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The Safety Edge

Bridge Overcoats

Managing Incidents

U.S. Department of Transportation

Federal Highway Administration

Public Roads

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

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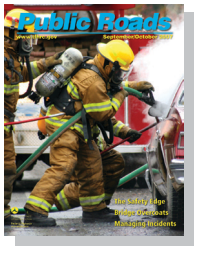

Front cover—These firefighters are responding to a crash, helping to increase the public's safety on the Nation's highways. In this issue of PUBLIC ROADS, authors John Corbin and David Helman introduce a multidisciplinary initiative, the National Unified Goal for Traffic Incident Management, that promotes collaboration between transportation and public safety organizations in managing crash scenes safely and efficiently. *Photo by Ron Hilton, Shutterstock.*

Back cover—When completed, these direct access ramps will provide access to urban neighborhoods along I–15 in San Diego, CA. The construction is one of 21 projects under TransNet, a locally funded transportation program. The San Diego Association of Governments (SANDAG) and the California Department of Transportation developed an interactive, online reporting tool, the Dashboard, to share project data and progress reports with each other and the public. To learn more, read "Accountability at a Glance" in this issue of PUBLIC ROADS. *Photo by Ryan Chung, SANDAG.*

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Guest Editorial

Taking Our Safety Responsibility Seriously

There is no question that in recent years safety has been a priority for the Federal Highway Administration (FHWA) and many partners around the country, as evidenced by the funding, research, practical advancements, and leadership commitments directed toward the issue. However, between 2004 and 2005, the fatalities on U.S. highways increased from about 42,600 to 43,443. This sobering statistic reveals that much more remains to be done.

Regardless of the measurement used, the United States has fallen behind many other countries that have taken assertive actions and made correspondingly large gains in road safety. The U.S. transportation community has the tools to achieve similar gains—but only through a long-term commitment to safety that involves major investments in people, capital, innovations, and leadership willpower.

Safety will not improve overnight. The road to success will test the resolve, dedication, and commitment of the transportation community to saving lives and changing, in many ways, societal acceptance of death on U.S. highways. Government leaders and the transportation community must maintain their focus on safety despite the barrage of immediate concerns and competing demands and issues. The leadership focus, among other things, must continue to encourage everyone in transportation to make a personal commitment to safety.

All roadway professionals "own" the highway safety problem. Planners, pavements experts, environmental specialists, operations professionals, and others have a stake and role in achieving the Nation's safety goals. By taking responsibility for the safety of U.S. roads, transportation professionals can and must be an integral part of the solution.

The next step is to create and instill a sense of personal responsibility within American society. The motoring public needs to embrace the idea that any death or injury is unacceptable.

Innovation also is key. FHWA, the American Association of State Highway and Transportation Officials, the Institute of Transportation Engineers, State departments of transportation, and others in the transportation community have identified many innovations, technologies, and practices that can, and do, contribute to saving lives.

This issue of PUBLIC ROADS contains an article on the safety edge, which is one important countermeasure that can help reduce the number of crashes due to pavement-edge dropoff. Additional tools such as cable median barriers, rumble strips and stripes, PEDSAFE (a guide to selecting countermeasures to improve pedestrian safety), roundabouts, road safety audits, and numerous other low-cost safety improvements offer opportunities to save lives.

Innovation also occurs at the program level, when highway professionals move their thinking into new realms to better understand safety problems and then use quantitative reasoning to address those problems. Likewise, reinventing the approach to target specific crash types and locations lends itself to applying appropriate countermeasures across the entire system. Nowhere would this be more beneficial than on local roads, where approximately 60 percent of fatalities occur. Targeted research and deployment efforts can aid greatly in application on local roads and elsewhere.

The FHWA Office of Safety and the Resource Center Safety and Design Team are working with partners on solutions to increase safety, such as the *Highway Safety Manual* (a companion document to the *Highway Capacity Manual*), the SafetyAnalyst software tools, and the Interactive Highway Safety Design Model. With these tools, the transportation community can make greater advances in safety than ever before. The challenge is to set our sights on eliminating the daily suffering and deaths on the Nation's roads and "move the numbers" so the next generation of Americans can drive on the safest roads in the world.

Patrick Hasson
Safety and Highway Design
Technical Service Team Leader
FHWA Resource Center

The Low-Cost Dropoff Solution

by Steve Moler

The safety edge, a relatively easy and inexpensive countermeasure to steep pavement edges, is reducing crashes on rural two-lane highways.

James Leben, an assistant district maintenance engineer with the Georgia Department of Transportation, measures a tapered safety edge applied in a 2004 demonstration project along a 21-kilometer (13-mile) section of State Route 88 near Augusta, GA. The safety edge is one means to help prevent crashes caused by pavement-edge dropoffs.

Four teenage boys from a high school in Clayton County, GA, were driving to school on a rural two-lane highway on a March morning in 2003 when something went terribly wrong.

About a quarter-mile from campus, the car's right tires slipped off the pavement and dropped onto the sandy shoulder. While attempting to return to the pavement, the 16-year-old driver overcorrected and lost control. The compact sedan crossed the centerline and slammed head-on into a school bus coming in the opposite direction. The driver and one passenger were pronounced dead at the scene; another passenger died later at the hospital. The fourth teenager was seriously injured but eventually recovered. The driver of the school bus, which was carrying no passengers, suffered only minor injuries.

One cause of the crash, according to the police report, involved a condition known as pavement-edge dropoff (PEDO), the uneven edge or vertical dropoff between the paved travel lane and the unpaved shoulder. Highway safety experts consider a dropoff of 12.7 centimeters (5 inches) or more to be unsafe, especially if the edge is at a 90-degree angle to the shoulder surface. A dropoff of 5.1 centimeters (2 inches) or more is considered a potential driving hazard. The dropoff along the stretch of highway where the teens' car slipped off the pavement ranged from about 5.1 to 10.2 centimeters (2 to 4 inches), according to two safety engineers from the Federal Highway Administration (FHWA) who visited the site the day after the crash.

