, and keep ensuring that a range of solutions is covered in the coordinated manner that is needed to increase safety on America's roads.



Michael Trentacoste
Director, Office of Safety R&D
Federal Highway Administration

IN STEP WITH SAFETY

by Tamara Redmon and Charles Zegeer

FHWA offers new guidance and technical assistance to help States develop action plans to protect pedestrians.

Pedestrian fatalities, which account for 11 percent of all roadway deaths nationwide, are a growing concern in the United States. In fact, the Federal Highway Administration (FHWA) has made reducing pedestrian fatalities a critical focus area within the Nation's overall safety goal.

In a May 2004 memorandum, former FHWA Associate Administrator for Safety George Ostensen described a new FHWA goal of cutting pedestrian fatalities by 10 percent by the year 2008. As a performance goal, Ostensen wrote, FHWA hoped that cities with the highest numbers of pedestrian fatalities per year would implement pedestrian safety plans.

To identify cities with high fatalities, FHWA analyzed national highway safety data to determine where concerted efforts could address one or more of the agency's three safety emphasis areas: roadway departures, intersections, and pedestrians. The analysis revealed a number of "focus States" with pedestrian fatality, injury, or crash rates higher than the national average: Arizona, California, Florida, Georgia, Hawaii, Illinois, Michigan, New Jersey, New Mexico, New York, North Carolina, Pennsylvania, and Texas. To address pedestrian safety, FHWA selected five focus cities, in addition to the focus States, because pedestrian activity can be viewed in one sense as a local issue, with limited jurisdiction by State authorities. The focus cities are Chicago, IL; Detroit, MI; Los Angeles, CA; New York, NY; and Phoenix, AZ.

At the State and local levels, developing pedestrian safety plans may be new tasks for personnel at individual transportation agencies, and existing staff may need experience and expertise in developing them. Accordingly, FHWA partnered with the Pedestrian and Bicycle Information Center (PBIC), a nonprofit program of the University of North Carolina Highway Safety Research Center, to address the need by creating a guide for State and local governments on how to develop and implement action plans. The final guide, *How to Develop a Pedestrian Safety Action Plan,* FHWA-SA-05-12, was completed in 2006.

The pedestrian safety guide, coupled with newly available technical assistance and training, provides the tools to help States, cities, and local governments address the challenge of ensuring the safety of pedestrians in the roadway environment. FHWA and PBIC created the guide for use by engineers, planners, traffic safety and enforcement professionals, public health and injury prevention professionals, and decisionmakers responsible for improving pedestrian safety at the State and local levels.

"The how-to guide will help the focus States and cities determine and address their pedestrian safety problems," says Beth Alicandri, director of FHWA's Office of Safety Programs, "but FHWA also sees it as a successful practices guide that communities throughout the entire United States can use to improve pedestrian safety."

Seven Steps to Safety

The new guide provides State and local officials with information about pedestrian safety issues, covering topics that range from identifying safety problems, analyzing data, and selecting optimal solutions to help agencies enhance existing safety programs and activities. Other useful information includes tips on involving stakeholders, potential funding sources for implementing projects, and methods for evaluating the outcomes of projects.

Designed primarily as a reference manual, the guide *How to Develop a Pedestrian Safety Action Plan* focuses

(Above) A new "how-to" document titled *How to Develop a Pedestrian Safety Action Plan* offers guidance to engineers and others involved in protecting the safety of pedestrians. Here, a "pork chop" island helps pedestrians navigate a complex intersection more safely. *Photo: Michael Ronkin, Designing Streets for Pedestrians and Bicyclists.*

on redesigning streets, implementing engineering countermeasures, and promoting safety education and enforcement programs that involve multiple agencies as well as community members. The guide lays out seven steps for developing a pedestrian safety action plan.

The first step is *planning and designing for pedestrian safety*. Major elements that affect pedestrian safety include land use, access management, street design, street connectivity, and site design. The guide explains, for example, that some design practices and policies that were conceived to improve mobility for motor vehicles, such as the use of multilane and higher speed arterials and collectors, are now considered barriers to a safe pedestrian environment.

Among the strategies listed in the guide to improve planning and design for pedestrians are the following:

- Slowing vehicle speeds
- Reducing street crossing distances for pedestrians
- Providing pedestrian facilities such as sidewalks and crossing islands where appropriate
- Encouraging mixed-use development by fostering small-scale retail in neighborhoods or placing schools in the center of neighborhoods to help create destinations within walking distance of where people live, learn, and work

The second step is *involving stakeholders* in the decisionmaking process, which helps yield more comprehensive solutions to safety problems. Stakeholders include citizens, citizen-based organizations, public employees and agencies, businesses, and the media.

"Stakeholders who are well informed about the problems and implications provide the best advice," says Peter Lagerwey, Seattle pedestrian and bicycle coordinator. "Local and statewide pedestrian safety action plans should also address the problems and needs at the neighborhood level to meet the diverse needs of an ever-changing population, including specific ethnic groups, age groups, and persons with disabilities."

Providing multiple venues for participation and feedback, such as public meetings, e-mail addresses, phone numbers, Web sites, and comment forms, maximizes convenience for diverse stakeholders. Also, project-specific task forces may be advisable for large, complicated, or controversial projects.

A digital illustration superimposed upon this photograph provides an example of how simple changes—access management, a raised median, bicycle lanes, sidewalks, and landscaping—can make the roadway environment more safe and appealing for pedestrians. *Photo: Michael Ronkin, Designing Streets for Pedestrians and Bicyclists.*

The third step, *collecting data to identify pedestrian safety problems*, focuses on reviewing crash statistics to verify the nature and extent of perceived problems. However, the guide advises against expending too many resources on data collection, as scarce dollars should be reserved for making safety improvements. Wherever possible, localities should create geocoded databases of pedestrian crashes to facilitate identifying problem locations. Once created, databases need to be maintained and updated over time.

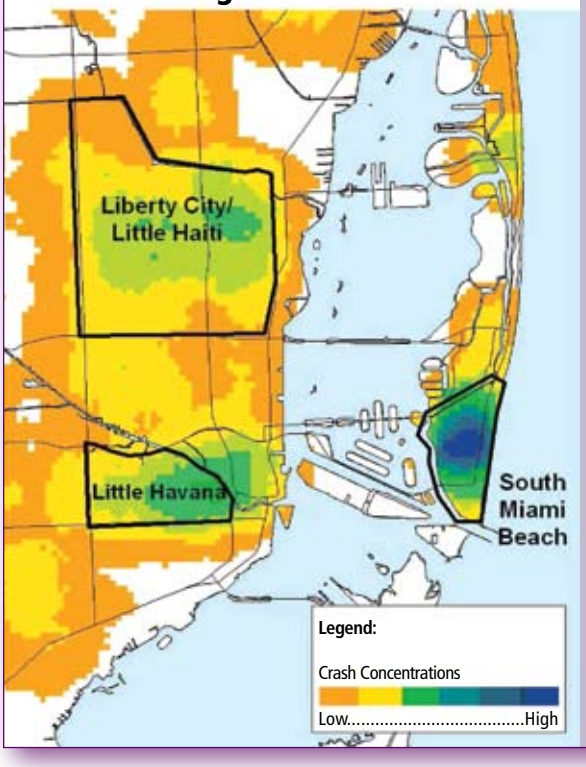
Fourth, systematically *analyzing information and prioritizing concerns* is crucial to identify where countermeasures should be implemented. Areas of need will always outstrip available funds, so localities need to develop a system of prioritization to rank the competing projects. Typically, the severity of pedestrian crashes is so disproportionately high compared to other motor vehicle crashes that reducing pedestrian crashes will yield a high safety dividend and high benefit/cost ratios.

To identify high pedestrian crash locations, the guide's authors recommend reviewing pedestrian crash data over a 3- to 5-year period. To assess entire corridors, the guide suggests breaking the study area into roadway segments of 0.8 kilometer to 8 kilometers (0.5 mile to 5 miles) in length and looking for patterns in crash locations or circumstances, such as a prevalence of crashes at transit stops or at night. Pedestrian safety concerns also can be identified through pedestrian safety audits conducted by a multidisciplinary team that examines walking facilities and pedestrian and driver behavior at a specific location or along a corridor.

The pedestrian safety guide will bolster ongoing State and local efforts, such as here, in California, where school officials and parents participate in a Safe Routes to School program.

www.pedbikeimages.org/Dan Burden

Miami-Dade High Pedestrian Crash Zones



NHTSA/Miami-Dade Pedestrian Safety Demonstration Project

The metropolitan planning organization (MPO) for Miami-Dade County, FL, created a series of maps using geographic information systems software to identify areas with a high number of pedestrian crashes. The MPO created this map showing Miami and South Beach in conjunction with the National Highway Traffic Safety Administration's (NHTSA) pedestrian safety demonstration project, which seeks to reduce deaths, injuries, and associated crash costs within the county's urban setting.

The guide explains how to implement systemwide changes, such as adopting more pedestrian-friendly policies (such as creating a pedestrian advisory board, providing pedestrian facilities as part of new projects, and designing roads for all users) and implementing educational programs in elementary schools.

The fifth step, *selecting safety solutions*, depends on the types of pedestrian crashes. The guide specifically addresses the following common pedestrian crash categories: walking-along-the-road, midblock, nighttime, intersection right-turn, intersection straight-through, intersection left-turn, signalized intersection, and transit-related crashes. Although law enforcement, education, land use, and site design represent effective countermeasures, the guide's primary focus is on engineering solutions.

For example, localities can reduce the number of walking-along-the-road crashes by installing sidewalks in urban areas and paved shoulders in rural areas, ensuring well-designed driveways and access control, and installing nighttime illumination.

Countermeasures to avoid midblock crashes include installing crossing islands, curb extensions, yield lines at uncontrolled crossings, or advance stop bars (a painted line placed before a street crossing to direct motor vehicles where to stop for pedestrians). Another midblock countermeasure is adding pedestrian-actuated traffic signals with pedestrian signal (Walk/Don't Walk) displays.

Intersection crashes involving pedestrians and turning vehicles may be reduced by providing tighter turning radii, raised median islands, or properly designed, channelized right-turn lanes.

Signalized intersections should typically have pedestrian signals, marked crosswalks, and adequate crossing times. Signal enhancements such as protected left-turn phasing, all-red intervals, leading pedestrian intervals, or pedestrian countdown signals also may be beneficial.

Routes with transit stops have a high potential for pedestrian crashes. Therefore, transit stops should be located at safe pedestrian crossing areas and where sidewalks and adequate lighting are provided.

The sixth step, *providing funding*, is crucial for implementation. With most State and local governments facing budget constraints, allocating funds for pedestrian safety can be challenging. Nevertheless, some States and towns are achieving very low pedestrian crash numbers despite limited funding.

A policy change or an update to a design standard that leads to fewer pedestrian crashes may not cost anything. For example, almost all arterial streets in Seattle, WA, have a design speed of 48 kilometers per hour (30 miles per hour), which is the legal speed limit unless otherwise posted. This may be one of many reasons why Seattle has one of the lowest pedestrian fatality rates in the country.

The guide discusses various funding sources and strategies that States and localities can use. For example, pedestrian safety improvements could be financed through annual maintenance budgets, routine accommodations in new projects, dedicated funds and set-asides, or partnerships with universities, private developers, public works entities, or utility companies, among others.

The final step, *creating the pedestrian safety action plan*, involves putting countermeasures into a practical and achievable strategy that enables the locality to measure progress over time. The plan provides the blueprint for going from the

Crosswalks and signals encourage pedestrians like those shown here to cross at signalized intersections.

Robert Schneider, Toole Design Group

Transit stops should be designed like this one with pedestrian needs in mind. Possible measures include shelters, signs, lighting, sidewalks connecting to the pedestrian travel network, and bus loading areas that are wheelchair accessible. *Photo: Michael Ronkin, Designing Streets for Pedestrians and Bicyclists.*

"where" to the "what" to the "how" stages in improving pedestrian safety. The typical action plan involves the following eight tasks: defining objectives; identifying locations with opportunities for improvement; assessing and selecting countermeasures; developing an implementation strategy; institutionalizing changes to planning, design, operational, and maintenance standards; considering land use and site design issues; reinforcing commitment; and evaluating the results of projects implemented. The guide describes each step in detail to help States and localities successfully develop their own comprehensive plans.

Getting the States Involved

The FHWA Office of Safety worked with the FHWA division offices in each focus State and city to identify people who would champion development and implementation of the pedestrian safety action plans. The champions were informed about the goals that FHWA aimed to accomplish and about free technical assistance from PBIC that could assist them in their efforts.

FHWA developed an e-mail list to keep the State and city champions up to date on the progress of projects and to enable them to communicate with each other. In addition, FHWA hosts monthly conference calls to discuss projects and issues of concern. The calls help keep projects in the forefront of the champions' minds.

In addition to these ongoing communication activities, FHWA sponsored a national meeting for the focus States and cities in October 2005 in Chicago, IL. The meeting was held in conjunction with the Association of Pedestrian and Bicycle Professionals' Professional Development Seminar series. The National Cooperative Highway Research Program covered travel costs for participants, and FHWA paid the registration fees.

The meeting introduced representatives from the focus States and cities to the topics that are covered in the guide. Engineers, planners, public officials, and advocates concerned with pedestrian safety delivered presentations. Federal, State, and local officials shared information

Michael Ronkin, Designing Streets for Pedestrians and Bicyclists

(Above) This crowded sidewalk, flanked by shops and outdoor seating, offers an inviting atmosphere where pedestrians can stroll and congregate. This sidewalk has a pedestrian level of service (LOS) rating of "A."

(Right) By contrast, the sidewalks here earn a pedestrian LOS rating of "F." According to the *Highway Capacity Manual* model, LOS ratings are primarily based on delay caused by other pedestrians on the sidewalk. This example illustrates the need for new LOS models to take into account such factors as safety and comfort.

Michael Ronkin, Designing Streets for Pedestrians and Bicyclists

on their successful programs and activities to improve pedestrian safety.

The presentations led participants through the steps involved in developing action plans, the goal being to change the way agencies approach pedestrian safety and to train their engineers and designers to account for pedestrian safety in their roadway plans. The first session addressed pedestrian crash data and analysis, starting with an overview of the new how-to guide and the importance of involving multiple stakeholders in the development of a pedestrian safety plan. The second session focused on developing countermeasures and obtaining funding for pedestrian safety improvements.

Many intersections, like the one shown here, are designed to accommodate large volumes of fast-moving vehicles. These types of intersections often pose risks to pedestrian safety. *Photo: Michael Ronkin, Designing Streets for Pedestrians and Bicyclists.*

Free Technical Assistance

As part of its FHWA contract, PBIC and its subcontractors also crafted a menu of technical assistance options for the focus States and cities to use when developing their pedestrian safety action plans. The team produced two courses to help direct the jurisdictions toward the goals of developing action plans and opening communication with relevant stakeholders. The first course, Designing Streets for Pedestrian Safety, is available as either a 1-day or 2-day training session. The other, Pedestrian Safety Plan Workshop, is a 2-day course.

The course Designing Streets for Pedestrian Safety focuses on engineering countermeasures and designs for pedestrian safety. "Too often roads have been designed for vehicles only, without regard to the pedestrians who have to cross the roads," says Bob Planthold, cochairman of California Walks, a pedestrian advocacy group.

The course discusses the following topics: planning factors that affect pedestrian safety, sidewalk design elements, transit interactions, street crossings, popular countermeasures and enhancements, and intersection designs and signalization options. The 2-day version of the course also includes a field trip to a problem location where participants work in groups to provide potential solutions to help "fix" the problem. In addition, attendees participate in a brainstorming session afterwards to report their solutions, share information with one another, and discuss the next steps needed to implement the proposed remedies.

Although FHWA provides funding for the trainers and their travel, the local host is responsible for inviting key people to the training, organizing the sessions, and taking care of logistics. The host solicits participation from advocates, key politicians, and decisionmakers as well. As of this writing, FHWA and PBIC presenters have conducted a total of 23 training sessions, in Arizona, California, Florida, Georgia, Hawaii, Illinois, Michigan, New Jersey, New Mexico, New York City, New York State, and Pennsylvania. Sessions are planned for Chicago, IL; North Carolina; and Texas.

Initial feedback indicates that course attendees find value in the course. "The modules that were developed for this training were extremely informative and brought a new way of thinking to New Jersey," says Sheree J. Davis, the bicycle and pedestrian program coordinator for the New Jersey Department of Transportation, who attended a session in March 2006. "The course was very organized, and it heightened the awareness that innovative thinking and the use of new technologies could work in a State that is so densely populated and congested," Davis says. "It was so well done that we would like [the PBIC and FHWA workshop instructors] to come back and [conduct] the workshop again."

Jim Ercolano, a pedestrian specialist for the New York State Department of Transportation, echoes those sentiments. The Designing Streets for Pedestrian Safety course "included a historic joint New York City Department of Transportation and New York State Department of Transportation session on Queens Boulevard, sponsored by [NYC's] Division of Traffic Planning," he says. "Class instruction and onsite assessment workshops were outstanding, reflected in the fact that more than 90 percent of course evaluations rated the training from good to excellent."

The other course, Pedestrian Safety Plan Workshop, essentially sums up the information in the new guide, *How to Develop a Pedestrian Safety Action Plan*. Topics covered include planning and designing for pedestrian safety, making a commitment, involving stakeholders, collecting data, analyzing information and prioritizing concerns, and selecting countermeasures. Like the first course, this one includes a field trip, brainstorming session, and discussion of next steps.

"Second only to the 2004 *AASHTO* [American Association of State Highway and Transportation Officials] *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, this how-to guide is an essential reference for pedestrian-related design, safety, and access issues," Ercolano says, pointing to the value of the workshop.

Despite the requirements placed on local hosts, past attendees indicate that the courses are worth the time and investment. "The FHWA courses on the pedestrian safety action plan and designing for pedestrian safety validate our anecdotal

insights and make it easier to educate and persuade local and State officials to pay proper attention to reducing collisions between vehicles and pedestrians," says Planthold, of California Walks. "The written guide and the companion course are a worthy investment of the time for all traffic, public safety, and public health professionals."

Adds Beth Rolandson, senior transportation planner for the city of Santa Monica, CA: "Many people working for municipalities have competing demands for their time, and it can be difficult to take the time to do more proactive work. Sometimes the big picture gets lost while accomplishing immediate tasks. Santa Monica is in the process of updating our community's circulation element, and the day after the training I went back to work and made sure safety was on the short list of community priorities for transportation."

Interest in the training sessions continues to grow. The State of New York, which held the first sessions of Designing Streets for Pedestrian Safety, is in the process of planning more sessions for this year and next, according to Ercolano. California, Florida, Michigan, and New Mexico also have requested more.

PBIC is in the process of training more trainers to join the team. FHWA also is adapting the live instructor courses to create online versions that can help keep down costs and provide more access to training opportunities. Safety Engineer Peter Eun, with FHWA's Resource Center, is pilot testing a distance learning version of the course Developing an Effective Pedestrian Safety Action Plan. If it proves successful, the Resource Center will offer the training more broadly in the near future. "A distance learning version would make it easier for State and local agencies with limited budgets to still have access to the training materials and the ability to ask questions of a panel of national pedestrian safety experts," Eun says.

Aside from the two courses, States are free to select the types of technical assistance that make the most sense for their given circumstances. For instance, States that are well along in the process of developing pedestrian safety plans may prefer a different type of assistance, such as having a pedestrian safety expert help them identify countermeasures for problem locations.

Michael Ronkin, Designing Streets for Pedestrians and Bicyclists

Technical workshops reinforce the pedestrian safety guide and illustrate safety countermeasures, such as well-delineated crosswalks and medians like the ones shown here from above.

Off to a Good Start

"The U.S. Department of Transportation has set ambitious safety goals, and achieving significant reductions in pedestrian fatalities is a critical step in reaching those goals," says FHWA Associate Administrator for Safety Jeff Lindley. "The focused approach helps us make significant progress in pedestrian safety, and the how-to guide and the training workshops are critical tools in implementing this approach."

"FHWA is showing a very proactive approach to protecting those most vulnerable to traffic collisions—pedestrians," says Planthold. "FHWA's work now makes clear that pedestrians also are a population to be considered in designing roads for safety—for all who use them."

Tamara Redmon is team leader for the Pedestrian and Bicycle Program in FHWA's Office of Safety. She has worked for FHWA for more than 15 years. She develops products and programs to help reduce pedestrian and bicyclist crashes, fatalities, and injuries. She holds a bachelor's degree from Virginia Polytechnic Institute and State University and a master's degree from Marymount University.

Charles Zegeer is the director of PBIC, an entity within the University of North Carolina Highway Safety Research Center. He has been principal investigator on numerous Federal studies related to the safety of roadway design and engineering measures, including pedestrian and bicyclist safety. He holds a bachelor's degree from Virginia Polytechnic Institute and State University and a master's in civil engineering from the University of Kentucky. He is a registered professional engineer.

For more information, contact Tamara Redmon at 202-366-4077 or tamara.redmon@fhwa.dot.gov, or Charles Zegeer at 919-962-7801 or charlie_zegeer@unc.edu. How to Develop a Pedestrian Safety Action Plan *is available for download at www.walkinginfo.org/pp/howtoguide2006.htm. Hard copies of the guide also are available and can be ordered in limited quantities at the same site.*

High-Tech in the Far West

by Kevin Benedict

The Idaho Transportation Department taps into wireless technology for collecting and reporting data on maintenance at rest stops.

According to a February 2006 announcement from Gartner, Inc., a computer research company, 14.9 million personal digital assistants (PDAs) were shipped in 2005 worldwide. These sales surpassed the previous high mark set in 2001 and represented a 19 percent increase from 2004. Some businesses already are discarding traditional paper forms and filing practices for these efficient mobile tools and disk storage methods. The result could be long-term savings in overhead costs and resources, improved accuracy in data collection and reporting, and expedited work performance.

Not only are private companies tapping into the potential of PDAs, State governments also are taking heed. In March 2005 the Idaho Transportation Department (ITD) launched a PDA pilot program that would help the agency achieve "enterprise application integration," which is defined by David S. Linthicum in his book *Enterprise Application Integration* as "a method of unifying disparate applications into a unified set of business applications."

In a long-term effort to improve business practices, ITD's managers decided that they would break new ground by introducing PDAs and specialized software to field inspectors in a pilot program that would help achieve the agency's goal of implementing programs that use the latest technological advancements. The pilot program provides mobile hardware and software to ITD's Maintenance Section to facilitate the collection and distribution of data on the maintenance of rest areas across the State's six regional districts.