When a vehicle slips off the pavement and onto an unpaved shoulder, the steep edge can make it difficult for a driver to reenter the paved travel lane safely. Studies show that when a driver encounters a steep pavement edge, he or she attempts to return immediately to the paved travel lane but in doing so tends to oversteer, causing intense rubbing, or "scrubbing," of vehicle tires against the pavement edge, which initially prevents the vehicle from climbing back onto the pavement. This oversteering can cause loss of control at the moment when the right rear tire climbs back onto the pavement, causing the vehicle to fishtail or go into a broadside skid.

FHWA Safety Engineer Frank Julian uses his shoe for scale to demonstrate the extent of the pavement-edge dropoff along the section of roadway where three teenagers were killed in a crash.

"This is likely what happened in the Lovejoy High School crash," says FHWA Safety Engineer Frank Julian, who visited and took photographs of the crash site and learned that there was evidence of scrubbing on the inside edge of the vehicle's right tires. According to the police report, skid marks were found coming back onto the roadway, leading the inspectors to believe that "overcorrection played a role in the [crash]."

Although relatively rare compared with other crash types, PEDO-related crashes tend to be more severe, say the authors of a recent study sponsored by the AAA Foundation for Traffic Safety. In fact, these crashes are more likely than others on similar roadways to result in serious injuries and are two to three times more likely to be fatal, primarily because the vehicle often leaves the roadway, rolls over, hits a roadside object, or is involved in a head-on collision. According to FHWA, an estimated 11,000 people suffer injuries and roughly 160 die annually in crashes related to unsafe pavement edges.

"Pavement-edge dropoff has been around for a long time, and it will continue to be a serious problem unless we do something different," says former FHWA Chief Highway Safety Engineer Rudy Umbs, who now works in the agency's Resource Center. "We need to keep asking ourselves, What are we going to do differently tomorrow and next week to eliminate pavement-edge dropoffs and reduce the potential for lane departure crashes like run-off-the-road and head-on crashes? The safety edge can make that difference."

One solution is to install a 30- to 35-degree tapered asphalt wedge or fillet, known as a safety edge, along each side of the roadway during resurfacing projects. The safety edge not only provides an angled and compacted transition that eliminates the abrupt dropoff, but it also provides for a stronger and more stable pavement edge, which makes it easier for drivers to maneuver their vehicles safely back onto the roadway. By offering a tapered, rather than vertical, transition between the paved surface and the unpaved shoulder, the safety edge is a low-cost means of improving safety on paved two-lane highways.

At the time of the crash, the highway, shown here, was a typical two-lane rural road with unpaved shoulders. Recently this section of road was upgraded to four lanes due to commercial and residential development in the area.

Red paint, as well as FHWA Safety Engineer Frank Julian's foot, marks the spot where the car reentered the paved travel lane and went into a broadside skid, colliding head-on with a school bus coming in the opposite direction.

Factors in PEDO Crashes

Numerous studies over the past three decades have analyzed the various combinations of conditions and circumstances that lead to PEDO-related crashes, such as the one involving the Georgia teens. Virtually all of the studies found that whether a driver regains control or crashes after slipping off the pavement edge depends on a variety of circumstances, including vehicle speed, steer angle, the vehicle's departure and return angle, vehicle size, dropoff severity, driver skills, roadside obstacles, and whether another vehicle is coming in the opposite direction. In the Georgia incident, as in many PEDO-related crashes, several dangerous circumstances converged to create the conditions conducive to a crash.

First, according to police findings and eyewitness accounts, the driver was likely exceeding—perhaps far exceeding—the 72 kilometer-per-hour, km/h (45 mile-per-hour, mi/h), speed limit. The car was a small sedan, which studies, including one conducted by researchers at the University of Michigan Transportation Research Institute, show have more difficulty recovering from pavement-edge dropoffs. The dropoff at the crash site was within the range that experts consider unsafe, and the driver was inexperienced, having had his driver's license for just 13 days. And finally, a vehicle—indeed, a fairly large one—was coming in the opposite direction. To complicate the situation, none of the teenagers was wearing a safety belt.

Magnitude of the Problem

A variety of conditions in the roadway environment can contribute to PEDO, including pavement-edge breaking, erosion, wear of the unpaved shoulders, or inadequate maintenance. A Transportation Research Board (TRB) report, *Construction of a Safe Pavement Edge: Minimizing the Effects of Shoulder Dropoff*, indicates that edge dropoff most commonly is encountered around mailboxes, on the insides of curves, on steep grades, at turnarounds, and along shaded areas. A combination of shoulder erosion and edge rutting caused by harsh weather and vehicles repeatedly leaving the paved travel lane typically is found at these locations.

Another circumstance that can aggravate PEDO is failure to bring the shoulder flush with the pavement following a resurfacing project. Problems develop when the pavement edge begins to crumble quickly from the lack of compaction, creating a vertical drop. Edge rutting and soil erosion from repeated vehicle impacts and the weather soon follow.

Just how serious is the PEDO problem overall? In 2006 the AAA Foundation for Traffic Safety sponsored a comprehensive study that attempted to answer that question. Conducted by the Iowa State University Center for Transportation Research and Education (CTRE) and the Midwest Research Institute, the study, *Safety Impacts of Pavement Edge Drop-offs*, found that most States routinely sample edge dropoffs for maintenance purposes. But that information is either not available or only indicates that a sampled section exceeds a certain threshold—in a sense, passes or fails, without giving a more descriptive assessment.

To gain a clearer understanding of the magnitude of the PEDO problem, the AAA Foundation studied randomly selected sections of paved rural two-lane highways with unpaved shoulders in two Midwestern States. The study found that 12 percent of dropoffs sampled in one State were 5.1 centimeters (2 inches) or more, 1 percent were 7.6 centimeters (3 inches) or more, and less than 1 percent were 10.2 centimeters (4 inches) or more. In the other, the situation was slightly worse. Almost 19 percent of the dropoffs sampled there measured 5.1 centimeters (2 inches) or more, 3 percent were 7.6 centimeters (3 inches) or more, 1 percent were 10.2 centimeters (4 inches) or more, and less than 1 percent were 12.7 centimeters (5 inches) or more.

The researchers found that in most cases, States are aware of edge dropoffs as an issue and, in many cases, have aggressive maintenance policies in place. However, edge dropoff persists due to harsh weather and traffic conditions. State and local agencies also have significant highway mileage to maintain and might not always be aware of all the locations where dropoffs have formed, according to Shauna Hallmark, a transportation engineer and professor in the Department of Civil, Construction, and Environmental Engineering at Iowa State's CTRE and the lead researcher on the AAA Foundation's study.

Another question transportation researchers are trying to answer is how often do PEDO-related crashes occur? Various studies in recent years have examined this question. One study, known as the *Southeast United States Fatal Crash Study* and headed by Karen Dixon, a civil engineering associate professor at the Georgia Institute of Technology, evaluated 150 randomly selected fatal crashes on rural two-lane State and nonstate highways in Georgia in 1997. Dixon and her colleagues estimated that in 21 of the 69 non-State-system fatal crashes in Georgia, or about 30 percent, edge rutting or PEDO was a causal factor.

The aforementioned study by the AAA Foundation also evaluated the number of crashes where characteristics indicated that edge dropoff might have had an impact. The researchers found that 17.7 percent of crashes on rural two-lane roadways in one State and 24.7 percent in

another were probably or possibly related to edge dropoffs. They also found indications that PEDO crashes are run-off-the-road crashes, which in general are more likely to be severe than other crash types.

Evolution of the Safety Edge

In numerous studies over the years, researchers have sought to understand the conditions that lead to PEDO crashes. In 1982, the Texas Transportation Institute conducted one of the first studies on the advantages of using an angled wedge along the pavement edge to minimize dropoff severity. The theory behind a tapered pavement edge was that it could help drivers make a smoother, more controlled reentry onto the paved travel lane than if there was a more abrupt or vertical edge.

In a 1986 study, researchers Don L. Ivey, a civil engineering professor emeritus at Texas A&M University, and Dean L. Sicking, a civil engineering professor at the University of Nebraska-Lincoln, analyzed the steer angle needed to remount dropoffs with different heights and edge shapes at 80 km/h (50 mi/h). A 10.2-centimeter (4-inch) vertical edge generally caused loss of control, but as the edge shape became flatter, fewer impacts were felt. The researchers then evaluated 5.1-, 10.2-, and 15.2-centimeter (2-, 4-, and 6-inch) dropoffs with a 45-degree wedge and found that drivers could recover within the 3.7-meter (12-foot) travel lane even with as much as a 15.2-centimeter (6-inch) dropoff.

That same year, researchers at the University of Michigan Transportation Research Institute compared vertical and 45-degree wedge dropoffs with hard and soft shoulders, various passenger vehicle sizes, and front- and rear-wheel-drive vehicles using nonprofessional drivers. The results showed that none of the nonprofessional drivers could negotiate a vertical dropoff of 11.4 centimeters (4.5 inches) or higher at any speed. Dropoffs near 7.6 centimeters (3 inches) could be negotiated at speeds of 48 km/h (30 mi/h) in large passenger cars, but smaller cars needed lower speeds to recover.

But with a 45-degree edge, drivers always were able to recover within their own lane when traveling at speeds up to 89 km/h (55 mi/h). The researchers also evaluated soft shoulders using a professional driver and concluded that dropoff height, not shoulder material, was the determining factor in being able to recovery safely.

A researcher is using a ruler and level to measure pavement-edge dropoff where rutting and erosion have occurred on a rural road in Iowa.

Shauna Hallmark, Iowa State University

The Georgia wedge, shown here, is bolted onto the screed end gate.

A 2005 study by the Center for Intelligent Systems Research used computer modeling to analyze vehicle recovery for various vehicle types, dropoff heights, and wedge angles. Pierre Delaigue, a research scientist with the center, presented the results from the study, *Safety of Excessive Pavement Wedge Due to Overlays*, at the 2005 TRB meeting in Washington, DC.

The study concluded that flatter wedges were always safer than steeper ones, regardless of dropoff height. Tractor semitrailers were most sensitive to PEDO, while pickup trucks were least sensitive. Passenger cars recovered from dropoffs of up to 12.7 centimeters (5 inches), provided a pavement wedge of 45 degrees or flatter was present. However, a 10.2-centimeter (4-inch) dropoff with a 45-degree wedge was too severe for the tractor semitrailer. But a 30-degree wedge allowed all vehicle types to recover safely.

Creating the Taper

Although the idea of using a tapered wedge had been around for years, determining a method to lay the wedge along a road shoulder during a resurfacing project posed an ongoing challenge.

In early 2003, Resource Center Safety Engineer Frank Julian and Pavement and Materials Engineer Chris Wagner began developing some basic concepts for how to create a tapered edge along the roadway shoulder. First, they built on Wagner's experience at the National Center for Asphalt Technology, where he conducted research in the late 1990s on creating tapered wedges at the longitudinal joints of asphalt pavement. Julian and Wagner next conceived of developing a device that could be attached to the end of an asphalt paver screed. The device needed to be able to create a smooth and compacted wedge along the edge of the roadway.