Rest stop inspections help to ensure that government contractors responsible for building and grounds conditions are completing tasks in accordance with contract provisions. In the pilot program, ITD maintenance inspectors replaced the old handwritten methods of collecting data by trading in pens and paper forms for handheld computers, styli (pointed pen-shaped tools that enable users to interact with computer screens), and specialized software.

"We are excited about the innovative use of PDA devices for maintenance activities," says Paul C. Ziman, who is the operations, pavement, maintenance, and materials engineer with the Federal Highway Administration's (FHWA) Idaho Division Office. "ITD has been

(Above) An employee with the Idaho Transportation Department (ITD) is using a PDA to record measurements. *Photo: Kevin Benedict, MobileDataforce.*

pleased with the performance of the PDAs. Currently, the main use is as a platform for supporting electronic forms in the field. This method would be ideal for any personnel required to complete paperwork while operating away from their office. The form design software is easy to use, and the forms themselves operate smoothly and intuitively. The hardware has proven to be highly reliable, and the link to the centralized database is both effortless on the part of the user and reliable."

About the Idaho Transportation Department

More than 1,800 employees statewide carry out ITD's commitment to provide safe, efficient travel. The ITD employees are stationed in virtually every part of Idaho, from the headquarters in Boise to ports of entry at the State's borders and at a number of maintenance buildings along rural highways.

The department is divided into six operating divisions, and the Maintenance Section is one of nine agency subsections. Its mission is to provide the best possible services to ITD, other agencies, and the public by keeping Idaho's State highways and associated facilities clean, safe, and reliable.

Among its other duties, the Maintenance Section is responsible for overseeing custodial services for the buildings and grounds at 30 rest areas and 10 fixed ports of entry. These areas are assessed regularly by Maintenance Section inspectors who complete documentation for grading contractor performance. ITD staff review the information during contract renewal periods. Upon request, the agency provides copies of the records to contractors so they can monitor their employee work performance.

The agency chose the Maintenance Section to participate in the pilot program because of the antiquated system previously used for the field inspections, the limited funding available for a pilot, and the small number of employees in the subsection who would need equipment. The aim was to provide maintenance inspectors with a quick and easy method of completing documentation while in the field and a way to share the information with ITD staff by transferring data from the handheld PDAs into a centralized, easily accessed database.

Doing Things the Old Way

Before the launch of the pilot program, Maintenance Section employees manually completed paper forms, a cumbersome task that involved filling in various inspection requirements and scoring the maintenance performance by hand. The field inspectors then submitted the paper forms by mailing them to a central office, where clerks would file them for future retrieval.

When ITD staff needed to check on the effectiveness of a government contractor, office employees located the appropriate paperwork and then faxed or mailed it to the requestors for review. The process was time consuming and prone to error.

The paper forms were sometimes lost in the mail, resulting in the need for additional inspections. Occasionally, the paperwork was misplaced or misfiled, causing employees to put aside other tasks to locate the information. Completed forms often were difficult to interpret or inconsistent with State reporting standards. Because ITD had no computerized database for the rest area inspection records, the only way to retrieve pertinent data and produce statistics was to search manually through stacks of papers and file folders.

Forming a Plan for the Pilot

For many organizations, implementing a new program can be daunting. Employees may have a certain comfort level in doing things the old way. But by setting priorities and goals, focusing on problems associated with current procedures, and planning new problem-solving strategies, change can open the door to new and better opportunities and result in establishing positive work-related procedures that benefit the organization as a whole.

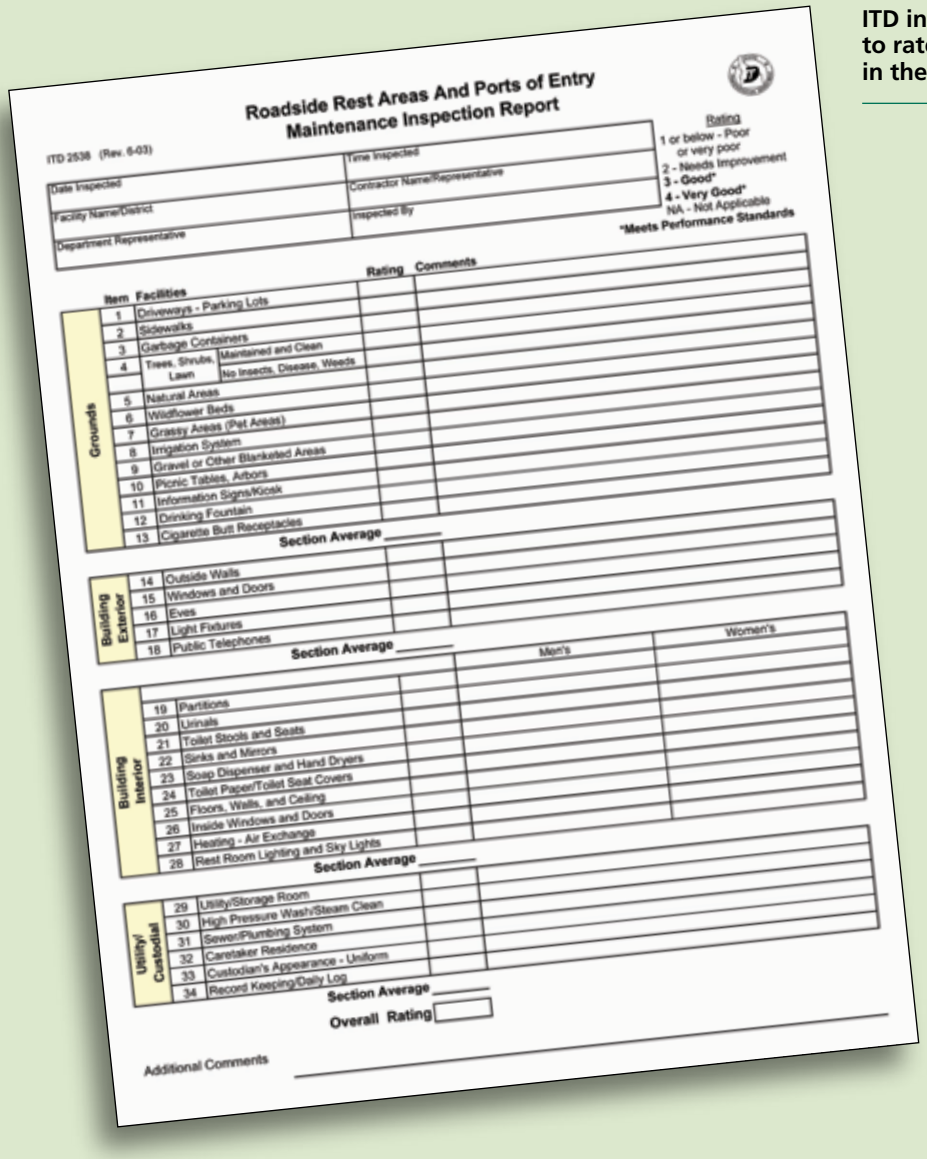
ITD assembled a team of employees who are affiliated directly or indirectly with the responsibilities of the Maintenance Section and who understand current organizational practices and the objectives of the pilot program. Equally important was the team's ability to encourage, influence, and enable others to commit to the project in a positive manner.

Together, the ITD team documented who was responsible for various aspects of the work, the process by which the maintenance inspections were completed manually, and how those processes interacted with the work practices of other agency employees. The team also identified problems and discussed potential solutions.

Researching various handheld computing options and data collection software, the team began the task of selecting the hardware and software that would assist inspectors in performing their jobs more efficiently and enable ITD to integrate inspection records into a central database. The team purchased standard handheld computers at

Kevin Benedict, MobileDataforce

An inspector with ITD is using a PDA to record her measurements of the maintenance performance at a rest stop.



Roadside Rest Areas And Ports of Entry
Maintenance Inspection Report

ITD 2538 (Rev. 6-03)

Date Inspected | Time Inspected
Facility Name/District | Contractor Name/Representative
Department Representative | Inspected By

Rating
1 or below - Poor or very poor
2 - Needs Improvement
3 - Good*
4 - Very Good*
NA - Not Applicable
*Meets Performance Standards

	Item	Facilities	Rating	Comments
Grounds	1	Driveways - Parking Lots		
	2	Sidewalks		
	3	Garbage Containers		
	4	Trees, Shrubs, Lawn — Maintained and Clean		
		Trees, Shrubs, Lawn — No Insects, Disease, Weeds		
	5	Natural Areas		
	6	Wildflower Beds		
	7	Grassy Areas (Pet Areas)		
	8	Irrigation System		
	9	Gravel or Other Blanketed Areas		
	10	Picnic Tables, Arbors		
	11	Information Signs/Kiosk		
	12	Drinking Fountain		
	13	Cigarette Butt Receptacles		

Section Average _____

Building Exterior	14	Outside Walls		
	15	Windows and Doors		
	16	Eves		
	17	Light Fixtures		
	18	Public Telephones		

Section Average _____

			Men's	Women's
Building Interior	19	Partitions		
	20	Urinals		
	21	Toilet Stools and Seats		
	22	Sinks and Mirrors		
	23	Soap Dispenser and Hand Dryers		
	24	Toilet Paper/Toilet Seat Covers		
	25	Floors, Walls, and Ceiling		
	26	Inside Windows and Doors		
	27	Heating - Air Exchange		
	28	Rest Room Lighting and Sky Lights		

Section Average _____

Utility/ Custodial	29	Utility/Storage Room	
	30	High Pressure Wash/Steam Clean	
	31	Sewer/Plumbing System	
	32	Caretaker Residence	
	33	Custodian's Appearance - Uniform	
	34	Record Keeping/Daily Log	

Section Average _____

Overall Rating

Additional Comments

ITD inspectors formerly used this paper form to rate maintenance performance at rest areas in the State. *Photo: ITD.*

a cost of $445 each and, to help ensure device durability, protective cases at $50 each. Vehicle power adaptors, purchased for $26 apiece, completed the hardware package.

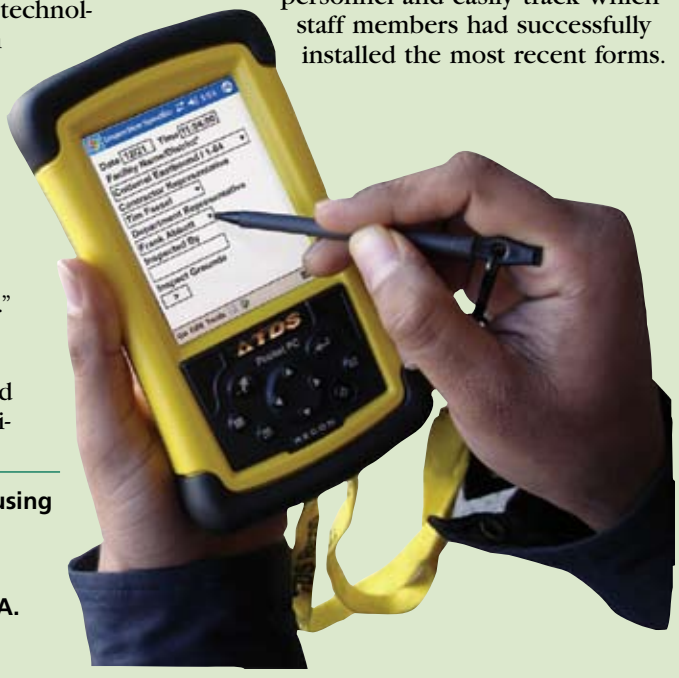
These items were distributed to 10 agency field inspectors. To ensure an efficient workflow, handheld computers also were provided to the ITD database developers and managers, enabling them to test new forms, applications, and synchronization processes before installing software changes or enhancements on the field devices.

ITD selected a company headquartered in Meridian, ID, just outside of Boise, to generate customized electronic forms for the handheld computers.

"Since we had a budget of only $1,500 for software development, we chose to work with a local software company that could easily provide onsite assistance," says Tony Ernest, information technology (IT) production specialist with ITD. "Company executives were able to meet directly with ITD staff over time to document potential obstacles and functional requirements."

The company developed a basic form capable of field input and synchronization with the central database. Using various components of the company's software, ITD then was able to implement its own updates, corrections, adjustments, and customizations to the form as necessary. The agency's IT staff uploaded the inspection forms to the field staff's handheld devices. The IT employees used their own agency-issued PDAs to revise existing forms or create new ones and test them in-house before distributing them to field personnel. "The electronic forms are very easy to create and modify for our specific needs," says Ernest.

Once the original process was implemented, ITD listened to feedback from those participating in the pilot program and made necessary modifications. The agency found, for example, that distributing assorted forms to field inspectors was challenging. In managing a widely dispersed workforce of inspectors and various versions of forms, the agency needed a timely means of deploying new and updated documents. As a solution, the ITD team selected a proprietary application that automatically publishes new forms or updated versions of forms to various mobile devices. The agency's IT staff was able to distribute forms quickly and conveniently to field personnel and easily track which staff members had successfully installed the most recent forms.



An ITD inspector is using a stylus to complete a maintenance performance form on a waterproof PDA. *Photo: Kevin Benedict, MobileDataforce.*

ITD continues to monitor program results and make adjustments as needed.

Buy-In From Management

A modest financial investment, coupled with strong support from the managers in ITD's Maintenance Section, played a vital roll in obtaining approval for the pilot program. The maintenance managers saw the value that technological advancements could bring to their section and had the authority to budget the necessary funding.

Managers in the Maintenance Section were able to garner additional support, both up and down the chain of command because the project was small, simple, and could be done through a low-cost proof of concept, and a positive result could affect many other areas of ITD. Further, the Maintenance Section was able to link the rest area inspection data to an existing database used for tracking other ITD facilities, further reducing initial funding requirements and helping it sell the project as a useful upgrade to an existing system.

Introducing the Technology

ITD required Maintenance Section employees to attend a 2-hour training session to learn the fundamentals of using PDAs for data collection and synchronization. During the classroom instruction, the employees were led through the process of completing forms using handheld devices.

Once the forms are downloaded on the field devices, the inspectors complete their documentation by tapping their styli on the appropriate options available in various drop-down menus. The menus contain the most common answers to the questions on the forms.

When the inspectors return to the office, they place the handheld device into a cradle attached to a desktop computer. The information is automatically transferred from the device to the agency's central database. Inspectors have the opportunity to revise or add comments directly to the database from their desktop computers after the synchronization process has taken place.

"The new process is very useful in the field," says Cathy Ford, administrator of ITD's Roadside Program. "The old way was very time consuming, and inspectors had to handwrite individual scores, tally up the scores, and provide detailed comments. With this new technology, we are able to reduce the time it takes to enter the information and allow the inspectors to choose from a variety of options using drop-down menus. The data is also stored on a central database, making it easy to access by anyone with permission."

Dick Powell, district maintenance manager with ITD, is pleased with another aspect of the new system. He says, "The process makes the reports uniform and legible."

Because the pilot program is a new undertaking, ITD is still developing the central database, fine-tuning it to be capable of running customized reports based on specified preferences.

Leading by Example

As a State agency rather than a commercial enterprise, ITD is not geared to measure data on a true return on investment for any project. Savings in manpower, time, and resources are an ongoing consideration, but in the case of this pilot program, the agency has not yet reported significant cost savings. The implementation of ITD's pilot program has, however, significantly improved the agency's inspection-related business practices.

"The PDAs have increased the ease and efficiency of the inspection process, making it less prone to error; enhanced the consistency of inspection standards across the State; and eliminated inconsistencies and errors due to illegible handwriting or poorly completed forms," ITD's Ernest summarizes. "The most vital improvement is the safe and efficient storage of inspection information, which makes complete and accurate historical data readily available and thus makes it much easier for district and headquarters decisionmakers to develop sound options for rest area maintenance. Further, the program was implemented without placing any additional burden on State personnel."

By balancing new ideas and available resources with long-term benefits, ITD is showing a way for State transportation agencies to use advanced communications technology.

The PDAs are expected to help increase the consistency of inspection standards across the State for rest stops along Idaho roads such as the one shown here.

Kevin Benedict, MobileDataforce

Kevin Benedict has worked in the high-tech industry for 16 years and in the software industry since 1992. He is the CEO of MobileDataforce™ Inc., a Boise-based software company that develops mobile solutions for use on handheld computers. He has served in leadership positions at IONA® Technologies, Netfish Technologies, Micron Electronics, Inc., Edifecs™ Commerce, Inc., and ProGroup®, Inc. In 2002 he led a team that negotiated the sale of Netfish Technologies to IONA Technologies. Benedict has spoken at conferences around the world on the subjects of mobilizing business solutions, B2B e-commerce standards, and the use of technology in healthcare.

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by Kenneth S. Opiela, Bradley M. Sant, and James A. Childers

Turning Young Drivers Into Survivors

A new FHWA outreach campaign educates teens on work zone safety.

At one time or another, all drivers encounter the unfamiliar traffic patterns and hazards posed by roadway work zones. In 2004, work zone crashes caused more than 1,000 deaths and nearly 50,000 injuries. The Federal Highway Administration (FHWA) estimates that highway construction will increase to meet new capacity demands and to address the deteriorating highway infrastructure.

The number of teenage drivers also is increasing, both in absolute numbers and as a proportion of the driving population. Each year at least 2 million people—mostly teenagers—begin driving. At the same time, motor vehicle crashes kill more teenagers than any other cause. In the 15- to 20-year-old age group, 32 percent of their fatalities occur in traffic crashes. According to the California Office of Traffic Safety, a 16-year-old is 20 times more likely to be killed in a crash than an adult, due in part to driving inexperience.

(Above) Improving understanding of work zone dangers is vital to the safety of new motorists. Here, orange cones and a directional sign direct a car away from the right-hand lane.

In 1999 the U.S. Congress called upon the U.S. Department of Transportation (USDOT) to create a work zone safety awareness and training campaign targeting young drivers. Among the motivating factors were the limited attention to work zone safety in driver training curricula, the need to educate driving instructors about the existence of a national standard for uniform traffic control in work zones, and the challenge of reaching teen drivers with safe driving messages.

The result was an FHWA partnership with the American Road & Transportation Builders Association (ARTBA) to develop and launch a safety campaign called Turning Point: Roadway Work Zone Safety for New Drivers. Through an interactive CD-ROM training tool, a safety video, a Web site, and collateral products, the campaign focuses on helping teenage motorists obtain the knowledge and skills they need to safely navigate the Nation's growing number of work zones.

A Public-Private Success

The target audience for Turning Point is drivers between the ages of 14 and 18 who are preparing for drivers licenses or who have limited experience driving. FHWA and ARTBA packaged the campaign materials into work zone safety toolkits and distributed them to key stakeholders, including instructors of driver education.

All photos courtesy of ARTBA.

Launched in 2005, Turning Point already is showing successful results. Bradley Huspek, president of the Driving School Association of the Americas, Inc., and administrator of the Sears Authorized Driving School in Michigan, terms the campaign "a fantastic job." He adds, "Instructors will be able to work the information [in the toolkit] into our existing curriculum very easily and in a variety of ways." According to Huspek, 30 toolkits would enable his organization to expose 11,000 students annually to the campaign's "vital information."

Developing the Campaign

To develop the campaign for Turning Point, FHWA and ARTBA partnered with the National Highway Traffic Safety Administration (NHTSA), which works with professional groups to develop curricula for training new drivers. Their preliminary research found that the current curriculum on safe driving through work zones was inadequate to cover the

One of Turning Point's goals is to incorporate work zone safety into driver education programs. Here, the orange barrels guide a student driver into a left merge to avoid a closed lane.

range of situations that drivers now encounter. ARTBA then set out to develop a multifaceted approach that supplements existing driver education programs with new educational materials.

The name Turning Point was selected because when new drivers receive their licenses, they reach a turning point in their lives. The goal was to remind teen drivers to handle this turning point in a positive and responsible way, recognizing the hazards and making the right decisions every time they drive, including when they negotiate work zones.

In addition to the teenage drivers themselves, other individuals and groups interested in ensuring that teens drive safely in work zones contributed to developing Turning Point. These contributors include driving instructors, other educators, parents, traffic safety advocates, transportation agencies, and the road construction industry. NHTSA, the National Safety Council (NSC), AAA Foundation for Traffic Safety, and other organizations also helped ARTBA and FHWA develop the program.

Materials and Messages

FHWA and ARTBA selected and designed the campaign materials in the toolkit to be in tune with teens' interests in multimedia technologies. The interactive CD-ROM, for example, guides teen drivers through real-life driving and decisionmaking scenarios. Another product, an educational Web site, combines online learning activities with resource information and hyperlinks to other traffic safety-related sites. A third piece, a motivational video on DVD, aims to shape new driver attitudes. Through a reality-based storyline, the video shows teens the real impact their driving has on human lives, especially their own.

A fourth outreach tool, a searchable CD-ROM database, offers additional resources that can help driving instructors reach out to teen drivers on work zone safety issues. Other materials are available as well to advertise the campaign's messages and inform specific stakeholders.

The ultimate goal is to create awareness in new drivers about the potentially hazardous driving situations of work zones and to educate them about the basic safety strategies for crash prevention. For instance, teenagers learn that work zones can be dangerous due to a number of factors, including uneven pavement, lane shifts, lane drops, narrowed lanes, unfamiliar traffic patterns, other people driving erratically, suddenly stopped traffic, and workers on the road.

After studying the materials, teenagers should be able to cite the following as potential consequences of reckless driving in a work zone: death of driver, passengers, or construction workers; serious injury to self or others; imprisonment in jail for manslaughter or other transgressions; damage to vehicle; loss of license (and mobility); parental censure; and embarrassment among peers.

According to research by the developers of Turning Point, many driver education programs are silent on work zone safety issues. In a parked car, this young driver is counseled by his driving instructor.

Speeding, already a hazardous practice by many teens on roadways, can be acutely dangerous in work zones. "Exceeding work zone speed limits is one of the most commonly and blatantly violated laws," says Huspek, "and I applaud the campaign's efforts toward increasing new driver awareness of this important safety topic."

New drivers learn basic prevention practices from Turning Point: slow down; pay attention, watch for signs, and look for hazards such as erratic drivers; eliminate distractions by getting off the cell phone, turning off the radio, and quieting friends in the car; and do not become frustrated with the wait and allow your impatience to lead you into doing something reckless. To that end, the campaign focuses on promoting and reinforcing five safety messages: know the work zone signs; pay attention to other drivers; stay focused and avoid distractions; expect the unexpected; and keep your cool, be patient.

Interactive Training Tool

The interactive CD-ROM, "Turning Point: Work Zones from Behind the Wheel," helps young motorists recognize possible hazards and puts them in challenging driving situations. The format is like that used for the AAA Foundation's driver-ZED® educational tool, which is similar to the automobile racing video games that many teens spend hours playing.

The CD-ROM begins with an introduction by a teen who talks briefly about the consequences of taking "hits" in work zones—to his car, head, or wallet (money

and license). The next screen enables the teenaged CD-ROM user to step through a work zone primer or see instructions on how to use the training video. (This makes the tool usable without other materials or an instructor.)

The CD-ROM utilizes video clips—most taken from real work zones in the District of Columbia, Maryland, and Virginia—in the interactive computer program, which walks the new driver through a variety of situations. In some cases the video shows staged events, such as a driver merging late in a work zone right-lane merge situation.

The training tool presents 20 driving situations in modules titled "Cruise Around Town" and "Head out on the Highway." Within these situations, teens encounter lane shifts, lane closures, crossovers, bidirectional operations, shoulder work, moving and short-term work operations, and other issues. Because it was impossible to address all situations, FHWA and ARTBA used research data and expert opinions to prioritize the options. The CD-ROM producers reviewed scenes carefully to note all hazards, avoid examples of poor motorist behavior, and assure compliance with the 2003 edition of the *Manual on Uniform Traffic Control Devices*.

In the video scenes, the perspective is that of a driver with dashboard and rearview mirror displays. At various points the video scene freezes and the teen is asked about the situation and what might happen, or is asked to point out potential hazards. After the teen keys in the responses, the video resumes and the commentator evaluates the answers. The interactive program tallies a teen's response score to assess his or her skill level.

The software installs automatically after being inserted into the CD-ROM or DVD drive and is self-contained, making it easy to reproduce and distribute. Users can start and restart the CD-ROM and print out certificates showing their scores when they have completed the training.

Web Site

To complement the CD-ROM training tool, ARTBA and FHWA developed the "Turning Point" Web site to provide an ongoing clearinghouse for materials related to work zone safety. The site is accessible to all stakeholders—new drivers, driving instructors, parents, and others. After educating the audience on the basics of work zone safety issues, the site provides additional factual data and news briefs. ARTBA and FHWA included the URL in the work zone safety toolkits distributed to driving educators, along with a guide explaining how the Web site can be used to support classroom instruction. For instance, instructors could assign or encourage students to use the site as part of their classroom or homework assignments.

Once a user arrives at the Web site, a brief introductory video plays, similar in style and theme to the introduction of the CD-ROM. Users can either skip the introduction or wait until its conclusion to arrive at the homepage, which explains the purpose of the site. From this page, the user can choose one of three tabs: For Teens, For Parents, or For Educators.

The homepage also includes a brief article on the Turning Point

"Typical" Teens

Although little data are available on the causes of crashes in work zones specifically involving teenagers, FHWA research indicates that some novice driver characteristics affect the high rate of teen crashes in general. These characteristics fall into three areas.

Ability to Recognize Hazards. New drivers generally lack the ability to recognize risks in the environment. Their inexperience means they have the following tendencies:

- They are slower to recognize potentially hazardous features and situations on the road.
- They underestimate the danger of certain risky situations, such as speeding and driving while impaired, while overestimating others.
- And they are more easily distracted from risk evaluation and have difficulty focusing on the driving task.

Knowledge and Implementation of Safe Procedures. Due to limited experience, teens are unlikely to react properly to work zone hazards. In general, they are not experienced in scanning the environment, recognizing potential hazards while they are still at a safe distance, and making tough decisions quickly. As a result, teens may:

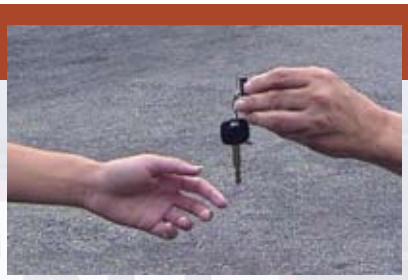
- Overestimate their ability to stop and underestimate the distance needed to stop safely
- Fail to consider other drivers' expectations and reactions to their behavior
- Expect other drivers to behave predictably
- Not recognize the impact of emotional and physical conditions on driving

Motivations. Considering common teenage traits, such as rebellion, angst, and overconfidence, is important when designing any learning program for them, particularly one aimed at safety practices. Evidence indicates that these traits lead to deliberately risky driving behaviors, such as speeding, driving while impaired, and not concentrating on the driving task. Causes for this risk taking can include the following:

- Strong need for stimulation (thrill seeking)
- Desire to impress peers
- Lack of immediate or intrinsic rewards for safe driving
- Little recognition of long-term consequences and little valuing of the future
- Sense of fatalism
- Unrealistic sense of control over a driving situation

Factors that motivate safe behavior in teens also are well known and can be applied to driving. The paramount motivator is simply the desire to get where one wants to go. Teens highly value the freedom that driving offers and do not want to jeopardize it. Other motivating factors include the following:

- Desire for unrestricted mobility
- Desire not to harm others
- Fear of other negative consequences such as parental censure, property damage, fines, and loss of license
- Personal or "close to home" negative driving experiences, such as those of friends
- Desire not to "look bad" to others as a result of driving stupidly or irresponsibly
- Regret for negative consequences of bad driving decisions



Both teenager and parent will benefit from studying and talking about the Turning Point materials before the car keys are handed over.

Lane shifts and unusual traffic patterns, like those shown here, are among the hazards that all drivers must be watchful for when navigating work zones. Inexperienced drivers in particular can be challenged by the unfamiliar.

campaign's goals and products, and links to separate pages. One page contains continuously cycled work zone facts, such as the number of injuries yearly and the costs of crashes. Other pages invite site users to contact FHWA or ARTBA to share feedback on the campaign materials or share information for use in tracking site usage and user demographics.

The teen-focused section of the Web site contains a tutorial on work zones. Another page, "Danger Zone," features newspaper and other accounts of real crashes in work zones and their outcomes. These stories should raise awareness of the real consequences of unsafe driving and, therefore, motivate teens to drive more safely.

The segment devoted to parents contains guidance on the role they can play in educating their teenagers. The site points out how parents first should educate themselves and then, based on expert recommendations, create the correct learning environment for their teens. Articles inform parents how to coach their teens in practice driving sessions, provide parents with insight into teen driving attitudes and behaviors, and update parents on aspects of driver education that have changed since they learned to drive. Site links encourage parents to find more information on Turning Point products and information on the "For Educators" page.

The educators' section contains links to assorted content regarding work zone safety; covers teamwork among teens, parents, and educators; provides information on obtaining Turning Point products; and offers the means for educators to evaluate the Turning Point program. The "Teaching Work Zone Safety" page includes a primer on roadway work zones and provides links to other national driving organizations with a stake in teen driving safety.

Other Toolkit Components

ARTBA and FHWA developed a variety of products to supplement the interactive training tool CD-ROM and Web site mainstays. Work Zone Safety Awareness & Training Resources, a searchable database included on a separate CD-ROM in the toolkit, contains materials useful for driving instructors. The database CD-ROM includes presentations from other campaigns on driving safely in work zones that were identified when researching Turning Point. One example is a 30-second television public service announcement titled "At the Office," developed for FHWA and since used in several States' safety campaigns. Another example is an 8-minute video, "A Sudden Change of Plans," developed by the Carolinas Associated General Contractors and the North Carolina Department of Transportation. This CD-ROM also includes descriptions of materials and selected samples from other campaigns and information about how to obtain them.

Work zone safety includes driving to ensure the safety of construction and maintenance workers. Two construction workers are shown behind a jersey barrier but still very close to traffic, requiring caution by the oncoming drivers.

Another Turning Point product is an 11-minute video on DVD called "Turning Point: Some Decisions Last a Lifetime." The video attempts to create an emotional connection to work zone safety, delivering the critical safety messages to new drivers in a context to which they can relate. The content includes a first-person narrative, fact-based fiction that tells the story of a teen who made a mistake in a work zone and ended up being both victim and cause of serious injury and death. The story is supplemented with interview bites from other teens and concludes with a strong motivational message that involves revisiting the consequences: "humanized statistics" that convey the numbers of young people seriously injured or killed each year, coupled with a visual depiction of a teen disappearing from a familiar scene—a carload of friends.

Early reviews of the video are enthusiastic. "It's an excellent tool to educate teen drivers about the importance of safely navigating work zones," says Robert E. Roush, school safety education advisor for the Pennsylvania Department of Education's Bureau of Teaching and Learning Support. "Students are more likely to accept the message since it comes from a peer."

An instructor's guide accompanying the toolkit introduces driver educators to the Turning Point campaign with explanations of the purpose, objectives, and messages. The instructor's guide describes the toolkit components—video, interactive CD training tool, resources CD, "Work Zone Primer" slide presentation, Web site, and supplemental materials—and offers tips on how to use them. The guide also provides commentary on the exercises in the interactive training tool to facilitate class discussions with students. Finally, the guide provides pre- and post-course quiz questions, answer sheets, and a form for teachers to evaluate the toolkit.

ARTBA and FHWA recruited a celebrity spokeswoman to encourage new drivers to observe the various messages on safe driving in work zones. Dominique Dawes, a U.S. gymnastics medalist at the 1992 and 1996 Olympics, already has made appearances to encourage teens to think about work zone safety.

By using a cell phone and personal digital assistant while in a car, these two young women are violating one of the five core messages of the Turning Point campaign—stay focused and avoid distractions.

A variety of collateral products help disseminate the campaign messages, including posters, bumper stickers, bookmarks, instructor's guides, brochures, factsheets, and press releases. ARTBA developed these items after reviewing similar products created by various Federal, State, local, and private entities.

Rolling Out the Campaign

In 2005, ARTBA held events to roll out the campaign for groups representing the target audiences. The Turning Point training and campaign materials constituted most of the contents of 5,000 toolkits distributed to driving instructors, parents, State agencies, and others. ARTBA is further marketing and distributing the Turning Point products to the primary audience of high-school-age new drivers and to three secondary audiences: traffic safety advocates and government officials, representatives of the roadway construction industry, and driver education instructors.

ARTBA plans to seek additional channels for distribution, potentially including manufacturers and dealers of automobiles, tires, and traffic safety devices. Further audiences might include auto insurance companies and other organizations with stakes in driver safety in work zones and on roadways in general.

Campaign Evaluation

The last aspect of Turning Point was an evaluation of the pilot rollout. Carried out by NSC and the University of North Carolina Highway Safety Research Center, the evaluation focused on soliciting feedback from driving instructors and their teen students about the effectiveness of the training materials. The objectives of the evaluation included verifying receipt of the toolkits by the target audience, gauging the extent of the toolkits' use in driver education courses, assessing the levels of knowledge gained by teenage students, measuring the success in changing student attitudes, and evaluating the overall quality and effectiveness of the final products in conveying the safety messages.

The results, issued in a report published in September 2005, included both quantitative and qualitative information. When asked to rate the overall effectiveness of the Turning Point toolkit in helping them communicate to students the importance of work zone safety, the teachers gave the toolkit an average rating of 8.2 on a scale of 1 to 10, where 1 is "not at all effective" and 10 is "extremely effective." All of the teachers surveyed reported incorporating some aspect of the Turning Point curriculum into their classroom instruction, with 88.2 percent reporting using the instructor's guide and 70.6 percent using the video.

Early qualitative feedback has been positive as well. "This is one of the best packages of training materials I have ever received," says Michael Nischan, a loss control and safety consultant for The McCart Group, a risk management and insurance brokerage in Atlanta, GA. "The amount of information, tools, and contacts, and the level of detail and professional organization are absolutely astounding."

Kenneth S. Opiela is the leader of the Roadside Team in FHWA's Office of Safety Research and Development. He manages the National Crash Analysis Center and Federal Outdoor Impact Laboratory, and supports FHWA efforts in roadway delineation, advanced research, driving simulation, and crash analyses. He holds a doctorate in civil engineering and a master's degree in urban planning from Wayne State University. He earned his bachelor's degree in civil engineering at Michigan State University.

Turning Point video clips from work zones on city roads and rural highways educate new drivers. In this simulation of the driver's viewpoint, the user appears to be peering over the steering wheel through the windshield. The city scene shows an orange-clad highway worker dangerously close to traffic.

In this work zone scene on a rural highway, the driver appears to be too close to the car ahead, perhaps because he or she did not account for slowed and congested traffic caused by the work zone.

Typical Work Zone Situations Facing Drivers Young and Old

Road Situation	Environment	Traffic Conditions	Work Zone Features	Driving Situation And Hazard
Divided highway	Rural 105 km/h (65 mi/h) speed limit Limited access	Light traffic 10 percent trucks	Roadside/ shoulder work	Speeding Inadequate clearance Workers accessing work vehicles
			Lane closure	Speeding Distracted driving Unable to merge (crash, intrusion into work zone)
			Lane shift	Following too closely Distracted Sideswipe or rear-end crash
		Medium traffic 15 percent trucks	Lane closure	Slow-moving vehicle ahead Visibility blocked by truck Intrusion into work zone Worker close to traffic
			Crossover	Tight geometrics Road-profile effects
		Heavy traffic 10 percent trucks	Lane closure	Distracted driving
			Crossover	Distracted driving Irregular pavement surface Inadequate markings
Two-lane roadway	Suburban 89 km/h (55 mi/h) speed limit Some driveways	Light traffic	Bidirectional operation	Flaggers
			Shoulder or roadside work	Construction traffic access
		Medium traffic	Bidirectional operation	Blocked driveways Head-on traffic in close setting
			Shoulder or roadside work	Driver confusion
Arterial	Suburban 72 km/h (45 mi/h) speed limit Access control	Medium traffic Pedestrians	Lane shift across centerline	School areas Parking
			Moving operation	Reduced sight lines
		Heavy traffic Pedestrians	Multilane closure	Moving equipment
			Middle-lane utility work	Reduced sight lines Confusion on where to turn
Intersection	Urban 48 km/h (30 mi/h) speed limit Frequent driveways	Light traffic Pedestrians	Lane closure	Dropoffs near turns Driveway confusion
			Lane closure and turn limits	Edge dropoffs Tight turns
		Medium traffic Pedestrians	Lane closure	Failure to see pedestrians crossing
			Lane closure and turn limits	Abrupt moves by other drivers

Source: FHWA and ARTBA.

Former Olympic gymnast Dominique Dawes (shown here) agreed to take on the role of spokeswoman for the Turning Point campaign.

Bradley M. Sant is responsible for ARTBA's National Work Zone Safety Information Clearinghouse (http://wzsafety.tamu.edu) and Traffic Safety Industry Division. Before joining ARTBA, Sant served as director of safety and health for the Building and Construction Trades Department of the AFL–CIO. He graduated from Utah State University with B.A. degrees in political science and Spanish. He earned a law degree from the Georgetown University Law Center.

James A. Childers manages the Turning Point campaign for ARTBA, under contract to FHWA, and developed ARTBA's roadway construction safety training video "Avoiding Collisions." Childers joined ARTBA in 2001, bringing a 27-year background as a training consultant, technical writer, scriptwriter, videographer, video editor, and photographer. During those years he worked with Federal, State, local, and foreign transportation agencies.

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Low Cost, High Return

by Dean M. Larsen, Fred N. Ranck, and John McFadden

Kentucky's Safety Circuit Rider program is delivering roadway improvements through economical methods.

Improving roadway safety is one of the Federal Highway Administration's (FHWA) "vital few" goals. Meeting this goal means not only focusing on the interstates and the National Highway System highways but also addressing safety concerns on local roads in communities across the country.

"According to 2004 FARS [Fatality Analysis Reporting System] data, approximately 58 percent of the Nation's roadway fatalities occurred on rural roads, and a number of these roads are locally owned," says Leslie Wright, manager of the Local/Tribal Road Safety Program in FHWA's Office of Safety. "With this in mind, making safety a priority on locally owned and rural roads by and large is crucial to reducing the Nation's 42,636 roadway deaths annually."

Reducing the number of highway fatalities and implementing safety improvements are ongoing challenges for local agencies contending with modest budgets that limit personnel, equipment, and other resources for constructing and maintaining roadway modifications. To improve safety, local agencies need access to best practices that are within their budgets and tailored to their needs.

In Kentucky, the rate of fatal crashes is climbing, according to recent research by the Kentucky Transportation Center (KTC), which includes Kentucky's Local Technical Assistance Program (LTAP), housed within the University of Kentucky's College of Engineering. As reported in the spring 2005 issue of the center's newsletter, *The Link*, Kentucky is among the top five States in the Nation in terms of fatalities resulting from roadway hazards on rural two-lane roads. However, Kentucky's new Safety Circuit Rider (SCR) pilot program is helping improve safety on the State's rural roads.

The Kentucky SCR program is a mobile outreach effort that provides face-to-face workshops on transportation-related safety for local government staff. According to *The Link* newsletter, Kentucky is focusing on three primary areas: reducing road departures (run-off-the-road collisions with fixed objects), intersection collisions, and collisions involving pedestrians.

The program's success is the result of technical support, training, and technology transfers that involve Federal, State, and local partners working together to implement small-scale, affordable, and perhaps overlooked safety improvements on locally managed roads. The counties involved in Kentucky have seen a marked improvement in safety through reductions in injuries and fatalities. Other States including Florida, Iowa, and Minnesota also have found success in similar programs.

Low-Cost Safety Improvements

Kentucky's SCR pilot program is an outgrowth from a series of workshops on low-cost safety improvements (LCSIs) launched by the FHWA Resource Center at the request of FHWA's Missouri Division Office. LCSIs are projects that cost $10,000 or less to implement.

Typical LCSIs include removing vegetation, including trees that pose a hazard (although such trees also might be delineated with object markers); building up shoulders to eliminate dropoffs; and adding signage to warn of unusual roadway features, such as sharp curves, or to accentuate the four corners of bridges. In some cases, improvements that are more intensive such as bridge widening also can be implemented.

(Above) Pike County in Kentucky used these gabion baskets (loose rocks held together with wire mesh) to repair roadway erosion caused by runoff from Ratliff's Creek. This countermeasure is one of the low-cost safety improvements initiated by Kentucky's Safety Circuit Rider program.

All photos are courtesy of the Kentucky SCR program.

SCR Pilot Program Initiated by FHWA

During the development in 2005 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, the U.S. Government Accountability Office (GAO) asked FHWA to review the safety benefits of LCSIs and adapt them for broader national use as part of an effort to address high-risk local roads. GAO included LCSIs in its report to the U.S. Congress.

Begun in 2005, the SCR initiative was a 1-year pilot program jointly funded by FHWA's offices of Safety, Professional and Corporate Development, and Federal Lands Highway. Four applicants were selected to receive $150,000 each. In addition to Kentucky, successful candidates were Florida, West Virginia, and the Northern Plains tribal group (serving Montana, North Dakota, South Dakota, Wyoming, and the northern Nebraska tribal lands).

"The goal of the FHWA pilot program was to assist local agencies in becoming safety-focused organizations by effectively applying the best and most appropriate tools to meet their needs," says FHWA's Leslie Wright. "The program was designed to leverage the existing safety management tools, in addition to new resources, as part of safety improvement strategies for local roadways. In this regard, the program sought to establish a framework in which oncall safety experts, known as Safety Circuit Riders, would be equipped to transfer knowledge and assist local safety managers in the implementation of specific improvement strategies."

FHWA's Office of Safety decided that its SCR pilot program would focus on three categories of fatal crashes on two-lane rural roads: run-off-the-road crashes and collisions with fixed objects, intersection crashes, and pedestrian-related crashes.

Other States that have used LCSI training successfully and disseminated best practices such as the SCR program at the county or local levels are California, Illinois, Iowa, Kentucky, Missouri, Nebraska, Oklahoma, and Wisconsin. FHWA is now collecting data on the results in Kentucky and the other States.

Implementing Kentucky's SCR

After Kentucky's LTAP was awarded SCR funding through FHWA's Office of Safety, the staff immediately began forming partnerships with organizations including local Area Development Districts (ADDs) to make the most of the limited dollars. Freddie Goble, a retired transportation planner, joined the LTAP staff to launch the program. Along with Terry Chism, a transportation safety engineer with FHWA's Kentucky Division Office, Goble attended an FHWA-sponsored training program on LCSIs in 2004 and later customized those materials for a Kentucky-specific 1-day workshop on LCSIs.

According to the Kentucky Council of Area Development Districts, Kentucky's counties are grouped into 15 regions, or ADDs, which serve as forums, clearinghouses, and technical centers for the regions. The ADDs would prove instrumental in helping implement the SCR program.

To launch the SCR initiative in Kentucky, a steering committee first identified the six counties with the worst crash records. Then, each of the six ADDs with the highest crash records hosted a workshop to disseminate best practices and share information on LCSIs. All counties in a host ADD were invited to send transportation professionals to the workshop, with representatives from the Kentucky Transportation Cabinet attending as well.

After the county representatives learned about the LCSI practices, the judge of each target county (an elected official who serves as the chief executive officer of the county but has no actual judicial power) was asked to select two roads to receive a road safety audit. The audits would help the counties pinpoint the specific safety issues on their chosen roads and select appropriate countermeasures.

To conduct the audits, KTC's Goble (the SCR and oncall safety expert) accompanied county representatives and, when available, traffic engineers from the Kentucky Department of Highways (KYDOH) for a drive along the selected high-crash roads. During the drive, the team pointed out safety concerns and discussed possible low-cost corrective measures. The team also looked at crash locations for possible corrective measures.

For example, the audit determined that an intersection near the town of Hazard needed several improvements to increase safety. Using the information they learned during the safety audit, Denny Ray Noble, Perry

Pulaski County, KY, replaced 762 linear meters (2,500 feet) of sidewalk along Jacksboro Road in the city of Somerset. *Top:* **The old sidewalk was at the same level, or even lower, than the roadway.** *Bottom:* **The new sidewalk, which is elevated above the level of the roadway, improves pedestrian safety along this road.**

Mason County widened this small bridge along Cliff Pike Road and added guardrails to improve safety.

County judge/executive, and Charles Cowell, deputy judge/executive, worked out a partnership with the KYDOH office in Jackson to implement several LCSIs at the junction of KY 15 and Crawford Mountain Road. Through the partnership, the Perry County Road Department removed approximately 382 cubic meters (500 cubic yards) of earthen embankment that was blocking motorists' views looking northward on KY 15 from Crawford Mountain Road.

The removal enabled the department to widen the existing roadway to accommodate a left-turn lane. The material from the embankment was used to fill a 10.6-meter (35-foot)-deep ravine directly adjacent to Crawford Mountain Road near the intersection. Perry County also widened the shoulder of KY 15 to accommodate an acceleration lane. The local agency provided the labor, equipment, and materials for excavating, widening, removing guardrails, and filling the ravine. KYDOH paved the road and applied the pavement markings. "This is an excellent example of partnerships to improve safety," FHWA's Chism says.

Later, after the safety improvements were implemented, Goble reviewed the roads and verified that the improvements were made correctly. Noble says the number of crashes at the Crawford Mountain Road intersection declined significantly after the improvements were made, making the project one of the best examples of the success of the Kentucky SCR program.