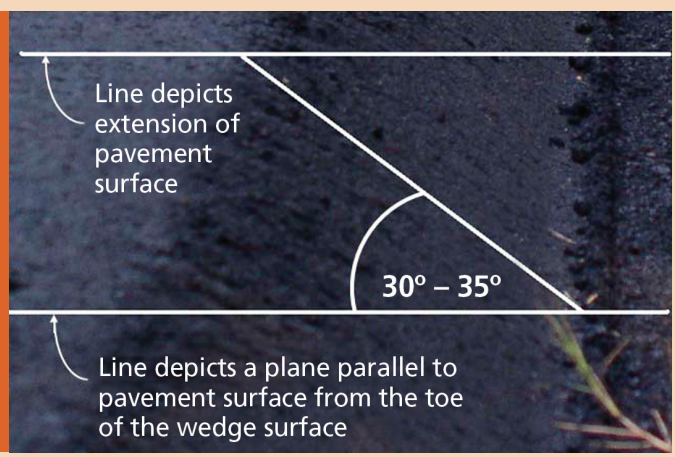
From this conceptual stage, Julian and Wagner developed a partnership with the Georgia Department of Transportation (GDOT) to design and plan a demonstration project to study the constructability of what they termed the safety edge on a resurfacing project. GDOT began the demonstration project in 2004 along a 21-kilometer (13-mile) section of State Route 88 just south of the town of Augusta. GDOT's maintenance department developed its own in-house device known as the Georgia wedge. Conceived by GDOT Maintenance Project Manager Lynn Bean, the wedge is essentially a modified strike-off bolted onto the screed end gate. The shoe of the end gate rides on the pavement shoulder and moves freely vertically, allowing it to adjust to height changes. A rounded leading edge produces the smooth appearance.

The safety edge was successfully installed with little impact on production and a project cost increase of less than 1 percent. After 1 year, the Georgia demonstration project found no visible signs of deterioration and reported no expectations for any long-term degeneration along the safety edge sections.

The sections of roadway paved without the safety edge during the demonstration project had degraded to a near-vertical edge during that same time, with cracking developing near the edge. The Georgia study concluded that the safety edge showed "promise as a low-cost solution to mitigate pavement shoulder dropoff . . . The implementation of the safety edge design would be most applicable to asphalt resurfacing projects on two-lane undivided roadways with limited paved shoulders."

According to highway safety experts at FHWA, the safety edge is

As shown here, the safety edge is measured 30 to 35 degrees up from the horizontal at the toe of the wedge surface.



Without the safety edge, this section of highway in a 2004 Georgia demonstration project developed a near-vertical drop just 1 year after a pavement overlay.

not intended to be an alternative to a flush shoulder, but rather can serve as a safety feature used in conjunction with current shoulder specifications. The recommended pavement wedge, measured 30 to 35 degrees from the horizontal, helps prevent drivers from overcorrecting if they drift onto the shoulder, thereby decreasing the likelihood of the vehicle crossing into opposing traffic or leaving the roadway.

"The safety edge is an ideal solution since the impact of a vehicle encountering a vertical difference between the edge of the roadway and shoulder can be lessened when dropoffs form and agencies aren't immediately aware and able to address the problem," says CTRE's Hallmark.

For these reasons and others, the safety edge is now a standard feature of resurfacing projects in Georgia.

Other Demonstration Projects

While the Georgia demonstration project got underway, FHWA asked TransTech Systems, Inc., to develop a device to manufacture

The sections with the safety edge in the same 2004 Georgia demonstration project showed no visible signs of deterioration.

Guidelines and Recommendations on PEDO

Although no national standards currently exist for pavement-edge dropoffs, several government and industry organizations provide some guidance:

A 2006 AAA Foundation for Traffic Safety study recommends that highway agencies require routine comprehensive sampling of PEDO on their roads, suggesting that any dropoffs of 5.1 centimeters (2 inches) or more should be corrected. The report also recommends that agencies adopt a policy of providing paved shoulders with a minimum width of 0.6 meter (2 feet) wherever possible and incorporate the safety edge in all roadway resurfacing projects to prevent severe PEDO.

The AAA Foundation further recommends that highway agencies review their databases to assess how PEDO might have contributed to crashes and then conduct additional research on crash occurrences and pavement-edge hazards specifically for rural roads. In addition, the study encourages highway agencies to train maintenance and construction staff, including private contractors, on the potential hazards of PEDO.

In its *Roadside Design Guide*, the American Association of State Highway and Transportation Officials (AASHTO) states that no vertical dropoff greater than 5 centimeters (2 inches) should occur between adjacent lanes, and pavement-edge dropoff greater than 7.6 centimeters (3 inches) should not be left overnight.

The *Manual on Uniform Traffic Control Devices* provides recommendations for signs used to warn motorists of unexpected conditions. For example, if the pavement-edge dropoff is less than 7.6 centimeters (3 inches), a "Low Shoulder" sign should be used. If the PEDO exceeds 7.6 centimeters (3 inches), a "Shoulder Drop Off" sign is recommended.

The AASHTO book *A Policy on Geometric Design of Highways and Streets* (also known as the "Green Book"), states that regular maintenance should provide for a shoulder that is flush with the pavement surface. Unstable shoulders generally undergo consolidation over time, and the elevation of the shoulder tends to sink below the paved travel lane. The resulting dropoff can adversely affect drivers when they slip onto the shoulder.

FHWA's *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects* offers guidance on PEDO in work zones. The document states that when shoulder dropoffs exceed 5 centimeters (2 inches) a "Low Shoulder" warning sign should be placed during construction. With dropoffs greater than 10 centimeters (4 inches), a 1:3 (18-degree) fillet with "Low Shoulder" warning signs should be provided.

the safety edge commercially. The company adapted its Notch Wedge Joint Maker™, which creates a tapered edge at the longitudinal joint on asphalt resurfacing projects, to produce the Shoulder Wedge Maker, which would create the safety edge. The device attaches to the screed face instead of the end gate and has a self-adjusting internal spring that allows it to follow the roadside surface independently of other paver components. The device has an angled surface that precompacts the asphalt as it enters the device, while another fixed-angle surface forms the tapered edge. As the asphalt is placed beneath the wedge-forming surface, it is smoothed to a finished surface on the tapered edge.

A recent demonstration project in New York's Schenectady County using the Shoulder Wedge Maker showed positive results. After the safety edge was installed in 2004 along two rural roads, annual inspections revealed that "the shoulder wedge has held up exceptionally well, with no degradation of the edge," says Dave Clements, an associate director in the Office of Operations Management for the New York State Department of Transportation, who supervised the inspections. Additional analysis has shown no cracking or breaking away of the wedge from the main rolled mat area.