Goble attributes much of this success to the availability of accurate geographic information system (GIS) maps of local roads. Combined with precise crash locations derived from global positioning system (GPS) technology, the GIS maps enabled State officials to compile the initial list of local roads with the highest number of crashes.

Examples of Low-Cost Safety Improvements

Roadside Hazard Mitigation
Removal of trees
Relocation of utility poles
Edge rumble on shoulders of rural four-lane highways
Geometric Features
Convert single-lane urban stop-control intersection to roundabout
Warning Signs and Measures
Advance warning signs
Advance curve warning signs with advisory speeds
Chevron alignment signs
Advance warning beacons
Advance intersection warning signs
Lighting
Intersection lighting
Regulatory Signs
Double-up of stop signs (left and right sides of road)
Add stop beacon to stop control (mounted on top of stop sign)
Provide larger street name guide signs
Markings
Mark centerline (on intersection approaches)
Mark edge line (on intersection approaches)
Signals
Improve visibility of signal heads—change post mount with mast arm signals
Replace 20-centimeter (8-inch) lenses with 30-centimeter (12-inch) lenses
Add signal head per lane
Provide left-turn lane, signalize, and left-turn phase
Improve signal timing (optimize)

Source: FHWA.

A Little Adds Up to a Lot

According to FHWA's Chism, the results of the Kentucky SCR program far exceeded anyone's expectations. "By the end of the first phase of the program in June 2005, Kentucky ended up improving 39 roads and spending only $235,000 on the safety improvements," Chism says. "Once the counties saw that they could do little things to improve safety, several expanded the program. All of the improvements were made with county funds and resources. I was amazed at the counties' responses and the excitement they demonstrated."

Some were so quick to make improvements that Goble was able to incorporate before and after photographs of their work into the workshop for the next county. With workshops occurring within 1 week of each other, the turnaround times were dramatic.

The public and media also responded well to the visible improvements in local roads. According to Goble, local newspapers sent reporters to ride along on the safety audits and frequently printed the before and after photographs.

Making the necessary improvements often required county personnel to access adjacent private land to cut down trees that posed a safety hazard. "The private property owners were very cooperative," Goble says. He attributes their support to the participation of the county judges, who approached the landowners and explained the need for the safety improvements.

In other projects, creative bargaining helped. "One landowner, when we told him we wanted to cut down several very old trees, thought about it and said, 'If you cut the trees, trim them, and stack them over there where I'm building a barn, you have my permission,'" Goble recalls. The county personnel readily agreed.

Tim Conley, Morgan County judge/executive, is pleased with the results of the Kentucky SCR program. "One of the roads we looked at, a new road in fact, had 13 reported [crashes] between 2000 and 2004. In 2005 there were no [crashes] on that road. It cost us $800

Between 2000 and 2005, 13 crashes were reported along this stretch of New Cummer Road in Morgan County. In 2005, county transportation officials dramatically improved safety along a bridge approach by clearing trees and brush to improve sight distances in the approach curve and installing Type 3 object markers to mark the bridge corners.

to make the improvements," Conley says. Even better, he reports that Morgan County made improvements on 8 to 10 additional roads outside the program, emphasizing that county crews now know what to look for.

Conley's constituents have let him know that they approve as well. "I had someone come up to me and tell me that one of the roads has improved 100 percent as a result of this work," he says.

James L. "Buddy" Gallenstein, the judge/executive for Mason County, says that the GPS crash data provided by the SCR program has "opened my eyes" to some problem roads in the county. According to Gallenstein, his office routinely receives crash data for highways and major roads, but the SCR program offers access to the same data at the local level for the first time.

"We plan to assess our roads on an annual basis now," Gallenstein says. He and his road supervisor also will be looking at opportunities to implement LCSIs when they make their annual priority assessments for roads.

Future Expansion

The Kentucky SCR program is now in its second phase, with six more counties identified to receive workshops and safety audits. Although the grant covered only a 1-year pilot program, the Kentucky Transportation Cabinet pledged sufficient funding to carry the program through 2006, and possibly 2007, reports Patsy Anderson, director of the Technology Transfer Program at KTC. Continued Federal funding for the program is uncertain at this time.

Lance Meredith recently replaced Goble as Kentucky's SCR. Meredith brings to the position 30 years as a traffic engineer with KYDOH and 2 years as a transportation planner at a Kentucky ADD. Twelve additional counties have been identified as focus counties, and many other jurisdictions are joining the program on a volunteer basis. LTAP also is taking steps to improve crash reporting systems on rural roads.

Partnerships Yield Results

Kentucky's program combined need, motivation, expertise, funding, and public support to achieve rapid success. Partnerships with stakeholders such as FHWA, the Kentucky Transportation Cabinet, local agencies, and the public, exchanging ideas and resources to launch the SCR program, were instrumental in helping Kentucky to improve safety on its rural roads.

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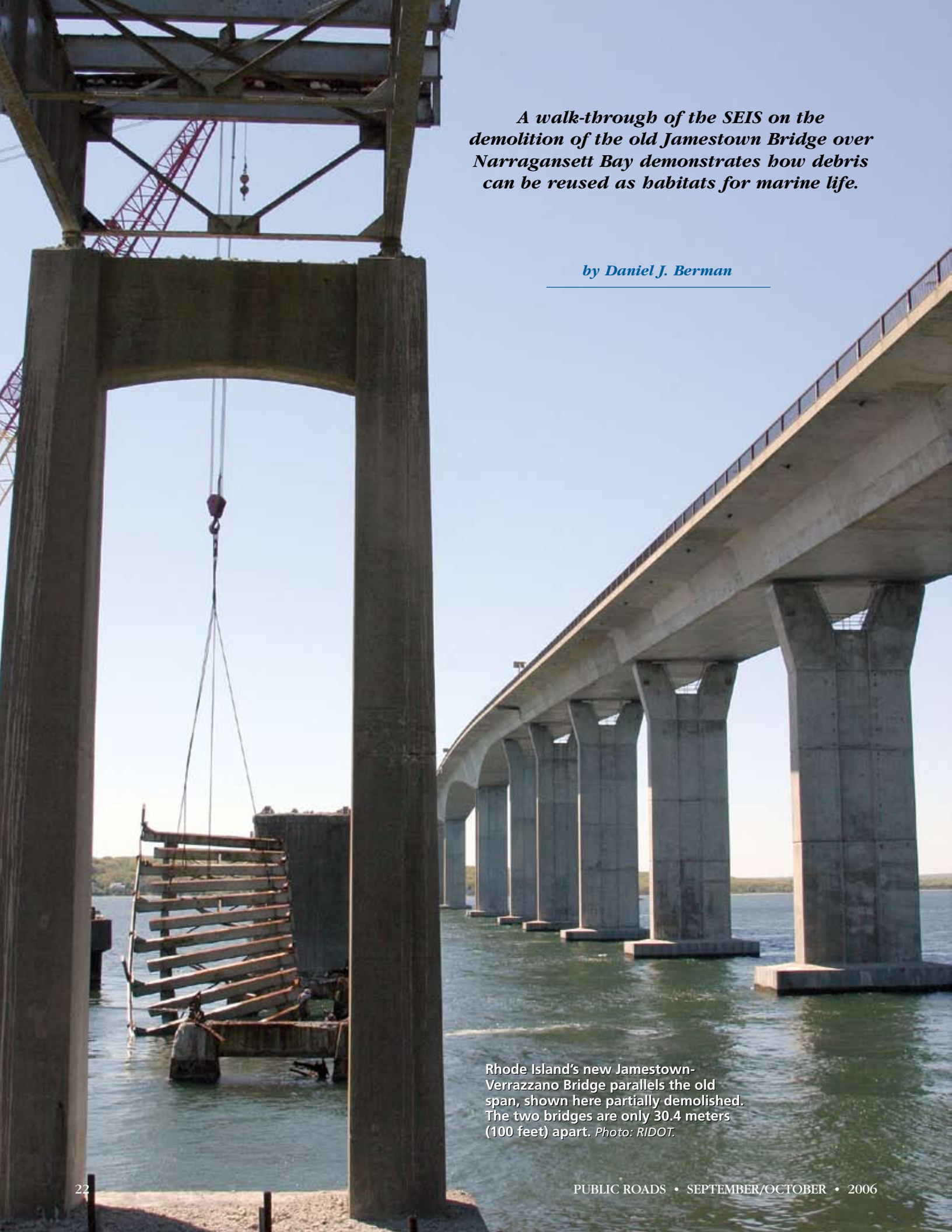
Fred N. Ranck, P.E., P.T.O.E., is a safety/geometric design engineer for FHWA's Safety and Highway Design Technical Service Team and a member of FHWA's Office of Transportation Operations team for the *Manual on Uniform Traffic Control Devices*. He was the principal investigator for development of the Walk Alert pedestrian safety program for FHWA/NHTSA and national director for the Operation Lifesaver program to promote safety at grade crossings.

John McFadden, Ph.D., P.E., P.T.O.E., is a safety/geometric design engineer for FHWA's Safety and Highway Design Technical Service Team at the Resource Center in Baltimore. Prior to joining FHWA, McFadden served as an assistant professor of civil and environmental engineering at the University of Alabama. McFadden received his Ph.D. in civil engineering with a minor in statistics from Pennsylvania State University. He received bachelor's and master's degrees in civil engineering from Villanova University in 1991 and 1994, respectively.

For more information about the Kentucky SCR program, contact Patsy Anderson at 859-257-4509, ext. 229, or panderso@engr.uky.edu. SCR Lance Meredith may be reached at 859-257-7405. For more information on implementing LCSI best practices at the State or county level, contact Leslie Wright at 202-366-2176 or leslie.wright@fhwa.dot.gov, or Dean Larsen at 410-962-2372 or dean.larsen@fhwa.dot.gov.

A walk-through of the SEIS on the demolition of the old Jamestown Bridge over Narragansett Bay demonstrates how debris can be reused as habitats for marine life.

by Daniel J. Berman



Rhode Island's new Jamestown-Verrazzano Bridge parallels the old span, shown here partially demolished. The two bridges are only 30.4 meters (100 feet) apart. *Photo: RIDOT.*

Recycling From Rhodes to Reefs

In the early 1980s, the Rhode Island Department of Transportation (RIDOT) and Federal Highway Administration (FHWA) approved replacement of the Old Jamestown Bridge, which was built in 1940 and had weathered the storms of Narragansett Bay for 66 years while carrying Route 138 over the west passage of the bay to link Jamestown and North Kingstown. Although construction of the new Jamestown-Verrazzano Bridge was completed in 1992, the Old Jamestown Bridge was not removed until 14 years later.

During the intervening years, removal of the old bridge remained a condition of the permit granted by the United States Coast Guard for construction of the new structure that replaced the old bridge. In 2003, the Coast Guard ordered RIDOT to remove the old bridge due to safety concerns, and the towns of North Kingstown and Jamestown also requested that RIDOT demolish the obsolete structure. Because removal of the old span remained a commitment under the environmental impact statement for the new bridge, RIDOT was legally obligated to proceed.

"The question was not whether it was to be removed, but what would be the easiest, most environmentally friendly, and most cost-effective method of removal," says RIDOT Chief Engineer Edmund T. Parker Jr., P.E. When demolition of the Old Jamestown Bridge finally began in 2006, the contractor used explosives to demolish the structure in two initial stages, which took place exactly 1 month apart in April and May 2006.

In accordance with the National Environmental Policy Act, RIDOT prepared a supplemental environmental impact statement (SEIS) to address the effects of removing the old span and to identify and evaluate alternatives for the ultimate disposition of the bridge materials. Because the structure had to be removed for legal reasons, a no-build (or "no-action" in this case) alternative was not applicable. Accordingly, the project alternatives were all identical in terms of demolition but differed in the disposition of the resulting debris. The contractor would need to dispose of approximately 5,442 metric tons (6,000 tons) of steel and 32,895 cubic meters (43,000 cubic yards) of concrete. The debris will be reused to create fish habitats, plus it will provide beneficial recreational and economic opportunities for the towns near it.

Alternatives for Debris Disposal

In the draft SEIS, the agency identified three viable alternatives. Each option was evaluated in terms of its comparative merits and anticipated social, economic, and environmental consequences:

1. *Landfill Disposal Alternative.* Under this option, all structural steel debris would be salvaged and recycled, and all concrete

This image shows the through truss span of the Old Jamestown Bridge, just before it hits the water following the April 18, 2006, first controlled explosive demolition. *Photo: RIDOT.*

RIDOT

Old Jamestown Bridge prior to demolition.

debris would be transported for permanent placement in an upland landfill.

2. *Artificial Reef Alternative*. All structural steel and concrete debris would be deployed by barge to create a marine artificial reef in Rhode Island's offshore waters.
3. *Hybrid Alternative*. All structural steel would be salvaged and recycled, and a marine artificial reef would be created using the concrete debris.

The agency estimated that the most expensive alternative, landfill disposal, would cost between $20 million and $24 million, of which approximately $4.5 million would be incurred in landfill disposal fees alone. Barges would transport the concrete debris to an unloading site, and then trucks would take the debris to a landfill. The trucks would produce air quality, noise, and traffic impacts for the duration of the removal operations. Given that this alternative would result in the permanent consumption of a significant volume of landfill space and would provide little social or environmental benefits to the community, landfill disposal was not considered a prudent alternative.

The remaining two options differed primarily in the ultimate disposition of the steel debris. The artificial reef alternative would deploy all of the steel and concrete to construct the reef, while the hybrid alternative would recycle the steel and build the reef using only the concrete.

The two alternatives were expected to have similar impacts and benefits. Given the successes of artificial reef initiatives in other States, RIDOT believed that the placement of suitable bridge structure at selected barren ocean bottom areas would represent a unique opportunity to enhance marine habitat. This use would offer potential long-term recreational and economic benefits through the creation of new fishing and sport-diving opportunities.

In terms of impacts, both reuse alternatives would result in minor localized noise and air quality effects from the transport of materials to the artificial reef site, and short-term disturbances to bottom sediments. The hybrid alternative would offer material conservation and economic benefits through steel recycling, but also would result in short-term impacts from the processing and transport of the metal to a recycling facility.

"Under both alternatives, the short-term impacts would be outweighed by the potential long-term benefits of the creation of the artificial reef," says Parker. Both alternatives, at an estimated cost of $16 million to $20 million each, would represent significant economic and environmental benefits when compared to conventional landfill disposal.

Weighing the Alternatives

Section 1805 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—directs States to make debris from bridge demolitions available for beneficial use by a Federal, State, or local government, unless such use obstructs navigation. This directive

RIDOT

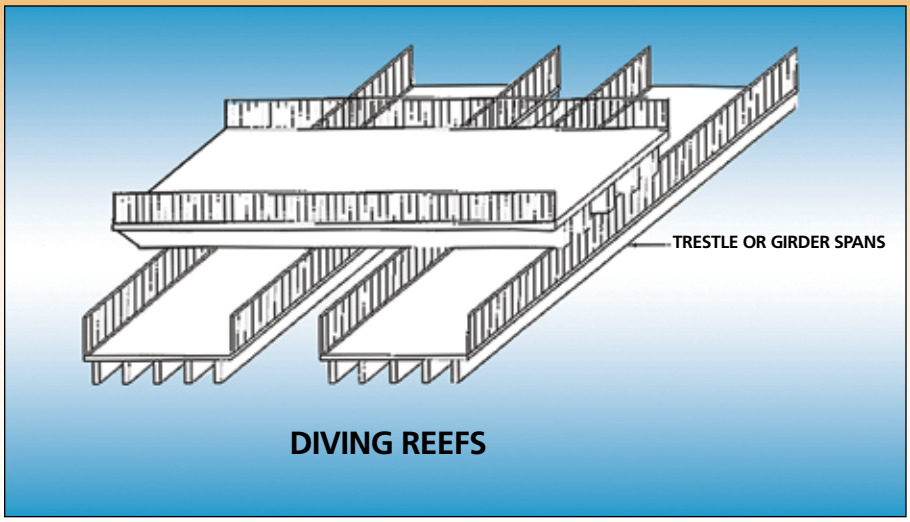
These workers are removing the deck of Old Jamestown Bridge during the preparatory work that preceded the first demolition.

applies to structures that are eligible for Federal assistance under the Highway Bridge Replacement and Rehabilitation Program. "Beneficial use" is defined as use of the debris for shore erosion control or stabilization, ecosystem restoration, or creation of marine habitat.

According to a March 2006 memorandum issued by M. Myint Lwin, P.E., S.E., director of FHWA's Office of Bridge Technology, "The recipient of the debris shall bear the additional cost of processing, delivery, placement, and use of the materials, and shall assume all legal responsibility for the placement of the debris. Preconstruction agreement should be established between the States and recipients of the debris, outlining responsibility, cost, and compliance with environmental laws and regulations. The agreement should include such language holding the owner of the demolished structures harmless in any liability action."

In 2003, RIDOT and FHWA approved the draft SEIS for distribution, identifying the second option—the artificial reef—as the preferred alternative. At the time, the two agencies preferred that alternative to the hybrid option because restriction of the reef material to concrete rubble would limit the opportunity to create a diverse series of artificial reefs for different purposes and user groups. Reef materials are evaluated based on their durability, stability, and nonpenetration. Old bridge structures with combinations of high truss, deck truss, and girders provide substrata for a variety of epifaunal organisms including barnacles, mussels, and hydroids. They also provide refuge habitat for the benefit of juvenile finfish. Concrete rubble from the bridge is ideal material for establishing benthic (sea bottom) lobster habitat.

Preliminary analyses also indicated that any savings from the salvage of



This drawing of RIDOT's original concept for the artificial reef project shows how the sections of girder spans could be used to form the reef. *Source: RIDOT.*

Important Factors in the Comparison of Alternatives

Alternative	Estimated Total Cost	Advantages	Disadvantages
Landfill Disposal	$20–24 million	• Natural resource recovery through the salvage of 5,442 metric tons (6,000 tons) of structural steel	• Considerable increase in overall project cost due to landfill disposal fees (approximately $4.5 million) • Permanent consumption of a significant volume of landfill space in the disposal of 32,895 cubic meters (43,000 cubic yards) of concrete, thus affecting the future capacity of State landfill resources • Short-term adverse traffic, noise, and air quality impacts in the transport of concrete and steel bridge materials
Artificial Reef	$16–20 million	• Potential marine habitat enhancement, human recreational and educational benefits (sport angling, artificial reef ecology) • Potential long-term economic (recreation and tourism) benefits to local communities • Viable reuse of bridge structure	• Presence of lead-based paints in structural steel elements; unresolved concerns regarding long-term ecological impacts of lead-based paints in the marine environment
Hybrid	$16–20 million	• Natural resource recovery through the salvage of 5,442 metric tons (6,000 tons) of structural steel • Potential marine habitat enhancement, human recreational and educational benefits (sport angling, artificial reef ecology) • Potential long-term economic (recreation and tourism) benefits to local communities • Viable reuse of portions of the bridge structure	• Potential short-term adverse traffic, noise, and air quality impacts during the transport of steel bridge materials for salvage

RIDOT

A construction barge is approaching the old bridge to salvage the steel for recycling.

structural steel would likely be offset by the additional costs incurred in the materials separation, handling, and mobilization required for transporting the steel by barge to an unloading site for subsequent sale to a scrap metal salvage facility. Although steel of this vintage has higher carbon content than newer steel and therefore is potentially more valuable, it was not until the sharp rise in steel prices in 2004–2005 that the value of the metal components became great enough to justify the additional costs of handling.

RIDOT held a public hearing in 2003 to solicit comments on the draft SEIS. The hearing was followed by a 1-month public comment period, during which agencies, organizations, and individuals could submit written comments. After the comment period, RIDOT undertook an extensive reassessment of the proposed project and the preferred alternative.

In 2004, RIDOT and FHWA approved the final SEIS for distribution, with the hybrid alternative now selected as the preferred choice. The decision to redesignate the preferred alternative and recycle the steel was based primarily on the presence of lead-based paints on the structural steel elements.

Although there are no definitive studies or data documenting the long-term stability of lead-based paints in a marine environment, empirical evidence suggests that such material would not pose an environmental hazard if deployed as reef material. Nevertheless, based on the level of concern expressed by the public, the agencies decided that the omission of a potential (albeit unlikely) source of contamination would outweigh the potential benefits offered by steel debris in terms of reef diversity.

Location of the Reef

During the public hearing and comment period following release of the draft SEIS, local commercial fishing organizations and individuals raised substantial concerns regarding three proposed near-shore locations for the artificial reef: Gooseberry Island, Black Point, and Sheep Point. The stakeholders were concerned about the potential for a reef to adversely affect bottom trawling and trap fisheries in those areas. After careful deliberation on the merits of near-shore reef development, the three sites were eliminated from consideration.

During the public comment period for the final SEIS, RIDOT received further comments from the Rhode Island Commercial Fishermen's Association regarding the proposed Block Island site. Again, the concern was that creating a reef at this location would interfere with commercial fishing operations.

Conversely, natural resource agencies expressed a preference for creation of reefs at the largest feasible number of appropriate sites so that the environmental benefits could be extended as broadly as possible. Reconciliation of these competing interests was left to the Federal and State agencies responsible for issuing permits for artificial reefs. In the end, none of the sites selected were within the bay area; however, numerous deep water sites were used in the Rhode Island Sound.

Another public concern was potential impacts from the use of explosives. The final SEIS was revised further to address that concern. Other revisions involved avoidance and minimization of potential impacts on the local communities from construction noise and other impacts.

Demolition Plans Modified

During preparation of the final SEIS, RIDOT conducted a comprehensive inspection of the trestle portion of the bridge. The agency had proposed that this portion, consisting of 305 meters (1,000 feet) from the West Abutment to Pier 28W, be retained for future development of a public recreational fishing pier. The inspection revealed, however, that this part of the bridge was extremely deteriorated, with critical deficiencies in the concrete deck and trestle portion of the bridge. After evaluating the inspection data, RIDOT concluded that the existing trestles were structurally unfit for a pier and that rehabilitation was neither practical nor economically feasible. Accordingly, the scope of the proposed demolition and removal was broadened to include the entire bridge.

Through further coordination between RIDOT and the Coast Guard, the original requirements for removal of the bridge piers, as stipulated in the permit for construction of the new Jamestown-Verrazzano Bridge, also were modified. The Coast Guard allowed for the pier footings to be cut off at elevations at or above the natural bay bottom, as opposed to 0.6 to 1.5 meters (2 to 5 feet) below the seabed, as originally specified. The modification still provides adequate navigational clearances but offers several benefits:

- Removal to elevations at or above the bay bottom decreased the number and magnitude of underwater blasts required for the demolition of individual piers, thus reducing potential impacts on the aquatic community from blast overpressure.
- Since pier removal below the seabed was no longer required, the magnitude and extent of benthic disturbance was reduced considerably, decreasing the amount of suspended sediments and potential turbidity impacts.
- The existing bridge piers themselves currently provide habitat for marine life. Although the upper portions of the piers will be removed, retention of pier stubs above bay bottom will continue to offer habitat to the aquatic community to supplement the new reef.
- A reduction in the required removal depth for the footings reduced demolition and removal costs.
- Since the pier footings contained the bulk of the concrete, the new removal limits also reduced the volume of concrete debris that would need to be transported. Although the quantity of concrete was less than originally estimated, this volume still was sufficient for creating the artificial reef.

Measures to Minimize Harm

The agencies and contractors identified several steps that would minimize impacts on the human and marine environments to the greatest extent possible. In addition, a major consideration was that the blast force and flying debris from demolition of the old bridge should not damage the new replacement bridge. RIDOT incorporated the following specific measures in the project:

- A consultant developed a detailed demolition plan for review and approval by RIDOT. The plan included the construction means

RIDOT

The pier column shown here next to a girder span will be cut off at an elevation at or above the natural bay bottom.

and methods such as design computations, measures to protect fish and wildlife, and the sequence and schedule of operations.
- The consultant developed work windows and other timing restrictions for underwater explosives to minimize impacts on marine fauna while maintaining the safety of the construction workers.
- The contractor employed delay charges to limit the blast pressure shock waves resulting from detonations of underwater explosives. Delay charges divide a large charge into a series of smaller charges that are detonated with millisecond delays between each blast. The result is a blast of force equal to the single, larger charge but generating much lower peak pressures and impulse strengths.
- Confined charges were required for the underwater demolition of the bridge piers. A confined charge exploded inside a structure channels more energy into breaking apart the structure and less to propagation of a potentially harmful shock wave, as the structure itself acts as a buffer between the explosion and the surrounding water.
- The contractor conducted boat-based reconnaissance for the presence of marine species of concern (including mammals such as fur seals) to verify that no such animals were present in the blast area prior to detonation. Preblast sonar surveys also were conducted to detect the presence of fish and to avoid blasting when large congregations were near the blasting operations.
- The contractor conducted seismic monitoring during demolition.
- RIDOT investigated several other measures but did not incorporate them into the project, including the use of "scare" charges, bubble curtains, and acoustical deterrents. These were not recommended due to their unproven effectiveness under the conditions anticipated in the open waters of Narragansett Bay.

Final Modifications

During development of the final SEIS, several agencies raised additional issues about the reef sites. Once again, the Rhode Island Commercial Fishermen's Association believed that the offshore reef locations would affect commercial marine fisheries because the proposed Block Island site is located well within the boundaries of regularly used commercial fishing grounds. Usage of these fishing grounds was well documented by the Rhode Island Coastal Resources Management Council and the Rhode Island Commercial Fishermen's Association.

The Rhode Island Department of Environmental Management (RIDEM) noted that the final SEIS did not mention the presence of eelgrass along the western shore of Conanicut Island, near the old bridge. The spatial extent of this resource needed to be identified and mapped prior to initiating the project so that the eelgrass could be protected.

The U.S. Environmental Protection Agency (EPA) supported the proposed changes to the project plan because the modifications would help reduce impacts on existing aquatic habitats by recycling the steel members and avoiding the placement of concrete in shallow water areas. EPA officials also supported measures to monitor and modify the new artificial reefs to clarify the steps that might be needed if the reef does not function as intended.

Blast Impacts

RIDEM officials noted that in the model used to predict the estimated larval mortality from a 1.4-kilogram (3-pound) confined blast, the researchers only studied the effects on cunner, tautog, and goby, under the assumption that these are the only species with swim bladders, which are subject to impacts from explosions. The most abundant larval species, bay anchovy, was not included in the model because it was incorrectly assumed that this species does not have a swim bladder. RIDEM officials determined that the greatest impact on important fisheries resources in Narragansett Bay, including lobster larvae, would occur if blasting took place during the warmer months of May through September, but that period also represents the best construction season.

In terms of blast impacts on other animals, seals are not threatened or endangered, although covered under the Marine Mammal Protection Act, and whales and dolphins are rarely seen in Narragansett Bay. All species

Removal Operations

The first blast ("Event 1") removed the center through truss superstructure so the steel could be recycled. The second blast ("Event 2") took place 1 month later and removed the deck truss and girder spans on either side of the center section as well as the two center piers. *Source: RIDOT.*

of sea turtles are either threatened or endangered. Several species occasionally are spotted in the bay during the summer months. Although EPA officials agreed that changes to the artificial reef component of the project would help alleviate many concerns, RIDOT also agreed to limit both underwater charge sizes and the number of allowable blast days in order to minimize disturbance to the ecology of Narragansett Bay.

Resuspended Sediments

Since the initial planning on the Jamestown Bridge replacement in 1992, some advances had occurred in research on the effects of resuspended sediments on marine organisms, specifically fish (including eggs, larvae, juveniles, and adults). Much of this research was derived from studies on dredging and resulting resuspension of sediments. The dredging research, although viewed with caution, can provide at least some insight for potential impacts on fish due to sediment resuspension.

EPA and RIDEM did not expect that adult and juvenile fish would be severely disrupted by sediment resuspension during demolition, as these motile organisms are capable of vacating disturbed areas. Fish eggs and larvae incapable of moving out of disturbed areas were potentially much more susceptible to harmful impacts. Recent literature suggests that some estuarine species may be particularly sensitive to suspended sediments. In a 2000 paper published by the U.S. Army Corps of Engineers' Dredging Operations and Environmental Research Program (DOER) in *DOER Technical Notes Collection*, D.G. Clarke and D.H. Wilber summarized the research. "The eggs and larvae of estuarine and coastal fish exhibit some of the most sensitive responses to suspended-sediment exposures of all the taxa and life history stages for which data are available," the authors reported.

This susceptibility appears to be highly species-specific. For example, experiments have shown lethal effects at suspended sediment dosages as low as several hundred milligrams per liter (mg/L) over a 24-hour exposure in certain species of larvae, while no effects were observed in some species at concentrations of more than 10,000 mg/L for 7 days. Two of the species in Narragansett Bay, Atlantic silverside (*Menidia menidia*) and white perch (*Morone americana*), are fish with the most sensitive lethal responses, exhibiting 10-percent mortality at concentrations less than 1,000 mg/L for 1- and 2-day durations, respectively, according to the findings of Clarke and Wilber.

Using a wide variety of published data, C.P. Newcombe and J.O.T. Jensen developed mathematical models to quantify the potential impacts of suspended sediment on a variety of freshwater and estuarine fish species. The empirical equations they developed and reported in a 1996 article in the *North American Journal of Fisheries Management* employed a "severity scale of ill effects associated with excess suspended sediments," which divided impacts into a 14-point scale, with 0 being no impact and 14 representing 80- to 100-percent mortality. RIDOT undertook an extensive reevaluation of the estimated fish mortality associated with underwater blasting and used more detailed information on the number of blast events, the timing of the blasts, and the size of the blasts allowed. Based on this evaluation, RIDOT projected total fish mortality between 1,600 and 4,700 fish. Although it is too soon to determine the actual impacts on the fish population, visual inspections noted very little impact from the current blasts.

Predicted Severity of Effects on Eggs and Larvae

Severity	Description of Effect	Predicted Suspended Sediment Concentration (mg SS/L)
0	No effects	
1	Alarm reactions	0
2	Abandonment of cover	0
3	Avoidance response	0
4	Short-term reduction in feeding rates	0
5	Minor physiological stress	0
6	Moderate physiological stress	0
7	Moderate habitat degradation	0
8	Indications of major physiological stress	2
9	Reduced growth rate; delayed hatching	54
10	0–20% mortality	1,336
11	>20–40% mortality	33,000
12	>40–60% mortality	817,000
13	>60–80% mortality	20,215,000
14	>80–100% mortality	500,019,000

This table shows predicted concentrations of suspended sediment per liter after a 39-hour exposure for the eggs and larvae of salmonids and nonsalmonids. *Source: Newcombe, C.P. and J.O.T. Jensen. 1996. "Channel suspended sediments and fisheries: A synthesis for quantitative assessment of risk and impact."* North American Journal of Fisheries Management*, 16(4): 693–727.*

Demolition Stages

Demolition of the Jamestown Bridge involved two major controlled explosions and about a dozen smaller ones. In April 2006, the contractor demolished the center truss section with its two adjoining deck truss sections using a blast that cut them into 6-meter (20-foot) sections. A series of explosions 1 month later removed the two long, low truss sections on either side of the center span. A third blast was planned to remove the two large center piers that held up the center span,

but instead that demolition was combined with the second blast.

The contractor used two types of charges. The first were linear shaped charges—devices that resemble thin, flexible lengths of copper pipe—wrapped around key connecting points. The heat from the charges essentially burns through the steel, allowing the sections to separate and fall into the water. The bridge segments were fitted with a cable and buoy system to facilitate safe and efficient removal of the steel debris for salvaging.

The two main concrete piers and smaller piers were removed by boring holes into the concrete and inserting conventional blasting charges. Because the charges were confined within the concrete, the explosions emitted little flying debris and did not produce fireballs. Clearing the debris so that marine traffic could pass safely was scheduled to take about 4 weeks. A portion of the main channel under the Jamestown-Verrazzano Bridge was reopened 1 week ahead of schedule because RIDOT worked with the U.S. Coast Guard to establish a temporary channel after clearing a major portion of the 671 meters (2,200 feet) of deck steel.

"Taking the bridge apart using controlled demolition required less time and was safer and more cost effective than manual disassembly," says Parker. "The use of explosives in bridge demolition is a proven technology that has been used throughout the United States."

All the demolitions were weather-dependent, and the first blast was delayed 2 weeks in April because of poor weather conditions. Approximately 6 days of clear weather were needed before each blast to set the charges, precut the steel, and check the wiring.

During the major controlled demolitions, the adjacent new Jamestown-Verrazzano Bridge (Route 138) was closed for 2 hours (a plan was in place for up to a 4-hour closing), and during the minor controlled demolitions, it was closed for about 30 minutes. To avoid affecting commuting periods and weekend events, the closures were restricted to 10 a.m. to 2 p.m. on Tuesdays, Wednesdays, and Thursdays. Local roads in Jamestown were closed as well, and the police and contractor employees maintained a clear zone for spectators to view the demolition blasts. Motorists were encouraged to avoid the area, and emergency vehicles, such as ambulances, were permitted access just prior to and after the controlled demolition.

"Rhode Island residents approached this project like it was a giant Fourth of July fireworks display," says Parker. RIDOT deployed fixed and portable electronic message boards to indicate detours, and disseminated traffic information and announcements through the State's Highway Advisory Radio System. Motorists also were notified of the road closures through RIDOT's Web site, www.dot.state.ri.us, and newspaper notices appeared in the *The Providence Journal* and other local newspapers. "Overall, the demolition and artificial reef creation was accomplished without a hitch," says Parker.

Lessons Learned

The successful demolition of the Old Jamestown Bridge is the first large-scale Rhode Island project to implement FHWA's policy for the "Use of Debris from Demolished Bridges and Overpasses," issued in the March 2006 memorandum mentioned earlier. The demolition of the Old Jamestown Bridge (including the ultimate disposal of the demolition material) required an unprecedented amount of coordination and cooperation from very unlikely groups of interested parties. The permitting and environmental process required time to collect relevant data and develop the most acceptable approach, not only to State and Federal interests but also to the local fishing and boating concerns.

Creating a marine reef in this manner involves a number of challenges. Responding to citizens needs should be the overarching goal and may require the State to accept positions that may not be backed by science. For example, although the risk of lead-based paint contamination may be minimal, it is a key aspect in the eyes of many environmental permit-

RIDOT

These citizens are watching the demolition from a safe distance.

The new bridge dwarfs the remains of the old one. *Photo: RIDOT.*

ting agencies. For this reason, this risk may be unacceptable for any amount of lead-based paint on bridge elements in New England.

Finally, the creation of marine reefs effectively meets the needs and commitments of more than one Federal and State government agency. Although not everything will be constructed as designed, by providing access to shared information, training, and financial resources, these facilities can be a cornerstone for research on marine mitigation.

Closing Remarks

After the first two explosions in April and May 2006, the demolition moved into a new phase in June and continued through to the fall. All of the steel sections were removed from the bay bottom, and the concrete pier columns were brought down to the water level. Using a demolition device called a hoe ram, which employs a long arm with a jackhammer-like head, the contractor broke apart the columns without using above-water explosives. The use of mechanical demolition avoided the need to close the adjacent Jamestown-Verrazzano Bridge. Mechanical demolition does generate some noise, but the decibel level was lower than pile driving. Where dust was an issue, the contractor incorporated a water line mist spray into the operation. Now that the piers are demolished to the waterline, underwater explosive charges will remove the pier sections to a depth safe for navigation.

Although the lessons learned in establishing relationships and developing procedures for material disposal will be valuable in the future, more followup studies by biologists and marine fisheries experts will be necessary to determine the actual success of the new artificial reef areas. RIDOT, working with the RIDEM, is committed to monitoring the reefs, and only time will tell regarding their success. Nevertheless, because of the RIDOT's sensitivity to the bay's importance, Rhode Island fisherman and recreational boaters will continue to enjoy the benefits of Narragansett Bay.

Dan Berman has served as assistant division administrator for FHWA's Rhode Island Division for the past 10 years. He has worked for FHWA for 32 years in transportation engineering, planning, and management at the regional level and at several division offices. From 1991–1996, he served as FHWA's first project manager for the $14.5 billion Central Artery/Tunnel (CA/T) Project in Boston, MA. He has a bachelor's degree in civil engineering from Lamar University in Beaumont, TX. He was a 1995 recipient of FHWA's Superior Achievement Award in recognition of his outstanding accomplishments on the CA/T Project.

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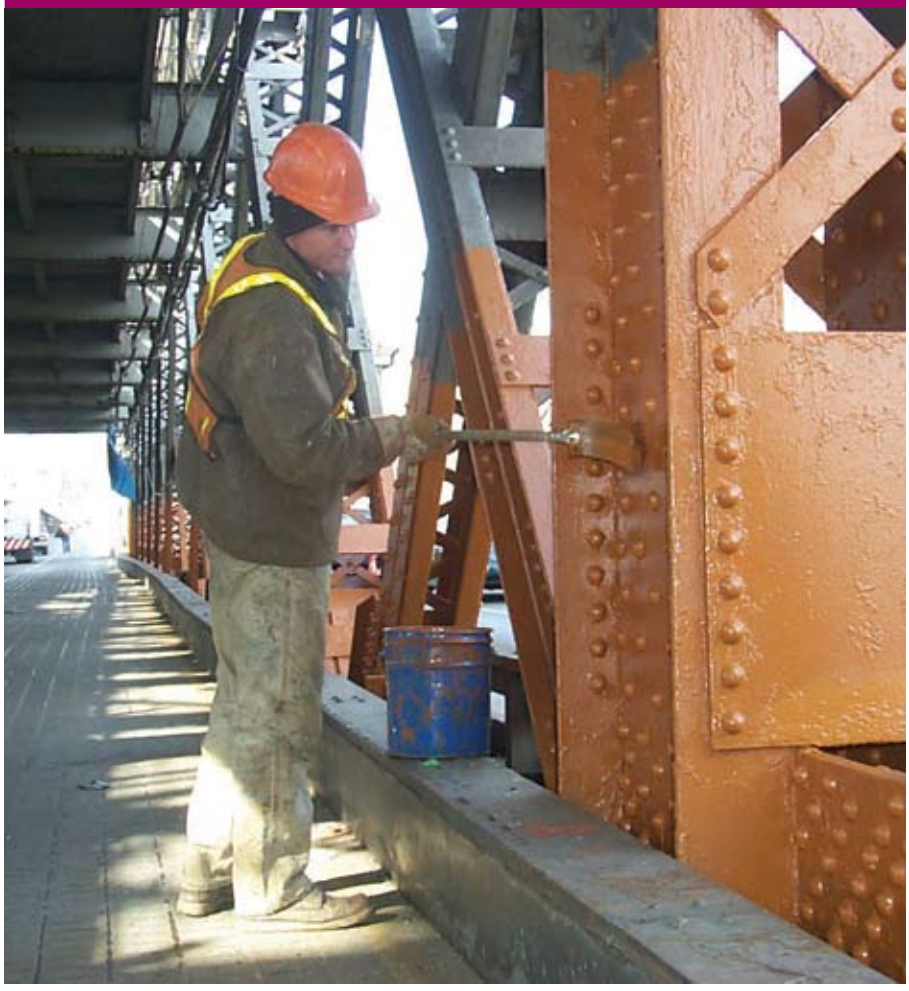
Are Two Coats As Effective As Three?

by Shuang-Ling Chong and Yuan Yao

This research studies two-step painting systems as a possible alternative for protecting steel bridges and overpasses from corrosion.

Until the late 1970s, virtually all steel bridges in the United States were protected from corrosion by paint systems that consisted of three to five thin coats of alkyd paint containing toxic lead and chromate. Over the course of several days, bridge workers would apply the paint directly onto the mill scale (black corrosion analogous to rust) that adheres to the formed steel when it is heated. Subsequent painting for preventive maintenance and corrosion protection was rare and generally reserved for larger spans.

Because the majority of the steel bridges in the interstate system were built between 1950 and 1980, many have little protection from corrosion because their coating systems have outlasted their useful lives. Often, harsh environments and exposure to roadway deicing chemicals (salts) intensify the effects of the natural aging process. Further, the presence of potentially hazardous substances in the existing paint complicates maintenance processes and dramatically increases related costs.



(Right) This New York City worker is applying a coating to a steel bridge structure. FHWA is studying the effects on costs of using two-coat painting systems on steel bridges and overpasses. *Photo: Fouad Althaibani, NYCDOT.*

Nearly 20 years ago, research led to the current standard, which is a three-coat system of zinc-rich primer/epoxy/polyurethane paint. Many States use the three-coat paint system as the preferred method of protection. In humid environments, for example, maintenance personnel use three coats of zinc-rich moisture-cured urethane (MCU)/MCU/polyurethane paint system.

A new class of coating systems consisting of a zinc-rich primer topcoated with fast-dry, high-build (thick film) polyaspartics, polyurethane, or polysiloxane promises anti-corrosive results that are comparable in some situations with the three-coat systems. These two-coat systems eliminate the intermediate epoxy layer, so painting a steel overpass can be completed overnight. When application specifications are followed, two-coat systems can reduce labor as well, increasing worker productivity and decreasing the overall cost of coating applications.

To assess the performance of these new two-coat systems, researchers at the Federal Highway Administration (FHWA) recently conducted a series of laboratory and outdoor tests that compared the performance of 11 two-coat rapid deployment systems with that of traditional three-coat systems.

Experimental Procedure at FHWA

The FHWA study used various combinations of primers and topcoats, applying the zinc-rich coating systems on clean steel panels according to the coating manufacturers' specifications. Each steel panel met the industry benchmark for near-white blast cleaning of painted or unpainted surfaces with abrasives, as set forth by the Steel Structures Painting Council, now the Society for Protective Coatings, under Surface Preparation standard 10 (SSPC-SP 10). The test panels measured 10.2 x 15.2 x 0.48 centimeters (4.0 x 6.0 x 0.19 inches). Prior to testing, the researchers scribed a 5-centimeter (2-inch) scratch diagonally on all of the coated panels to assess how each coating performed in terms of rust creepage—the growth of rust from a scribe through the coating.

The drying times of all the topcoats, including dry-to-touch times and dry-to-handle times, were tested using the American Society for Testing and Materials (ASTM) Method D 1640 (the industry standard for drying, curing, and film formation). The researchers measured the adhesion strengths by a pneumatic pulloff adhesion tester under ASTM Method D 4541 (again, the industry standard). They measured the gloss following the ASTM Method D 523. Gloss enhances appearance, and the reduction of gloss can signal chemical changes that may affect the paint's corrosion resistance.

The study involved both laboratory and outdoor tests to evaluate the coatings. The researchers prepared 8 replicate panels for each of the 11 coating systems, using 4 in the lab test and 4 outdoors. In the laboratory test, the panels were cycled through freeze, ultraviolet light (UV)/condensation, and salt-fog/dry-air conditions over the course of 500 hours. The researchers repeated this process 10 times, for a total test duration of 5,000 hours.

The researchers used a hot salt fog, generated with a 5-percent-by-weight solution of sodium chloride, and alternated that with ambient air at 1-hour intervals during the third phase of each cycle. Next, they examined the panels for surface failures such as blistering, rusting, or other imperfections. They also measured the panels for rust creepage at the scratched scribes after each test cycle (every 500 hours), using an FHWA-developed imaging technique designated as ASTM Method D 7087-05a.

The FHWA researchers evaluated eight two-coat, zinc-rich primer/topcoat systems, including four original manufacturer-recommended systems and four product-interchange

The Basics of Bridge Paints

Zinc Primers. There are two types of zinc-rich primers: organic and inorganic. Organic primers are epoxy-containing zinc-rich primers. Work crews can apply them using brush, roller, or spray. If not topcoated, zinc primers do not protect steel as well as inorganic primers. However, both organic and inorganic primers offer the same degrees of protection if they are topcoated.

Moisture-cured urethane (MCU) zinc primer is a new type of organic. MCU coatings are more tolerant to humid environments than epoxy-based primers and are one-component products.

Inorganic zinc-rich primers are silicate-containing primers. They may be used as a stand-alone coating but typically are topcoated with a compatible paint or epoxy. Generally, inorganic primers must be spray applied.

Polyurea is a polymer technology used in coatings to protect steel from corrosion and abrasion. Conventional polyurea is known to cure very rapidly, but it needs special equipment to apply.

Polyurethane is a polymer coating that is formed by reacting polyisocyanate with polyol or base resin. It is a high-performance topcoat.

Polysiloxane, better known as silicone, is an inorganic polymer that is resistant to water, chemicals, and oxidation, and has good color and gloss retention.

Polyaspartics are a new coating technology that builds on conventional polyurethanes and provides even faster dry times. Polyaspartics dry quickly and can be applied with high thickness.

Laboratory Test Conditions

Freeze: 68 hours

Temperature: –23° Celsius, C (–10° Fahrenheit, F)

UV/Condensation: 216 hours (9 days)

Test cycle: 4 hours UV/4 hours condensation cycle

UV lamp: UVA-340

UV temperature: 60° C (140° F)

Condensation temperature: 40° C (104° F)

Cyclic Salt Fog: 216 hours (9 days)

Test cycle: 1 hour wet/1 hour dry

Wet cycle: 5-percent sodium chloride (salt) solution. Fog introduced at 35° C (95° F)

Dry cycle: Air purged to the test chamber at ambient temperature

Source: FHWA.