The Indiana Department of Transportation (INDOT) currently is involved in an FHWA-sponsored study under the Transportation Pooled Fund Program to evaluate the safety edge's effectiveness in helping prevent and mitigate PEDO-related crashes. Eight companies were awarded contracts that called for installing the safety edge in 2004 and 2005 along nine rural, two-lane highways with minimal shoulders, using either the Shoulder Wedge Maker or a similar device developed in-house at INDOT. Four contractors used the existing device, while the others developed their own versions loosely based on the Georgia wedge.

The contractors have installed the safety edge successfully on seven of the nine projects to date, at minimal additional cost. "In fact, most of the contractors didn't even factor the safety edge into their bids," says Elizabeth Pastuszka, an INDOT pavement and materials engineer who was involved in construction of the demonstration projects. "In the two unsuccessful projects, the problems we had were totally unrelated to the safety edge itself."

Reducing Tort Liability

Another benefit of the safety edge is the potential to reduce tort liability. In the 2004 FHWA report *Construction of a Safe Pavement Edge: Minimizing the Effects of Shoulder Dropoff*, FHWA's Wagner and GDOT researcher Yeonsoo Stanley Kim noted that PEDO is a common source of tort claims against highway agencies. The authors cite court cases in Louisiana, Minnesota, and South Carolina where monetary judgments were awarded to motorists involved in PEDO crashes. In these cases, the transportation agencies were found liable for creating unsafe conditions and not warning about them.

The study by the AAA Foundation in Iowa and Missouri found that crashes in which PEDO was the major cause resulted in major tort liability suits. Claims filed between 2000 and 2005 in Iowa, for example, in which "pavement/shoulder edge" or "shoulder conditions" were cited as the major cause of the crash were the highest ranking tort liability claims in terms of total dollar value. In fiscal years

(Left) In a typical pavement resurfacing project, the asphalt at the edge remains soft because there is little or no compaction, as seen here.

(Below) A 30- to 35-degree tapered edge or fillet, as demonstrated here by an engineer using a ruler and level, provides a compacted, and therefore more stable, pavement edge.

2000–2003, these claims accounted for 38 percent of the total dollar value of claims filed against the Iowa Department of Transportation.

From 2000 to 2005, 23 PEDO-related tort liability claims were filed against Iowa, the study reported. Of those, however, compensation was awarded to the plaintiff in only two cases. Based on these findings, the authors concluded: "The [Iowa] DOT believes [the State's] demonstrably strong maintenance policy has contributed to [its] success in defending against tort liability claims related to pavement-edge dropoff. When States and other highway agencies are not able to defend themselves successfully, edge dropoff can result in significant liability."

From 1988 to 2003, Louisiana had 388 claims filed against it for alleged roadway shoulder defects, including PEDO, according to former Assistant Attorney General James R. Dawson. The State paid out an average of $62,144 per claim, totaling more than $241 million, regardless of whether it won or lost the case.

Citing these statistics at a 2004 workshop on managing pavement-edge dropoffs in Atlanta, GA, Dawson concluded that "shoulder defects, including dropoff problems, are a major factor in how we are able to spend our dollars on improving highway safety."

The safety edge is indeed a promising technology that safety experts say can help eliminate these shoulder defects and prevent tragedies like the one near Lovejoy High School from happening again.

Steve Moler is a public affairs specialist at FHWA's Resource Center. He has been with FHWA since 2001, providing the agency's field offices and partners with support in media relations, public relations, and public involvement communications. He earned a bachelor's degree in journalism from the University of Colorado at Boulder. He can be reached at 415–744–3103 or steve.moler@fhwa.dot.gov.

For more information about road departure issues and effective countermeasures, please visit the FHWA Office of Safety's "Road Departure Safety" Web site at http://safety.fhwa.dot.gov/roadway_dept/index.htm, or contact Chris Wagner at 404-562-3693 or christopher.wagner@fhwa.dot.gov, or Frank Julian at 404-562-3689 or frank.julian@fhwa.dot.gov.

Accountability At a Glance

by Richard G. Chavez, Allan Kosup, Bart Desai, and Donna Huey

California is harnessing the power of the Internet to provide transparency of management on a $3 billion program of transportation improvements.

As with most urban areas in the United States, transportation facilities in San Diego, CA, have struggled to keep pace with ever-growing demand. Traffic congestion continues to worsen in the San Diego metropolitan area as increases in motorized travel exceed the available capacity. This trend is expected to intensify over time.

In 1990, the San Diego region's daily travel demand was 9 million trips involving some form of motorized travel. By 2003, demand had reached 13.5 million daily trips, and by 2030 it is expected to increase to 16 million. These figures are from *Mobility 2030*, a transportation plan developed by the San Diego Association of Governments (SANDAG). The region's planning and transportation agency, SANDAG is responsible for major highway, transit, and other infrastructure projects for 19 local governments.

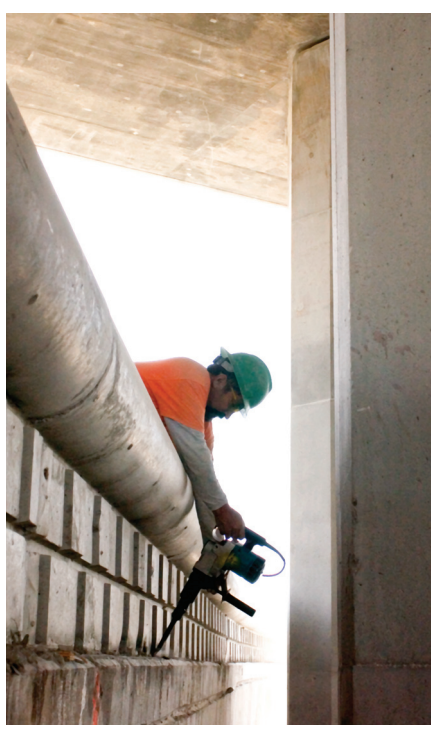
Recognizing the need to maintain local funding for transportation projects, San Diego voters acted in 2004 to extend TransNet, an existing local sales tax. The tax is used to finance highway, transit, and local road projects that are aimed at reducing traffic congestion in San Diego County.