Two-Coat and Three-Coat Systems Tested By FHWA

System Number	Coating Description	System Category	Nominal Dry-Film Thickness, micrometer (µm) (mil)	VOC Content[a], g/L
1	Zinc-rich MCU (P1)/ Polyaspartics (T1)	M	75/200 (3/8)	340/289
2	Zinc-rich MCU (P2)/ Polyaspartics (T2)	M	75/175 (3/7)	320/172
3	Zinc-rich MCU (P1)/MCU/ Aliphatic polyurethane (T3)	A	75/100/75 (3/4/3)	340/340/335
4	Organic, zinc-rich epoxy (P3)/ Epoxy/Aliphatic polyurethane (T4)	A	100/50/50 (4/4/2)	326/195/264
5	Inorganic, zinc-rich alkyl silicate (P4)/Epoxy/Aliphatic polyurethane (T4)	A	75/100/50 (3/4/2)	288/195/264
6	Organic, zinc-rich epoxy (P3)/ Polyaspartics (T1)	B	100/200 (4/8)	326/289
7	Organic, zinc-rich epoxy (P3)/ Polyaspartics (T2)	B	100/175 (4/7)	326/172
8	Inorganic, zinc-rich alkyl silicate (P4)/Polyaspartics (T1)	B	75/175 (3/7)	288/289
9	Inorganic, zinc-rich alkyl silicate (P4)/Polyaspartics (T2)	B	75/175 (3/7)	288/172
10	Organic, zinc-rich epoxy (P3)/ Aliphatic polyurethane (T5)	M	100/100 (4/4)	326/383
11	Organic, zinc-rich epoxy (P3)/ Polysiloxane (T6)	M	100/150 (4/6)	326/216

P: Primer
T: Topcoat
a: Labeled by suppliers
M: Manufacturer's recommended topcoat
A: Three-coat, conventional, zinc-rich coating system
B: Organic zinc primer or inorganic zinc primer with polyaspartic topcoat

Source: FHWA.

systems. Three three-coat, zinc-rich systems served as controls. The volatile-organic-compound (VOC) content of all the coating materials was less than or equal to 340 grams per liter, g/L (2.8 pounds per gallon).

The researchers also exposed another set of coated panels for 2 years at a marine site in Sea Isle City, NJ. All the panels were placed at a 45-degree angle on wooden racks, facing directly south, and were sprayed every day with natural seawater to accelerate corrosion.

The Texas Department of Transportation's (TxDOT) experience with the two-coat painting system suggests such coastal testing is crucial and could have very influential results. "Two-coat painting does offer the advantage of saving time and money, but we haven't seen a system yet that we feel confident will give better or equal performance with the standard three-coat system for marine environments," explains Johnnie S. Miller, P.E., director of TxDOT's Construction Division, Materials and Pavements Section, Traffic Materials Branch. "Our use of the organic zinc/acrylic—vinyl or latex—topcoat system has worked out well for most of our State since Texas is predominantly a low-corrosive environment; however, we do not use this system along our coast."

And, like a few other States, "We are just now exploring more two-coat systems for marine environments as paint companies develop alternatives to the standard three-coat system," Miller says.

Clocking Drying Times

In the first part of the study, the FHWA researchers applied various primers and topcoats to the steel plates and then clocked the drying times. The dry-to-touch times for all the topcoats ranged from 0.5 to 1.6 hours. The dry-to-handle times ranged from 3 to 5 hours. The drying times proved similar for the topcoats in both the two- and three-coat systems. Especially for dry-to-handle times, however, the polyaspartics dried more quickly than conventional topcoats, given that they were applied as much thicker films than the topcoats in the three-coat systems. The drying times of the zinc-rich primers were similar, all drying in 2 hours.

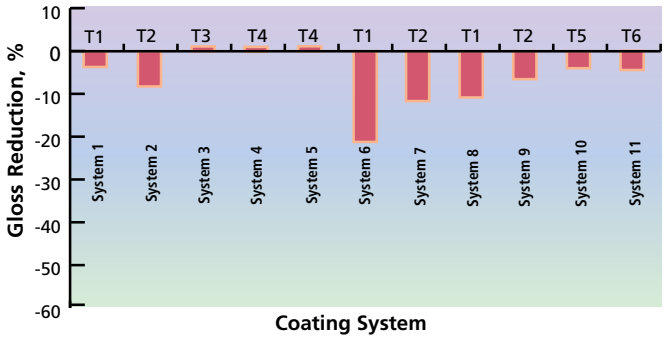
Drying Times for Topcoats Tested

Topcoat	System Used	Dry-Film Thickness[a], µm (mil)	Dry-to-Touch Time (Hours)	Dry-to-Handle Time (Hours)
T1	two-coat	200 (8)	0.5	3.0
T2	two-coat	175 (7)	1.0	3.5
T3	three-coat	75 (3)	1.0	5.0
T4	three-coat	50 (2)	1.0	3.0
T5	two-coat	100 (4)	0.5	4.5
T6	two-coat	150 (6)	1.6	5.0

a: Targeted dry-film thickness in the dry-time test

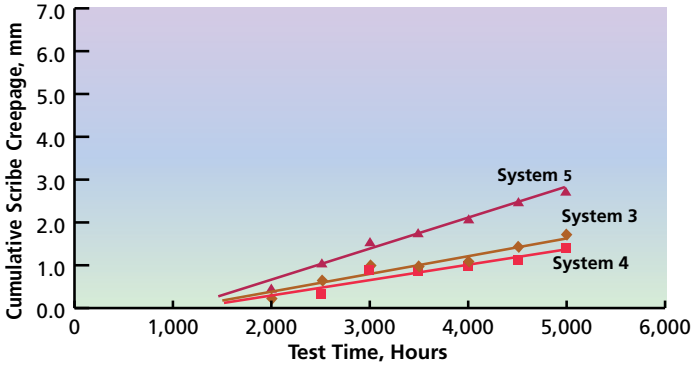
This table of the drying times for all six topcoats tested shows the rapid setup (drying) times for the polyaspartics (T1 and T2). Despite up to four-times-thicker application, the two-coat dry-to-handle times were less than or equal to those of topcoats in conventional systems. *Source: FHWA.*

Gloss Reduction



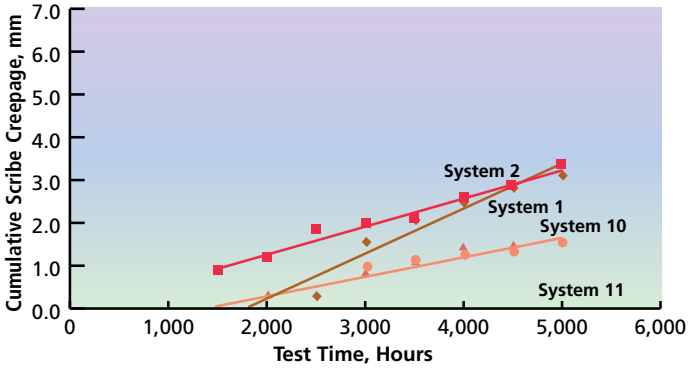
This bar graph compares the gloss reduction for all the coating systems after the 5,000-hour laboratory test. The researchers found that the conventional coatings (systems 3, 4, and 5) performed somewhat better than the two-coat systems. *Source: FHWA.*

Scribe Creepage for Three-Coat Systems



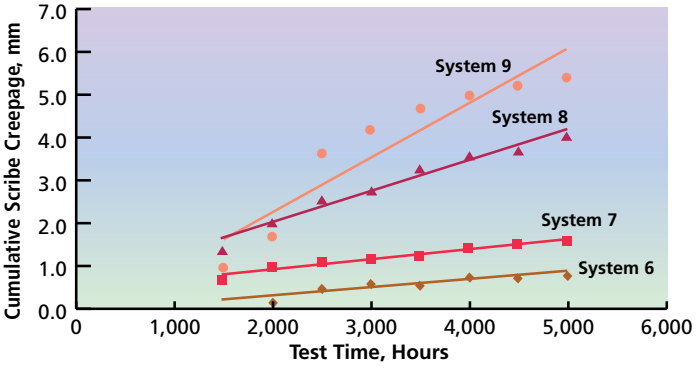
At approximately 1,500 hours, scribe creepage for the three conventional coating systems—all with aliphatic polyurethane topcoats but varying by primers of zinc-rich MCU, organic zinc-rich epoxy, or inorganic zinc-rich alkyl silicate—started to appear. System 5 entailed significantly more and faster creepage than systems 3 and 4. *Source: FHWA.*

Scribe Creepage for Two-Coat Systems Following Manufacturer Recommendations



Scribe creepage during the lab test for four of the eight two-coat systems—two comprising zinc-rich MCU and polyaspartic topcoats, the other two comprising organic zinc-rich epoxy but varying by aliphatic polyurethane or polysiloxane topcoats—are displayed in this graph. The blends are per the manufacturers' recommendations. *Source: FHWA.*

Scribe Creepage for Two-Coat Systems Not Following Manufacturer Recommendations



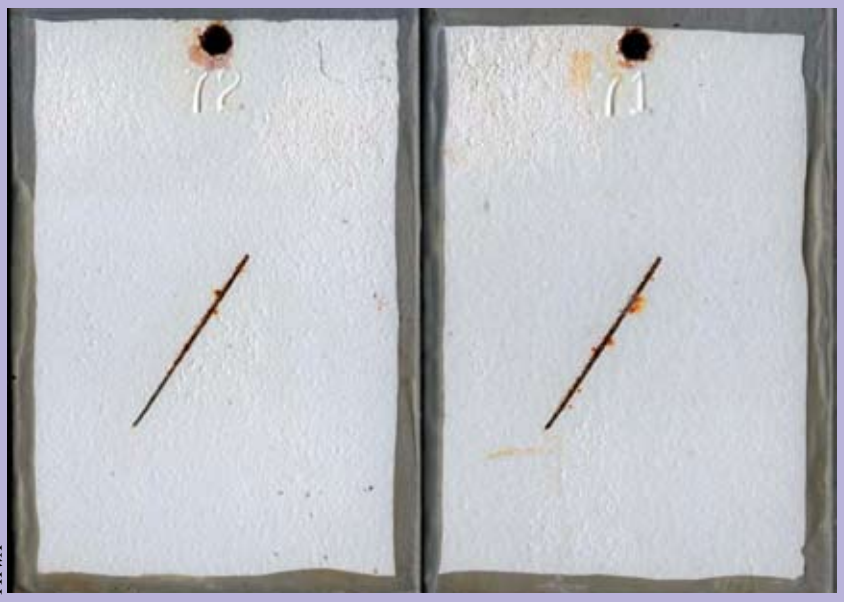
This graph shows wide creepage disparities between systems 6 and 7 on one hand and systems 8 and 9 on the other during the lab test. The blends did not necessarily follow manufacturer recommendations and consisted of polyaspartic topcoats with organic or inorganic zinc primers, the last of which was involved in the worst scribe creepages. *Source: FHWA.*

Laboratory Tests

None of the coating systems showed surface failures except system 6, a combination of organic zinc-rich epoxy primer and polyaspartic topcoat, which developed extensive topcoat wrinkling. After the full, 5,000-hour laboratory test, the topcoat gloss diminished for the two-coat systems but not for the three-coat systems. System 6, with the polyaspartics topcoat, lost the highest amount of gloss (21 percent), suggesting that it might be affected by the surface wrinkling.

In general, the adhesion strength remained nearly constant. Among all the coating systems, those using inorganic zinc alkyl silicate primer (systems 5, 8, and 9) displayed the lowest adhesion strength (about 5.0 megapascals), which the researchers expected, given that inorganic zinc is known to have a low cohesive strength. The researchers found the other systems to be at least two or three times as strong in terms of adhesion.

All of the coating systems and the controls developed rust creepage at the scratched scribe after the 5,000-hour test, and the mean creepage distance grew linearly with test time. The researchers obtained the mean creepage by averaging the creepage of each set



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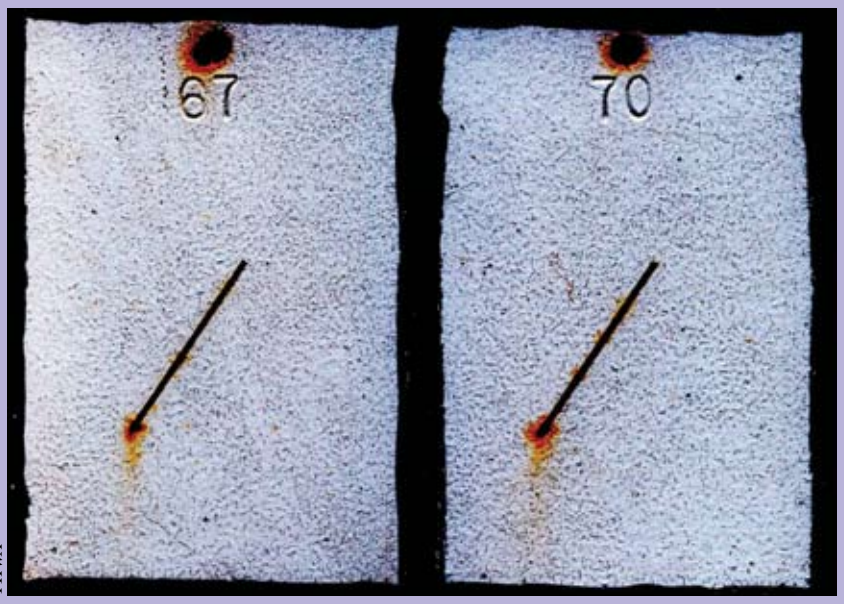

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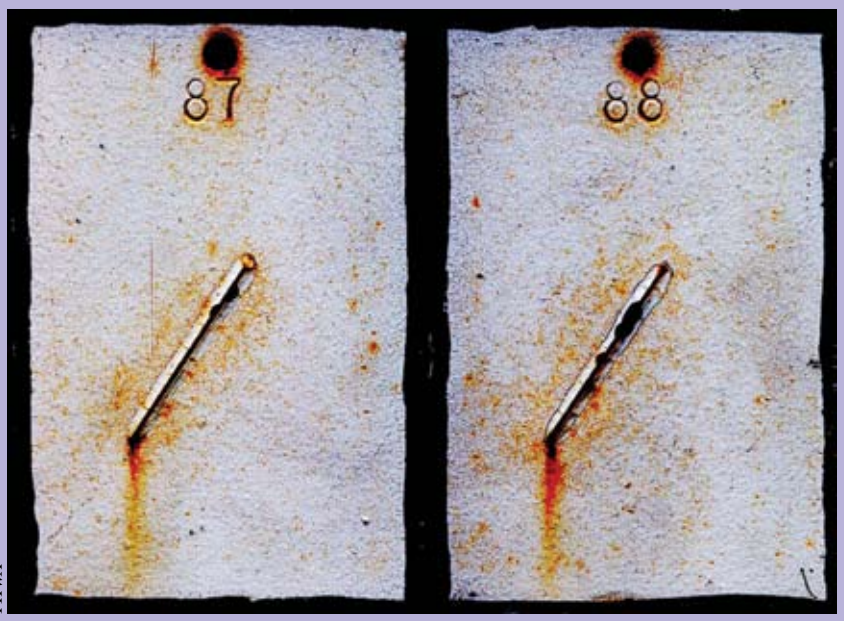


FHWA

The panel condition of system 6 (organic zinc/polyaspartics) is shown (first two photos) after the 5,000-hour laboratory test, where wrinkling occurred. The next two photos show the condition of system 6 after the 2-year outdoor exposure, which caused cracking. The final set of photos shows the condition of system 7 (inorganic zinc/polyaspartics) after the 2-year outdoor exposure, where cracking was even more pronounced.

of four replicates and used a statistical linear regression analysis to obtain relatively high correlation factors, indicating a good linear fit.

Three-coat systems. The three-coat systems (systems 3, 4, and 5) developed scribe creepage in the amounts of 1.7, 1.4, and 2.8 millimeters (mm) (0.067, 0.055, and 0.110 inch), respectively, after the full lab test. The researchers consider these lengths quite small, indicating good overall coating performance on the SSPC-SP 10 steel surfaces. The inorganic zinc system (system 5) did not perform as well as in an earlier test, indicating that the inorganic system can be sensitive to application techniques and curing conditions. The creepage measured 1.6 mm (0.063 inch) after 3,000 hours instead of the zero obtained previously. However, the larger scribe creepage found during this study actually included both rust and topcoat delamination (that is, a separation between the topcoat and primer where portions of the primer were not rusted).

Two-coat systems. The two-coat systems (systems 1, 2, 10, and 11) exhibited scribe creepage of 3.1, 3.3, 1.6, and 1.6 mm, (0.122, 0.130, 0.063, and 0.063 inch), respectively, after the 5,000-hour test. The first two systems, using polyaspartics as topcoats, performed similarly to or slightly worse than the three-coat systems with intermediate coats.

On the other hand, systems 10 and 11, using a different type of zinc-rich primer and topcoats with slightly longer drying times than polyaspartics (polyurethane and polysiloxane), performed as well as the three-coat systems (systems 3, 4, and 5) in terms of the small amount

Comparison of Scribe Creepage

Test	Coating System Number										
	1	2	3	4	5	6	7	8	9	10	11
	Mean Scribe Creepage, mm										
A	3.1	3.3	1.7	1.4	2.8	0.8	1.6	4.0	5.4	1.6	1.6
B	0.0	1.5	1.0	0.0	1.7	0.0	1.3	2.6	1.8	0.9	0.8

A: 5,000-hour laboratory test
B: 2-year outdoor exposure in marine environment

As indicated by the larger scribe creepage values in the row labeled "A," the laboratory tests proved to accelerate corrosion more so than outdoor exposure in a marine environment. *Source: FHWA.*

of scribe creepage—less than 2 mm (0.079 inch). This suggests that when using a two-coat system, the proper formulation of paint primer and topcoat can make a difference in the results.

Interchange of products from different manufacturers. Bridge owners have applied coating systems with organic zinc epoxy primer and inorganic zinc alkyl silicate primer on many steel bridges across the United States. Part of the mission of FHWA's test was to gauge the viability of using a polyaspartic topcoat in combination with such zinc-rich primers from various manufacturers. At the scribe, the organic zinc primers topcoated with polyaspartics (systems 6 and 7) performed better than the systems using zinc-rich MCU primers (systems 1 and 2). The creepage was small—0.8 and 1.6 mm (0.031 and 0.063 inch)—for the two systems, respectively. These creepage values are equal to or less than those developed by the three-coat systems.

However, because the organic zinc primer topcoated with polyaspartics (system 6) developed surface wrinkling, the researchers concluded that the combination does not make for an effective coating system. Likewise, the inorganic zinc primer appears to be sensitive to topcoat type; that is, it is not compatible with polyaspartics. Using polyaspartics with that primer (systems 8 and 9) reduced the coating performance at the scribe, where rust creepage increased to as much as 4.0 and 5.4 mm (0.157 and 0.213 inch), respectively.

System 9 panels developed delamination at the scribe in addition to the creepage, further suggesting low compatibility of the polyaspartic topcoat with the inorganic zinc primer. Among the four interchange systems, only system 7 performed well. Therefore, to ensure effective coating performance, both the organic and inorganic zinc primers should be used only with topcoats recommended by their manufacturers.

Outdoor Tests

After 2 years of outdoor exposure at the Sea Isle site in New Jersey, systems 6 and 7 showed cracking over all of their coating surfaces. Cracking is a more severe failure mode than the wrinkling alone, observed in the laboratory test for system 6. The inhospitable environment and intense UV light at Sea Isle probably caused the failure because no such faults occurred in the lab test.

All the coating systems exhibited zero or some rust creepage at the scribe after the outdoor test, but these creepage amounts were smaller than those found in the laboratory because of the accelerated conditions of the laboratory test. The rust creepage also grew linearly with exposure time in both the laboratory and the field tests.

Exposure to corrosive elements reduced the gloss of all topcoats except polysiloxane (System 11) by 60 to 90 percent. The researchers attribute this large reduction to the high UV light intensity at the outdoor site. Among the six topcoats, therefore, the polysiloxane shows the greatest ability to retain gloss under intense UV conditions.

The adhesion strengths before and after the 2-year outdoor exposure followed a similar pattern to that of the laboratory tests. Essentially, these results demonstrate that all the coating systems

State Applications

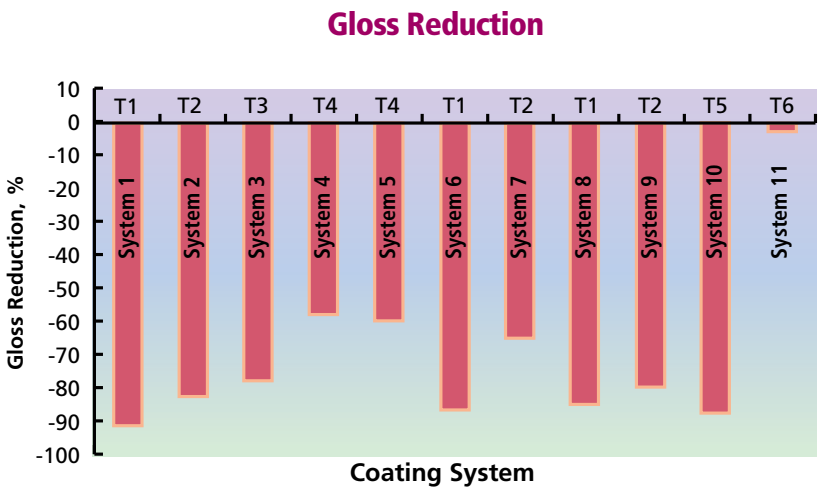
Several State departments of transportation (DOTs) report usage of two-coat painting systems to varying extents. In fall 2004, the Connecticut Department of Transportation (ConnDOT) painted half of an overpass on I–84 with the traditional three-coat system and half with a two-coat system. According to Brian Castler, ConnDOT's bureau chief for finance and administration, ConnDOT was able to quantify that the two-coat system, which took less time to apply, did indeed lower the contractor's labor costs, reduce travel delay and related expenses for road users, and save the State money in terms of shutting down lanes and other administrative costs.

ConnDOT has used the two-coat system on four bridges so far. "The jury is still out," Castler says, on whether the two coats will hold up as well as the traditional three, but preliminary examinations indicate that the systems are "comparable."

If two-coat painting systems gain acceptance, there could be benefits for Connecticut and the Northeast in particular, Castler says. Because the region is relatively cold and damp, the window for roadwork, especially painting, is closed more often than for other areas of the country.

For now, ConnDOT officials believe the new method "may not be the ultimate solution for every bridge and overpass, but it is very promising especially for high-traffic areas," Castler says. "It's another tool in our tool bag."

The Pennsylvania Department of Transportation (PennDOT) also is interested in two-coat painting. "We have the new two-coat, organic zinc-rich coating system in technical review," explains PennDOT Chief Engineer M.G. Patel. "We have four future projects designated as tests for this system. We look forward to seeing the results."



This bar graph shows the gloss reduction of the 11 rapid deployment test coatings after the 2-year outdoor exposure in a marine environment. Compared to the laboratory tests, the outdoor exposure had a much more dramatic impact on reducing the coating gloss. *Source: FHWA.*

retained their mechanical strength throughout the test period.

Correlation

All the panels showed zero or some scribe creepage in both the laboratory and outdoor tests. After one-third of each test period had elapsed (5,000 hours for the laboratory test versus 2 years for the outdoor exposure), the indoor creepages measured much larger than the outdoor creepages, indicating that the laboratory conditions had greatly accelerated corrosion. Linear regression fitted to the lab and outdoor creepage results yield a correlation coefficient of 0.65, which the researchers consider to be fairly strong, especially because the outdoor environment is highly variable compared with the controlled conditions in the lab. Therefore, the researchers conclude that the accelerated laboratory test employed in this study appears to reliably predict the relative field performance of these coating systems.

Use as Recommended

The FHWA study showed that with regard to physical and chemical properties, all the topcoats in the two-coat systems dried quickly. The gloss of the two-coat systems diminished after the laboratory test but stayed the same for the three-coat systems. Conventional aliphatic polyurethane showed slightly better performance than the fast-dry polyaspartics, polyurethane, and polysiloxane after the lab test using a UVA lamp. However, only polysiloxane retained much of its gloss under the intense UV conditions at Sea Isle. And adhesion strength showed little variation in either the laboratory or outdoor tests. Even though the "aesthetic appeal" of the paint diminished as the gloss decreased, the integrity of the coating systems remained approximately the same; however, any decrease in gloss may be an indicator of material deterioration.

In terms of rust creepage, the study revealed that the currently available two-coat, zinc-rich primer/fast-dry topcoat systems (where both primer and topcoat are provided by the same manufacturer) all performed well, without any surface failures, but with zero or a small amount of rust creepage at the scribe after both the 5,000-hour accelerated laboratory test and the 2-year outdoor exposure in a salt-rich environment.

Ultimately, the FHWA researchers concluded that the two-coat systems performed comparably to the conventional three-coat, zinc-rich primer/epoxy/polyurethane systems. The results obtained in the FHWA study indicate that the new two-coat, zinc-rich coating systems can replace the three-coat systems to protect steel structures without sacrificing much corrosion resistance. At the same time, painting costs and traffic congestion will be reduced. Shop painting of new steel bridge structures using two-coat systems is recommended by FHWA to ensure good performance.

In addition, the researchers found that the organic zinc epoxy primer topcoated with two different polyaspartics performed as well at the scribe as those topcoated with the matched intermediate coat and topcoat designed by the same manufacturers. However, one of the two systems developed topcoat-wrinkling failures after the laboratory test, and both systems displayed cracking after the 2-year outdoor exposure. As a result, the researchers advise that the organic zinc epoxy primer as well as the inorganic zinc alkyl silicate primer should be used only with their own matched topcoats; otherwise, their performance may be reduced when they are topcoated with polyaspartics. Further, these results indicate that the new polyaspartic topcoats should be used with the MCU primers as specified by their manufacturers and not as topcoats for the organic zinc epoxy primer or inorganic zinc alkyl silicate primer.

These are the results to date. To collect additional data, FHWA will continue working with State DOTs to evaluate the field performance of the two-coat system on existing bridges.

Shuang-Ling Chong, Ph.D., has been a research chemist at FHWA since 1989. Chong's responsibilities have included managing the Paint and Corrosion Laboratory, studying accelerated testing of various bridge coatings, and developing methods for characterizing coating materials and failures. She earned her doctorate in physical chemistry in 1969 from Rutgers, The State University of New Jersey.

Yuan Yao is a chemist employed by Soil and Land Use Technology, Inc. She works onsite at FHWA's Turner-Fairbank Highway Research Center. Yao earned her M.S. degree in chemistry from the University of North Carolina at Charlotte in 1991.

For more information, contact Shuang-Ling Chong at 202-493-3081, shuang-ling.chong@fhwa.dot.gov, or Yuan Yao at 202-493-3092, yuan.yao@fhwa.dot.gov.

Along the Road

Along the Road is the place to look for information about current and upcoming activities, developments, trends, and items of general interest to the highway community. This information comes from U.S. Department of Transportation (USDOT) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Management and Administration

SCDOT, FHWA Honored for Preservation Of Revolutionary War Battlefield

In March 2006, the South Carolina Department of Transportation (SCDOT) and the Federal Highway Administration (FHWA) received a "2006 South Carolina Historic Preservation Award" for preserving a long-lost Revolutionary War battlefield.

Governor Mark Sanford was on hand to present awards from the Palmetto Trust for Historic Preservation, in conjunction with the South Carolina State Historic Preservation Office. "Each one of you [is a hero] as it relates to historic preservation," Governor Sanford told the award winners during the ceremony.

SCDOT and FHWA received the award for preservation of the Fish Dam Ford Battlefield in Chester County. SCDOT discovered the battlefield during a bridge replacement project over the Broad River.

"After the discovery of the long-lost battlefield, SCDOT consulted our partner, FHWA, and other experts on the next course of action to make sure the battlefield would be preserved," says SCDOT Executive Director Elizabeth S. Mabry. "SCDOT and FHWA came up with what I believe is a 'win-win' idea—to purchase the battlefield outright for preservation."

SCDOT had identified the battlefield during an archaeological survey, and it was deemed eligible for the National Register of Historic Places. The State also determined that the construction of the new bridge would have an adverse effect on the battlefield. Closing the old bridge while replacing it in the same location or moving it to a different location were not options because of other historical impacts and traffic congestion. By minimizing the project design, SCDOT was able to minimize encroachment on the battlefield. Archaeological research and deep testing indicated that the 1780 ground surface was now buried under 2.1 meters (7 feet) of alluvium deposited during the intervening centuries. Traditional archaeological excavations would have cost an estimated $2 million. To mitigate the impacts of construction, SCDOT instead purchased the battlefield and an adjoining tract for $293,000 and set it aside for permanent preservation, overseen by a State management agency.

Division Administrator Bob L. Lee, head of FHWA's South Carolina Division Office, says, "This is a great example of people and agencies working together on many levels of Federal, State, and local government. Preserving this land through a purchase agreement was clearly the right thing to do. It is a savings to taxpayers, a benefit to local motorists who will use the new bridge much sooner than had we gone the excavation route, and, of course, it is also a treasured resource for historians."

For more information on the "2006 South Carolina Historic Preservation Awards," visit www.state.sc.us /scdah/hpawards2006.htm.

SCDOT

SCDOT

Palmetto Trust for Historic Preservation Chairman Frank Wideman (left) presents SCDOT and FHWA with an award at the "2006 South Carolina Historic Preservation Awards" ceremony on March 28, 2006, at the South Carolina Department of Archives and History. Accepting the award (from left to right) are Elizabeth S. Mabry, executive director of SCDOT; Robert L. Lee, FHWA division administrator; J. Shane Belcher, environmental coordinator for FHWA; Patrick L. Tyndall, environmental program manager for FHWA; Bonnie L. Frick, SCDOT environmental project coordinator; and Wayne D. Roberts, SCDOT chief archaeologist.

Policy and Legislation

San Francisco Mayor Announces Citywide B20 Plan

The San Francisco City Government has long been a leader in its commitment to alternative transportation fuels to promote clean air, encourage renewable energy, and reduce greenhouse gas emissions. On May 18, 2006, Mayor Gavin Newsom issued an executive directive designed to accelerate municipal use of biodiesel in place of diesel fuel. At present, the city uses about 30.3 million liters (8 million gallons) of diesel per year. Among other things, the executive directive states that the city must initiate and complete the biodiesel pilot project by December 31, 2006.

Biodiesel is a renewable diesel fuel made from domestic resources such as soybean oil or other fats and vegetable oils. It can be used in any diesel engine with few or no modifications, and can be blended with petroleum diesel at any level. Biodiesel significantly cuts harmful environmental emissions, promotes greater energy independence, and boosts the economy. Today, more than 600 commercial fleets nationwide use biodiesel and 850 retail filling stations make it available to the public.

The National Biodiesel Board (NBB) praised the city for its commitment to biodiesel. "This makes San Francisco the largest U.S. city ever to institute such broad biodiesel use," said Joe Jobe, NBB chief executive officer. "The mayor's leadership in taking his city diesel fleet to B20 [a blend of 20 percent biodiesel and 80 percent petroleum diesel] is a demonstration of true

commitment to the environment and to weaning ourselves from foreign oil."

In 1999, San Francisco's Healthy Air and Smog Prevention Ordinance established requirements for fleets to purchase vehicles using alternative fuels or energy-efficient vehicles with low emissions. San Francisco now has more than 800 alternative fuel vehicles in its fleets. Several city departments and agencies have successfully used B20, including San Francisco International Airport, the city and county of San Francisco Departments of Public Works, San Francisco Municipal Railway (MUNI) buses, and the San Francisco Zoo. Ferries operating out of San Francisco also have used B20 with excellent results.

Additional information about biodiesel is available online at www.biodiesel.org

NBB

Technical News

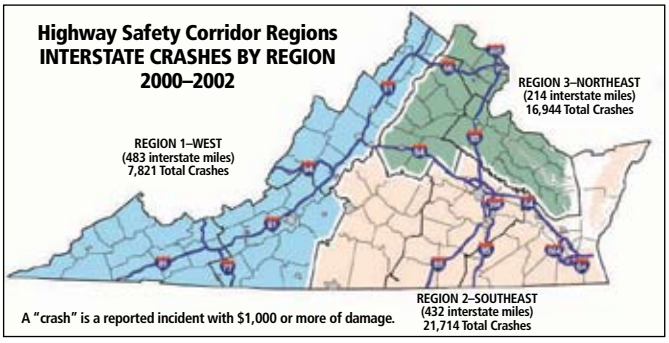
Virginia's Highway Safety Corridors Reduce Crashes

The recent establishment of safety corridors on I–81 and I–95 is credited with helping to reduce crashes. The Virginia Department of Transportation (VDOT) reports that the total number of crashes decreased by 29 percent in the I–81 safety corridor and 13 percent in the I–95 safety corridor in 2005 as compared to the previous year. To increase safety, the 2003 General Assembly directed three State agencies—Virginia State Police, Department of Motor Vehicles, and VDOT—to create a Highway Safety Corridor Program that addresses safety in high-crash locations on interstate and primary roads (routes numbered 1 through 599). The three agencies combined crash data with public comment to establish highway safety corridors.

The State is divided into three highway safety corridor regions, and segments of interstates in each region have higher than expected crash rates and severity, including injuries and fatalities. The first stretch, which was designated in January 2004 for increased enforcement and fines under the Highway Safety Corridor Program, was a 24-kilometer (15-mile) section of I–81, from mile marker 127 near Ironto in Montgomery County to mile marker 142 near Salem in Roanoke County. The second highway safety corridor, designated in January 2005, is a 21-kilometer (13-mile) stretch of I–95 between mile marker 70 near Bells Road in Richmond County and mile marker 83 near Parham Road in Henrico County. The establishment of these safety corridors was accompanied by an intense public relations campaign, increased fines, and signs that publicize the new fines schedule. Tickets for speeding could result in fines up to $500. Criminal offenses such as reckless driving or driving under the influence could result in fines up to $2,500.

For more information, visit www.virginiadot.org/comtravel/ct-highway-safety-corridor.asp.

VDOT



VDOT

This map shows Virginia's three highway safety corridor regions. Segments of interstates in each region have been identified as having higher than expected crash rates and severity.

WSDOT Tests Portable Incident Screens

The Washington State Department of Transportation (WSDOT) has rolled out a Portable Incident Screen pilot project on Interstate 90 in the Spokane region. These custom-built screens are put up at traffic incident sites to shield the crash scene from motorists driving by. The intent is to stop rubberneckers from slowing traffic and to prevent possible secondary crashes.

WSDOT will be collecting data during the test deployment in April 2006 to evaluate driver and traffic reactions. Traffic counters will collect volume and speed data while hidden cameras will evaluate the drivers' reactions and responses. This information will be contrasted with data that were collected during an analysis phase. WSDOT utilized information from similar programs in California and Massachusetts to help develop this pilot project.

The portable screens are the product of an innovative partnership between WSDOT and the Washington State Patrol that encourages "outside the box" thinking to find new ways to help keep traffic moving.

For more information on this subject and other key issues, please refer to The Gray Notebook *for the quarter ending December 2005, available at www.wsdot.wa.gov/accountability.*

Personnel

Dulles Metrorail Panel Members and Schedule Announced

On June 7, 2006, the American Society of Civil Engineers (ASCE) announced the roster for its Dulles Corridor Metrorail Tunnel Review Panel. Serving as the panel's chairman was Robert S. O'Neil, P.E., a member of the National Academy of Engineering, who has more than 40 years of experience in the planning, design, and implementation of major transportation projects, including urban transportation systems, highways, railroads, and other domestic and international facilities.

The panel consisted of Brenda Bohlke, Ph.D., P.G., who specializes in tunnel design and construction; Young Ho Chang, P.E., who specializes in local land use, zoning, and surface transportation; Richard Gray, P.G., who specializes in geology; Ray Sandiford, P.E., who specializes in underground construction costs; and Richard Tucker, Ph.D., P.E., who specializes in heavy construction, risk management, and cost.

The panel, which was formed at the request of Virginia Secretary of Transportation Pierce R. Homer, was tasked with conducting an independent evaluation of tunnel and aerial structure alternatives for the Tysons Corner segment of the proposed Metrorail extension to the Dulles International Airport. Evaluation began during a 2-day meeting in northern Virginia, June 7 and 8, and final recommendations were made to the Secretary; Fairfax County, VA; and the Federal Transit Administration (FTA) at the end of July. The panel drew the additional technical information needed to complete its assessment from representatives of the Virginia Department of Rail and Public Transportation, the Fairfax County Office of Transportation, FTA, the Metropolitan Washington Airports Authority, and the Washington Metropolitan Area Transit Authority, which also attended the group's meetings.

The panel's final report can be viewed at www.asce.org.

ASCE

USDOT Secretary Mineta Announces Resignation

After serving as the U.S. Transportation Secretary for more than 5 years, Norman Y. Mineta announced his formal resignation in a letter to President George W. Bush on June 20, 2006. Secretary Mineta's resignation became effective on July 7, 2006.

During his time at USDOT, Secretary Mineta started the Transportation Security Administration following the September 11, 2001, attacks. He also worked to secure passage of SAFETEA-LU, legislation that authorized Federal surface transportation programs for highways, highway safety, and transit for the 5-year period from 2005 to 2009.

Secretary Mineta's transportation career spans four decades. Prior to his appointment as U.S. Transportation Secretary in January 2001, Secretary Mineta served as a 10-term California Congressman. He served as chairman of the House of Representatives Public Works and Transportation Committee between 1992 and 1994. He chaired the committee's Aviation Subcommittee between 1981 and 1988, and chaired its Surface Transportation Subcommittee from 1989 to 1991. He was also a primary author of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA).

Public Information and Information Exchange

RTAP Releases New Emergency Preparedness Toolbox

In the wake of last year's tragic hurricane season, the National Rural Transit Assistance Program (RTAP) has released a new interactive DVD training module to help transit managers across the country assess hazards and threats more effectively and develop emergency response plans. The DVD, under development for nearly 9 months, was unveiled in June 2006 in Orlando, FL, at the annual Community Transportation Association of America Expo. Funded by the Federal Transit Administration and administered by the American Public Works Association, RTAP provides training products and technical assistance at the national level for use by State DOTs and local transit agencies.

The *RTAP Threat, Vulnerability, and Emergency Preparedness Toolbox* leads the transit manager through a planning process to (1) identify those assets that are most essential, (2) assess safety hazards and security threats to those critical assets, (3) develop plans to reduce the likelihood and impact of those threats, and (4) establish protocols for managing critical incidents if and when they occur. This planning process helps transit managers set priorities in safety and security, regardless of agency size. The DVD and accompanying workbook include instructional materials, tests and exams, exercises to help managers set priorities, and essential protocols for a variety of disaster scenarios.

"The devastation in Louisiana and Mississippi has forced communities all across the country to take a second look at their evacuation plans, and indeed their disaster response strategies," notes David Barr, acting national RTAP director. "Our goal with this product is to give transit operators the tools to prepare for, survive, and recover from the hazards they face."

Several States, notably Alabama, Idaho, New Mexico, North Carolina, and Utah, pilot tested the DVD. Starting in late July 2006, RTAP distributed the final product through State DOTs and through the RTAP resource library.

APWA

FHWA and NHTSA Work to Increase Hispanic Pedestrian and Bicycle Safety

Findings from a 2004 report by the Center for Applied Research and The Media Network, Inc., indicate that an average of 545 Hispanic pedestrians and 79 Hispanic bicyclists are killed in crashes with motor vehicles every year. Accordingly, FHWA and the National Highway Traffic Safety Administration (NHTSA) further researched this problem and developed appropriate materials and a marketing plan to convey safety messages to Hispanics.

FHWA and NHTSA just completed a 2.5-year effort to determine the extent of the pedestrian and bicycle safety problem as it relates to Hispanic populations in the United States. The scope of the first part of the project (completed in December 2004) was to determine the extent of the problem. The second part, developing the marketing plan to show interested audiences how to best "sell" safety to Hispanic audiences, used the information gathered in the first part.

FHWA distributed 10,000 copies of bilingual brochures and fliers to reach out to the Hispanic community in the United States. The brochure features a bilingual dictionary, reinforcing messages about pedestrian and bicyclist safety.

The task included developing actual products based on the recommendations of the marketing plan.

The two agencies created five brochures, five posters, and two radio public service announcements to address issues such as alcohol, pedestrian signals, crosswalks, sidewalks, and bicycle safety. FHWA and NHTSA produced all marketing materials in both English and Spanish, and the materials can be ordered online.

The marketing plan, "Promoting Pedestrian and Bicyclist Safety to Hispanic Audiences," can be viewed at http://safety.fhwa.dot.gov/ped_bike/toc.htm.

Work Zone Public Information and Outreach Strategies Now Available

FHWA's new guide, *Work Zone Public Information and Outreach Strategies* (FHWA-HOP-05-067), is intended to help transportation agencies plan and implement effective public information campaigns to increase work zone safety. It is the second of four guides intended to support implementation of FHWA's Final Rule on Work Zone Safety and Mobility. The new guide and an overall implementation guide for the rule, *Implementing the Rule on Work Zone Safety and Mobility* (FHWA-HOP-05-065), are available online at http://ops.fhwa.dot.gov/wz/resources/final_rule.htm.

For further information about the rule or the implementation guidance materials, please contact Tracy Scriba at 202–366–0855.

WSDOT Announces Projects to Motivate Change in Commuting Habits

In early 2006, the Washington State Department of Transportation (WSDOT) selected 17 projects to receive more than $1.3 million under the Trip Reduction Performance Program (TRPP), created by the Washington State Legislature in 2003. The program's purpose is to encourage private companies, public agencies, developers, and property managers to provide services and incentives that persuade people to leave their cars in favor of using buses, trains, vanpools, and other commuting alternatives. The TRPP projects are expected to remove a total of 3,831 daily commute vehicle trips from the State highway system.

In Duwamish, an area near Seattle, the Duwamish Transportation Management Association (TMA) received nearly $264,000, one of the larger TRPP awards. The TRPP project will help businesses and employees prepare for the closure of the Alaskan Way Viaduct. One quarter of all north-south traffic through Seattle (103,000 vehicles) use the viaduct every day. The project is expected to eliminate a total of 600 daily vehicle commute trips in the south Seattle industrial neighborhood that stretches from the professional sports stadiums to King County International Airport.

"We need more space on our neighborhood streets for trucks," says Dave Gering, executive director of Duwamish TMA, referring to an increased capacity for commercial traffic that will result from commuters switching to transit and other alternatives. "This funding is the cornerstone of an innovative project that will move more people and vehicles efficiently in the Duwamish area," he adds.

In addition to the TRPP projects, WSDOT uses its Commute Trip Reduction Program and vanpool programs to improve the efficiency of the transportation system by reducing drive-alone commuting. Companies and agencies that reduce employee commute trips through vanpools and other alternatives may reduce their business costs for taxes and employee parking.

For a complete list of projects selected for the 2005–2007 TRPP, visit www.wsdot.wa.gov/tdm/program_summaries/trpp_projects_2005-2007.cfm.

Nation's Travel Information Number Celebrates 5th Anniversary

Five years ago, the first call to 511—the Nation's travel information number—was placed in the Cincinnati and northern Kentucky area by then Kentucky Governor Paul E. Patton. Since that first call on June 21, 2001, more than 53 million 511 calls have been made nationwide. More than 18 million calls were made to 511 in 2005, a 23-percent increase from 2004.

Today, 30 active 511 systems are deployed in 24 States, accessible by more than 93 million Americans. An additional 8 States are expected to launch 511 services in 2006, which means roughly 50 percent of the population will be served by 511. A growing number of travelers and transportation agencies are discovering the benefits of 511 services. One call can alert drivers, tourists, and transit riders to real-time information on traffic incidents and delays, special road conditions, and transit information. With this information, travelers can make better decisions to avoid traffic congestion and weather-related hazards.

"Overall, this is a celebratory year for transportation and traveler information," says John Njord, executive director of the Utah Department of Transportation and chairman of the 511 Deployment Coalition. "The Eisenhower Interstate Highway System turned 50 just days after 511 turned 5 years old."

June 29, 2006, marked the 50th anniversary of the day Federal legislation was signed to begin engineering the U.S. Interstate Highway System, which today stretches 74,000 kilometers (46,000 miles).

Last year, President George W. Bush signed the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) bill, which called for "ensuring that a national, interoperable 511 system, along with a national traffic information system that includes a user-friendly, comprehensive Web site, is fully implemented for use by travelers throughout the United States by September 30, 2010." The 511 Deployment Coalition is actively working with States and regions operating and planning 511 services to achieve this goal.

The coalition is a partnership of the American Association of State Highway and Transportation Officials, the American Public Transportation Association, the Intelligent Transportation Society of America, and USDOT. For more information on 511, visit www.deploy511.org.

PBS&J

Continued on page 45

Internet Watch

By Ellen Schweppe

FHWA Launches "Corporate Research And Technology" Web Site

Thomas Edison once said, "The value of an idea lies in the using of it." At the Federal Highway Administration (FHWA), researchers work every day to come up with new ideas and turn them into successful projects and innovations for use by transportation agencies around the world. Until recently, however, it was difficult for practitioners to learn about FHWA's ideas and use them in their own work because no central access point existed on the Internet for information or updates about FHWA's research and technology (R&T) activities.