SANDAG and the California Department of Transportation (Caltrans), as the trustees of the public's money, have initiated an aggressive effort to design and build several critical highway and transit projects quickly. To update the public regarding these key projects, the agencies developed the TransNet Dashboard, an Internet communications tool that provides real-time online information on such crucial items as project budgets, cost estimates, and schedules.

The Dashboard does more than enable the public to keep tabs on tax dollars. By providing a single platform that SANDAG, Caltrans, and their partners can use to share data, the Dashboard also functions as a sophisticated program management tool.

The TransNet and Early Action Programs

In 1987, voters in San Diego County approved the TransNet Program, a local half-cent sales tax used to fund a variety of transportation projects throughout the county. One of the largest transportation improvement programs in California, TransNet is expected to generate $3.3 billion by 2008 (nominal dollars not adjusted for inflation) and $14 billion (in 2002 dollars) by 2048.



Ryan Chung, SANDAG

This worker is putting the finishing touches on an access ramp for the four-lane "freeway within a freeway" Interstate 15 in San Diego, CA. The project is part of the TransNet Early Action Program.

To expedite critical transportation improvements in the county, SANDAG approved in 2005 a $3 billion TransNet-funded Early Action Program. The new program includes 21 highly anticipated highway and transit projects along six major corridors: Interstates 5, 15, and 805; State Routes (S.R.) 52 and 76; and the Midcoast Light Rail Project. All of the projects are scheduled to be completed by 2015.

Key participants in the TransNet Program and Early Action Program include Caltrans, which is a full partner with SANDAG in developing new roadways, widening existing facilities, and providing new transportation infrastructure such as managed high-occupancy vehicle (HOV) toll lanes, reversible lanes, and entry-exit points for bus rapid transit systems. Two providers of transit service in the San Diego area—the Metropolitan Transit System and North County Transit District—also participate in implementing TransNet projects.

Another key organization that is kept apprised of the Early Action Program's status is the Independent Taxpayer Oversight Committee. Mandated by the ordinance extending TransNet, the committee was created to oversee the program's expenditures and ensure that voter mandates are fulfilled. The committee also may make recommendations to improve the program's financial integrity and performance.

Management and Communications

Faced with the scale and scope of the Early Action Program, SANDAG

needed an innovative management approach that would enable it to oversee the program's many components while also providing a reliable and efficient method for conveying progress to its many partners and the public. To succeed, SANDAG and its partners needed a system that would provide accountability and promote transparency.

SANDAG "realized the need and the value of program transparency and accountability to all stakeholders," says Jack Boda, SANDAG mobility director. SANDAG accomplished both objectives, he says, "through an innovative, interactive, online reporting tool." The tool, the Dashboard, combines financial information and other project data, and it "allows the public access to transportation progress specifically along routes that they are interested in," Boda notes.

"Asking the public to tax themselves for a specific purpose brings up the obvious question of 'What am I getting for my money?'" says Christine Valle, manager of the Caltrans TransNet Program office. "The Dashboard gives us a method of answering that question on an ongoing basis," Valle says. "In real time the taxpayer and road user can learn the status and cost of the improvements that impact their daily commutes."

Joel Haven, a Caltrans corridor director for the S.R. 52 and I–805 corridors, adds, "The Dashboard was needed to provide open communication about our projects to the Independent Taxpayer Oversight Committee and to the public about what is happening on our corridors." By providing a central location for disseminating this information, the Dashboard provides a "consistent, current message about our corridors," Haven notes.

Communication Complications

With all transportation projects, communication among participants and stakeholders is paramount to ensuring success. However, SANDAG and Caltrans each have their own independent processes, tools, and legacy systems that were designed for internal use. For example, both agencies employ different systems for accounting and project scheduling. Caltrans uses a Common Business Oriented Language (COBOL)-based accounting system that is 30 years old, while SANDAG employs more current accounting software.

Complicating matters further, expenditures related to individual corridors are reported by many agencies and consultants operating under multiple contracts. These expenditures include such items as highway work, bus purchases, and transit station construction. For a corridor director to manage a single corridor's budget, these expenditures must be "married" across agencies.

Before the Dashboard's development, integrating electronic data was especially difficult. The differences complicated attempts by the agencies to share information related to changes in budget and scope throughout a project's duration. As a result, staff sometimes had difficulty explaining why costs or schedules changed significantly from original estimates.

Such difficulties can generate additional complications. For example, the absence of standardized approaches for tracking revenues and expenditures required staff at both agencies to conduct many manual computations as they prepared reports, resulting in inconsistencies. Without a central repository for project information, SANDAG and Caltrans personnel often had to collect, combine, and verify information independently from disparate sources. Meanwhile, the incompatibility of systems used to schedule projects precluded regular, consistent updates of budgets and schedules, occasionally resulting in compromised data quality.

San Diego's $3 billion TransNet Early Action Program encompasses more than 21 highway and transit projects along six major transportation corridors. The map shows nine of the projects.

SANDAG/Caltrans

What the Public Sees

To overcome these deficiencies, SANDAG, Caltrans, and the engineering consulting firm PBS&J developed the TransNet Dashboard. As part of this effort, the consultant assessed the TransNet Program, reviewed the current business practices of the two

organizations, summarized relevant industry best practices, and made recommendations for improving areas critical to TransNet's success.

The upshot of this process was development of the TransNet Dashboard. Located on the Internet at www.transnettrip.com, the Dashboard offers up-to-date information regarding TransNet corridor projects, project timelines, milestones, budgets, and expenditures.

Divided into three main viewing sections, the Dashboard presents data regarding the overall program, individual corridors, or project segments within each corridor. Within each of these views, users can see a snapshot of a particular project, along with information about its schedule, budget, and cost estimates. For example, the current plan for each project is compared to the baseline plan, and charts and graphs depict such items as the sources of funding and actual cashflows versus budgeted cashflows per project. Additional information may be included regarding any trends, risks, or other issues that TransNet participants wish to note.

Designed to remind users of a car's dashboard and other traffic-related images, the program denotes the status of a project's budget and schedule using gauges and stoplights. The number beside a stoplight indicates the quantity of corridors, segments, or phases whose status is good (green), cautious (yellow), or at risk (red). In this way, users can check the status of the overall Early Action Program, the six major corridors, and the 21 segments that compose the corridors.

Furthermore, each segment is divided into four phases related to project implementation: environmental planning, design engineering, right-of-way acquisition, and construction. Users can learn the status of each phase within a segment. Through the same color-coded approach used with the stoplights, the Dashboard's gauges fluctuate in color depending on the number of corridors, segments, or phases that currently are at each status.

SANDAG/Caltrans

Construction of the I–15 bridge shown in this aerial photograph is one project under San Diego's TransNet Early Action Program.

Using an internal site not accessible to the public, transportation managers have access to additional information, including data on cost management that enable staff to evaluate budgets according to projects, segments, project estimates, and alternatives. Complete schedules, cost data, and system inputs also are available. A custom query option enables project managers and others to search for such information as item unit prices and the bids received for a given project. These queries can be conducted according to such variables as bid date, bidder, and quantity.

SANDAG/Caltrans

As one of the TransNet Early Action Program's six major corridors, a segment of I–5 (seen in this aerial photograph) in San Diego is to be augmented with HOV lanes.

How the Dashboard Works

The Dashboard's core function is to incorporate data from various sources regarding budgets and expenditures, scheduling, and information related to project scope, risk, and cost estimates. SANDAG, Caltrans, and consultants employed by either agency provide the financial data and other information. Because these organizations use accounting systems that differ significantly, all financial data are channeled through and integrated in a "middleware" tool that compiles the data into a single, usable format to populate the Dashboard with meaningful information.

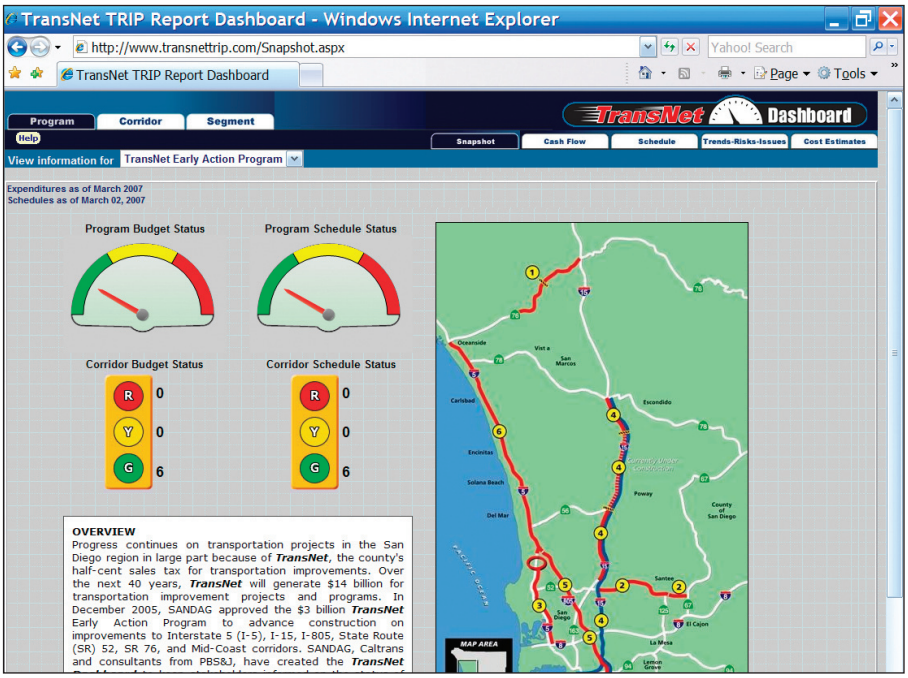
Primavera 5.0, another project management software program, is used for scheduling information in four main categories: logic-based schedules, resource-loaded schedules, earning rules, and earned percent complete.

Individual project teams develop a project's *logic-based schedule* by determining the activities that the project will require, the duration of those activities, and the ways in which they are interdependent. The resulting baseline schedule forms the basis for tracking and reporting as the project proceeds.

Resources are assigned to various activities in a project's work plan based on the project's budget. A work plan is a tool to identify key activities, allocate resources, and track project performance. Generally provided in hours or dollars, the resources are "earned" as a project progresses. A project's resources then are summarized and attributed to the larger corridor and the total program level.

Earning rules define how budget units can be earned based on progress. For example, such a rule could specify for a design project that a certain percentage of budget units may be earned only when a deliverable is submitted. The rules are designed to ensure that earned values remain objective and consistent throughout multiple projects.

Finally, *earned percent complete* comprises the amount of budget



SANDAG/Caltrans

The Dashboard offers up-to-date information about TransNet corridor projects, project timelines, milestones, budgets, and expenditures, either at the level of the overall program, as shown in this screen shot, or for individual corridors, or project segments within each corridor.

units earned based on the work completed to date divided by the total budget units. This figure typically is calculated at the project level each month and then summarized and attributed to the corridor and program levels for reporting purposes.

Information related to project scope, risk, and cost estimates is derived from various sources and integrated by means of a cost management system before inclusion in the Dashboard. Project managers and corridor directors provide information regarding trends, risks, progress, and other issues. Project cost estimates and changes are entered into the cost management system.

Using the pertinent budgetary and scheduling information, the Dashboard determines the status of the overall Early Action Program, the six corridors, their segments, and the phases of each segment, and assigns each element the appropriate color. Status is accorded based on the two basic elements of budget and schedule.