To solve this problem and ensure that practitioners around the world can learn about the agency's efforts, FHWA launched the new "Corporate Research and Technology" Web site at www.fhwa.dot.gov/crt. The site provides an umbrella portal for stakeholders, such as research directors from State departments of transportation and other individuals interested in highway technology, seeking direct access to updates on FHWA's R&T activities and initiatives.

"The purpose of the site is to give people a better understanding of the integrated and comprehensive nature of FHWA R&T activities," says John Munro, an R&T systems analyst at FHWA. The site is an outgrowth of the *Corporate Master Plan for Research and Deployment of Technology & Innovation* (FHWA-RD-03-077), which calls for FHWA to communicate its R&T program and projects effectively to stakeholders "consistently and with the appropriate level of detail."

Innovation Life Cycle: An Information Lifeline

To organize information, the site uses an "innovation life cycle" concept with five phases: agenda, ongoing research, technologies, deployment, and impacts. The life cycle concept illustrates that highway R&T deployment is neither linear nor finite. Instead, each phase supports another phase. When site visitors click on a phase on the circular life cycle illustration on the homepage, they are connected to documents and links corresponding to that phase.

By clicking on the "Agenda" phase of the life cycle, users can learn about the R&T agenda-setting process. This section also includes links to information about and results from recent workshops on advanced research. When users click on the "Ongoing Research" phase of the life cycle, they find a summary of FHWA's research portfolio and links to other sites containing information on highway research. In this section of the site, for example, users can read about FHWA's efforts to find ways to improve the design of the pedestrian environment for people with disabilities. Or, users can learn about what FHWA is doing to develop new materials for use in the Nation's highway system.

The "Technologies" phase of the life cycle highlights the 24 priority, market-ready technologies and innovations that FHWA is encouraging transportation agencies to deploy, such as cable median barriers and the air void analyzer. In the "Deployment" section, users are introduced to a new framework for tracking the progress of technology deployment to improve decisionmaking and performance measurement. The "Impacts" section provides examples of how FHWA evaluates R&T benefits, including the Long-Term Pavement Performance program and the National Model for the Statewide Application of Data Collection and Management Technology to Improve Highway Safety.

By clicking on the middle of the life cycle, users can access examples of program roadmaps and information about opportunities to participate in planning activities. FHWA will add new roadmaps as they are updated and revised over the next several months.

FHWA anticipates several other changes to the site in the future. According to Munro, "We plan to develop a Web-based Corporate R&T report that will provide site users with a comprehensive picture of FHWA's R&T portfolio." FHWA also will post more information about the Advanced Research Agenda and Highways for LIFE programs.

Collecting Your Thoughts

Rather than simply providing new channels for the one-way flow of information, FHWA designed the site to enable technical experts and the public to participate in the development, deployment, and evaluation of its R&T projects and programs.

"One of the most interesting features of the site is interactive Web tools and features that enable stakeholders to get involved in scientific peer reviews and national conversations about technology and research," says Munro.

The "Get Involved" section of the site, for example, provides portals that visitors can use to submit ideas for new R&T initiatives or to comment on current activities and products. Visitors also are encouraged to provide suggestions through the "We Want Your Feedback" section. FHWA plans to respond to comments and suggestions in a timely manner.

Ellen Schweppe is a contributing writer for PUBLIC ROADS.

FHWA's "Corporate Research and Technology" Web site.

Two New NHI Courses Focus On Preserving And Protecting The Environment

The Federal Highway Administration (FHWA) is committed to creating a safe and efficient highway and intermodal transportation system that is accessible and convenient but at the same time protects and, where practical, even enhances the environment. Water quality and historically important properties are two areas of the environment that often are affected by transportation projects. Both are especially important to communities. Historic properties provide the public with a tangible link to the past and establish a unique sense of identity for communities. Clean water is essential to a healthy ecosystem and a necessity for the people living in nearby communities.

NHI's courses on historic preservation and water quality management of highway runoff will help transportation professionals comply with associated regulations and create balance between project delivery and stewardship of historic properties such as the Mills Ruins Park, shown here, in Minneapolis, MN.

Transportation projects must comply with regulations related to each of these environmental areas. The National Highway Institute (NHI) is offering two new courses to help transportation professionals preserve and protect historic properties and water quality through a deeper understanding of the regulatory requirements associated with each area. Both courses, Beyond Compliance: Historic Preservation in Transportation Project Development (FHWA-NHI-142049) and Water Quality Management of Highway Runoff (FHWA-NHI-142047), offer practical approaches for managing environmental concerns during transportation projects.

The course Beyond Compliance: Historic Preservation in Transportation Project Development emphasizes the importance of balancing stewardship and project delivery in transportation projects. The course focuses on the fundamentals of the laws that address historic preservation and the relationships among these laws: the National Historic Preservation Act of 1966, Section 106 of the National Environmental Policy Act of 1969 (NEPA), and Section 4(f) of the Department of Transportation Act of 1966.

In particular, the course focuses on the revised Section 106 regulation, which strongly fosters close coordination between Section 106 activities and NEPA requirements; encourages consultation with Native Americans, local communities, and the public in transportation projects; and streamlines and improves the flexibility of the consultation process. The course is designed for transportation professionals and stakeholders involved in or affected by the Federal-Aid Highway Program. Upon completing the course, participants will be able to do the following:

- Identify key historic preservation laws and other authorities
- Describe the NEPA transportation decisionmaking process
- Describe the Section 106 process
- Define the roles and responsibilities of all parties in the Section 106 process
- Describe the relationship among Section 106, NEPA project development, and Section 4(f)
- Identify principles and opportunities for environmental streamlining and stewardship

For more information on the course Beyond Compliance: Historic Preservation in Transportation Project Development, contact MaryAnn Naber at 202–366–2060 or maryann.naber@fhwa.dot.gov.

The Water Quality Management of Highway Runoff course provides an understanding of the legal responsibilities, terminology, and the general roles of players in the regulatory process, all of which are critical for the proper planning, budgeting, and implementation of water quality management. In addition, the course presents approaches and technologies for the proper selection, design, construction, maintenance, and evaluation of best management practices (BMPs) that help mitigate the impacts of highway runoff on surrounding waters.

The Federal Water Pollution Control Act Amendments of 1972 were passed to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The law regulates discharges to U.S. waters through permits issued under the National Pollutant Discharge Elimination System program and places requirements on State transportation agencies for managing runoff water quality.

Transportation professionals including State departments of transportation staff, design engineers, construction personnel, inspectors, biologists, landscape architects, botanists, and environmental scientists will benefit from this course. Upon completing the course, participants will be able to do the following:

- Identify and characterize the quantity and quality of highway runoff
- Describe how highway runoff can affect ecosystems
- List major Federal requirements that apply to the management of highway runoff
- Explain how to select a mitigation strategy from a watershed perspective
- Describe design concepts and considerations in selecting and siting appropriate BMPs for controlling highway runoff
- Develop conceptual designs for various BMPs considering treatment targets, design requirements, BMP performance goals, and siting and maintenance considerations
- Explain how to integrate the mitigation of highway runoff impacts into the project development process
- Discuss the importance of BMP inspection, performance evaluation, monitoring, and maintenance

For more information on the course Water Quality Management of Highway Runoff, contact Patricia Cazenas at 202–366–4085 or patricia.cazenas@fhwa.dot.gov.

For course scheduling, contact Sherron Monts at 703–235–0534. For more information, visit NHI's Web site at www.nhi.fhwa.dot.gov. To learn more about other NHI courses, consult the course catalog available on the NHI Web site, or contact NHI at 703–235–0500 (phone) or 703–235–0593 (fax).

Along the Road *continued from page 42*

Public Information and Information Exchange

RideShare Alliance Updates Web Site On Carpooling

Recent updates to the "RideShare Alliance" Web site (www.rideshare.us) make organizing an online rideshare or carpool page for school, work, or special events even easier. Listed events can be public or private, and visitors can link directly to listings or the event organizers can provide a lookup code that will take users straight to the appropriate page. The flexible new search interface enables viewers to search using any combination of terms and to link directly to a search results page if there is more than one listing that users might want to browse.

The student government at Lane Community College in Eugene, OR, officially adopted the system last year. Since then, the students promoted its use around campus using printed fliers and a link from the school Web site. The RideShare Alliance has offered alternatives to the transportation options available for the school, which is located in a hard-to-reach area that makes walking and bicycling less practical. The students' RideShare Alliance page proved invaluable in helping students carpool to school during a mass-transit strike that occurred just weeks after they set up their page.

For more information on conserving resources and saving money by carpooling, visit www.rideshare.us.

Communication Product Updates

Compiled by Zac Ellis of FHWA's Office of Research and Technology Services

Below are brief descriptions of products recently published online by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. Some of the publications also may be available from the National Technical Information Service (NTIS). In some cases, limited copies are available from the Research and Technology (R&T) Product Distribution Center.

When ordering from NTIS, include the NTIS publication number (PB number) and the publication title. You also may visit the NTIS Web site at www.ntis.gov to order publications online. Call NTIS for current prices. For customers outside the United States, Canada, and Mexico, the cost is usually double the listed price. Address requests to:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703–605–6000
Toll-free number: 800–553–NTIS (6847)

Address requests for items available from the R&T Product Distribution Center to:

R&T Product Distribution Center, HRTS-03
Federal Highway Administration
9701 Philadelphia Court, Unit Q
Lanham, MD 20706
Telephone: 301–577–0818
Fax: 301–577–1421

For more information on research and technology publications from FHWA, visit the Turner-Fairbank Highway Research Center's (TFHRC) Web site at www.tfhrc.gov, FHWA's Web site at www.fhwa.dot.gov, the National Transportation Library's Web site at http://ntl.bts.gov, or the OneDOT information network at http://dotlibrary.dot.gov.

Federal Highway Administration University Course on Bicycle and Pedestrian Transportation (TechBrief) Publication No. FHWA-HRT-06-065

The second edition of the *Federal Highway Administration University Course on Bicycle and Pedestrian Transportation*, a set of resources designed to provide background materials for an undergraduate or graduate university course, is now available from FHWA. FHWA distributes this teaching resource to stimulate the development of university courses nationwide on bicycle and pedestrian transportation. The course is divided into five modules, which are sectioned into lessons. In the 24 lessons, the course covers a wide range of topics as outlined below:

- Module 1: Course Introduction
- Module 2: Bicycle and Pedestrian Planning
- Module 3: Pedestrian Facility Design
- Module 4: Bicycle Facility Design
- Module 5: Issues Common to Bicycle and Pedestrian Transportation

The complete report may be obtained from the R&T Product Distribution Center by e-mail to report.center@fhwa.dot.gov, by fax to 301–577–1421, or by phone to 301–577–0818.

Design of Continuously Reinforced Concrete Pavements Using Glass Fiber Reinforced Polymer Rebars Publication No. FHWA-HRT-05-081

FHWA, in a cooperative agreement with West Virginia University, is performing a research study entitled Development and Deployment of Second Generation FRP Composites Applied to Concrete Pavements. This publication, *Design of Continuously Reinforced Concrete Pavements Using Glass Fiber Reinforced Polymer Rebars*, documents the third of four tasks within that study. The corrosion resistance characteristics of glass fiber reinforced polymer (GFRP) rebars make them a promising substitute for conventional steel reinforcing rebars in continuously reinforced concrete pavements (CRCPs). Studies are conducted on the effect of using GFRP rebars as reinforcement in CRCP on concrete stress development, which directly relates to the concrete crack formation that is inevitable in CRCP. Under restrained conditions, concrete volumes change because of shrinkage and temperature variations, causing early-age cracks in CRCP.

In this study, an analytical model has been developed to simulate the shrinkage and thermal stress distributions in concrete due to the restraint provided by GFRP rebars in comparison with the stresses induced by steel rebars. The results show that the stress level in concrete is reduced with GFRP rebars because of the low Young's modulus of GFRP. In addition, the analytical model has been used to estimate concrete strain variation in reinforced concrete slabs because of changes in concrete volume. Results then were compared with the experimental observation. Finite element (FE) methods also were developed to predict the stress distribution and crack width in the GFRP-reinforced CRCP section that is subjected to the concrete volume changes under various CRCP design considerations. Examples include the coefficient of thermal expansion of concrete, the friction from the pavement's subbase, and the bond slip between concrete and reinforcement.

Based on the results from the FE simulation along with the mechanistic analysis, a series of feasible designs of the GFRP-reinforced CRCP has been proposed. The stress levels in the GFRP reinforcement, the crack

widths, and the crack spacings of the proposed pavements are shown to be within the allowable design requirements.

The document is available online at www.fhwa.dot.gov/pavement/pccp/pubs/05081. Free printed copies are available from the R&T Product Distribution Center. Printed copies also may be purchased from NTIS. The NTIS order number is PB2006-101243.

Why Your Agency Should Consider Asset Management Systems for Roadway Safety Publication No. FHWA-HRT-05-077

This primer provides a general overview of asset management systems for roadway safety elements and initial guidance for agencies beginning to consider those systems. Asset management is a strategic approach to managing transportation infrastructure elements. It provides a systematic process for maintaining, upgrading, and operating physical assets cost effectively.

Information in the primer can help State departments of transportation (DOTs) increase their use of state-of-the-practice techniques on roadway safety hardware management systems. FHWA developed the primer for State DOT personnel, particularly chief engineers and other top management, involved with planning, funding, and executing roadway safety hardware management systems.

The document is available online at www.tfhrc.gov/safety/pubs/05077/index.htm. Free printed copies are available from the R&T Product Distribution Center. Printed copies also may be purchased from NTIS. The NTIS order number is PB2006-101561.

Roadway Safety Hardware Asset Management Systems Case Studies Publication No. FHWA-HRT-05-073

This study provides information to State DOTs on roadway safety hardware management systems that can help increase use of state-of-the-practice techniques. FHWA developed this report for State DOT personnel, particularly chief engineers and other top management, involved with planning, funding, and executing roadway safety hardware management systems.

Free printed copies are available from the R&T Product Distribution Center. Printed copies also may be purchased from NTIS. The NTIS order number is PB2006-101186.

Improving Pavements With Long-Term Pavement Performance: Products for Today and Tomorrow Publication No. FHWA-RD-03-049

This report is a compilation of award-winning technical papers from the third annual International Contest on Long-Term Pavement Performance (LTPP) Data Analysis 2001–2002. In 1998, FHWA, the LTPP program, and the Highway Division Pavements Committee of the American Society of Civil Engineers initiated a program to organize an international contest on the use of LTPP data. The competition was designed to involve university students—future pavement engineers—in the analysis of data from the LTPP database. The program has been in operation for 4 years, and the papers contained in this document are the results of the 2001–2002 contest.

Printed copies may be purchased from NTIS. The NTIS order number is PB2006-101652.

Reporting Changes Of Address

PUBLIC ROADS has two categories of subscribers. One includes the organizations and people who receive the magazine without charge; the editorial office of the magazine maintains the mailing list for this group. The other category is the group of people and companies that pay to receive the magazine; the mailing list for this group is maintained by the Superintendent of Documents for the U.S. Government Printing Office.

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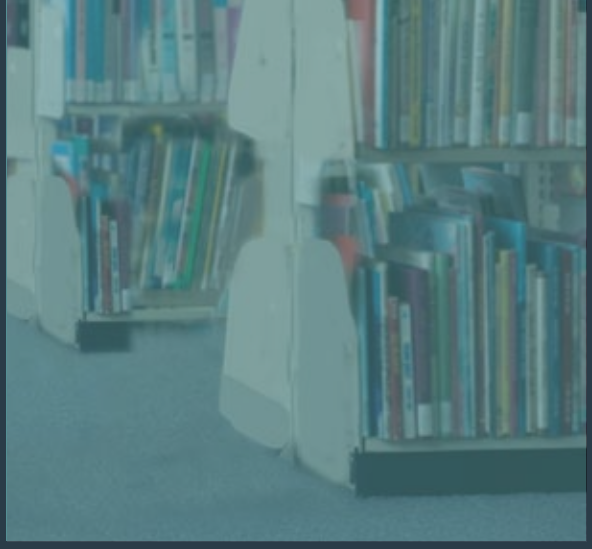
Conferences/Special Events Calendar

Date	Conference	Sponsor	Location	Contact
November 16–17, 2006	ARTBA's 18th Annual Public-Private Ventures in Transportation Conference	American Road & Transportation Builders Association (ARTBA)	Washington, DC	Ed Tarrant 202-289-4434, ext. 204 etarrant@artba.org www.ARTBAPPVConference.org
November 29–December 1, 2006	Managing Travel for Planned Special Events	American Association of State Highway and Transportation Officials, American Public Transportation Association, American Public Works Association, 511 Deployment Coalition, Federal Highway Administration (FHWA), Institute of Transportation Engineers (ITE), National Association of City Transportation Officials, National Traffic Incident Management Coalition, National Transportation Operations Coalition, Public Technology Institute, and Transportation Research Board (TRB) Committees on Transportation Issues in Major U.S. Cities, Freeway Operations, and Traffic Signal Systems	Newport Beach, CA	Richard Cunard 202-334-2965 rcunard@nas.edu www.trb.org/conferences/timpse
December 4–7, 2006	Highway Geophysics—Nondestructive Evaluation Conference	Missouri Department of Transportation, FHWA, TRB, American Society of Civil Engineers—Geo-Institute, and Environmental & Engineering Geophysical Society	St. Louis, MO	Tom Fennessey 573-526-4340 thomas.fennessey@modot.mo.gov www.umr.edu/2006geophysics
January 16–19, 2007	Geosynthetics 2007	Industrial Fabrics Association International, Geosynthetic Materials Association, North American Geosynthetics Society, International Geosynthetics Society, and Geosynthetic Institute	Washington, DC	Jill Rutledge 651-225-6981 jmrutledge@ifai.com www.geoshow.info
January 21–25, 2007	TRB 86th Annual Meeting	TRB	Washington, DC	Linda Karson 202-334-2934 lkarson@nas.edu www.trb.org/meeting
March 25–27, 2007	Lifesavers 2007 National Conference on Highway Safety Priorities		Chicago, IL	Mary Lofgren 703-922-7944 marylofgren@cox.net www.lifesaversconference.org
March 25–28, 2007	ITE 2007 Technical Conference and Exhibit	ITE	San Diego, CA	Christina Denekas 202-289-0222 ite_staff@ite.org www.ite.org
June 3–8, 2007	First North American Landslide Conference	Association of Environmental & Engineering Geologists, Geo-Institute, American Rock Mechanics Association International, Canadian Geotechnical Society, and TRB	Vail, CO	Keith Turner 303-273-3802 kturner@mines.edu www.mines.edu/academic/geology/landslidevail2007



Looking for Transportation Research Board (TRB) Publications?

The TRB Publications Index contains more than 30,000 papers, articles, and reports from 1923 to 2006.

Go to http://pubsindex.trb.org for the latest transportation information and research results.

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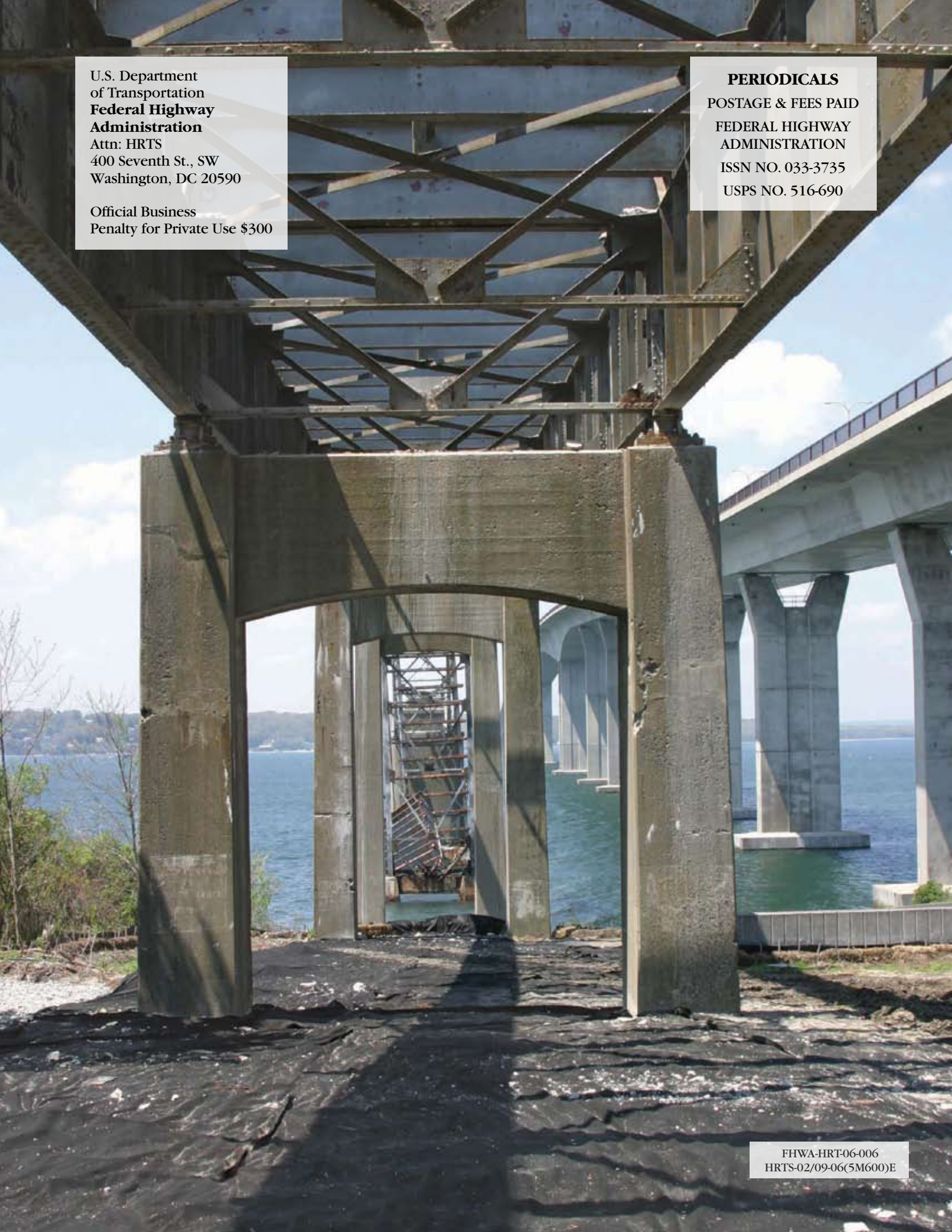

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