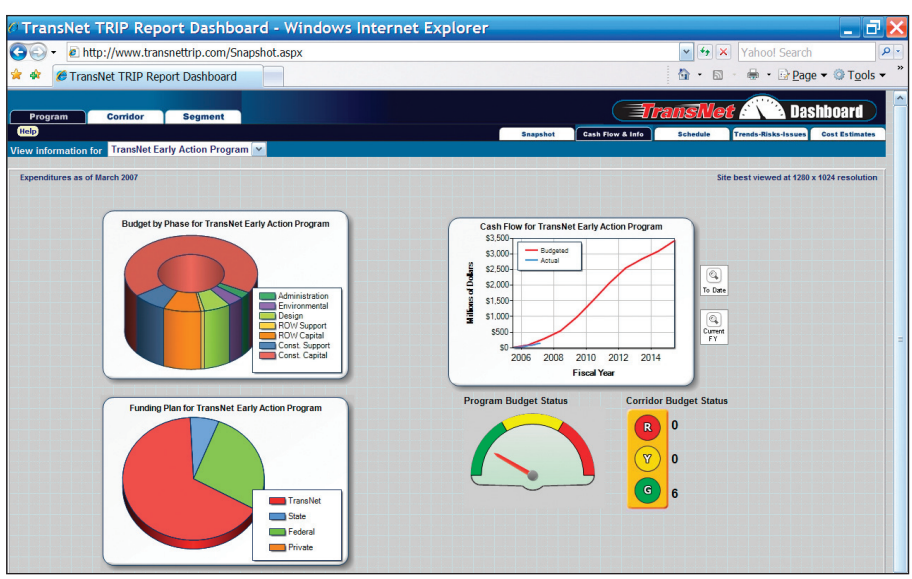
Essentially, the Dashboard determines a project's budgetary status by evaluating the percentage of the budget that has been expended at a given time versus the percentage of work conducted to that point. If the percentage of the budget expended is less than or within 10 percent of the percentage of work completed, the project's budgetary status is considered good, or green. If the percentage of the budget expended exceeds the percentage of work completed by 10 percent to 20 percent, the project's budgetary status is deemed cautious, or yellow. Finally, a project's budget is considered at risk, or red, if the percentage of the budget expended exceeds the percentage of work completed by more than 20 percent.

The Dashboard conducts a similar process to evaluate a project in terms of schedule. It compares a project's progress at a certain point to the baseline schedule that was developed at the outset and then denotes the current schedule status by employing the same percentages used to determine budget status.

One-Stop Shopping For Information

The Dashboard made its online debut in August 2006. That month, the Web site experienced 20,816 "hits," or pages viewed. In its first 7 months, the site had approximately 127,000 hits, for an average of 18,142 per month.

By providing regular updates on a project's budget and schedule, the Dashboard enables the public, elected officials, other representatives of SANDAG member governments, and the Independent Taxpayer Oversight Committee to track the progress of the overall Early Action Program and its various components. Until now, such information generally was unavailable in a readily accessible fashion. The intended beneficiaries of the transportation improvements—the public—could not easily access information on the status of the projects it is financing. However, the Dashboard enables taxpayers to remain informed about the TransNet



SANDAG/Caltrans

Members of the public can use the Dashboard to check the status of such details as the TransNet Early Action Program's budget and cashflows, summarized in graphs in this screen shot.

Program. "We feel that we are giving the public more confidence in what we are doing," Haven says. "This creates a better, more trusting atmosphere."

Because of the Internet, the Dashboard likewise simplifies the process by which an interested citizen can learn about the work of SANDAG and Caltrans, Valle says. "This is one more example of how the average person can find out information from a public agency without having to pick up the phone during regular business hours," she says. "The Dashboard extends the 'people resources' at both Caltrans and SANDAG to a 24/7 operation, allowing access to the project and corridor information at the public's convenience."

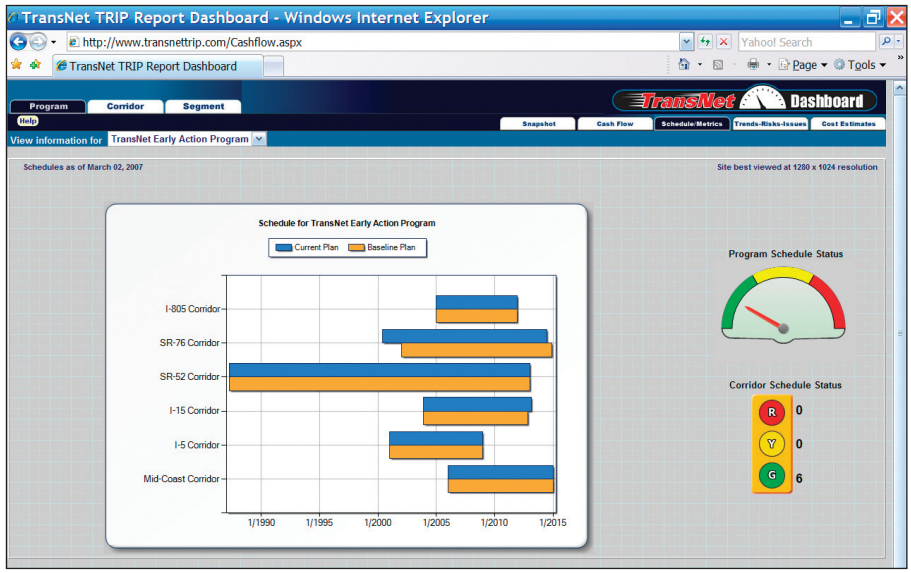
The needs of the Independent Taxpayer Oversight Committee have been more than met by the Dashboard, according to Maryam Babaki, the committee's chairperson. The committee's responsibilities include reviewing TransNet projects quarterly to assess their performance in terms of cost control and adherence to schedules. Without the Dashboard, Babaki says, it would have been a "daunting task" for committee members—busy professionals themselves—to take the time to sit down with project staff and review the many projects. Instead, "the Dashboard has essentially put all this information at the committee's fingertips," Babaki says. "Members can logon at their own convenience and get easy-to-comprehend information with as much detail as needed, be it at the program or the project level."

Just as important, the Dashboard provides a centralized location for SANDAG and Caltrans staff and other project participants to access critical information that previously would have taken much longer to locate. People directly involved in the program through SANDAG or Caltrans can bore deeper into the data, viewing information on cashflow, schedules, market trends and related issues, and cost estimates at the level of the overall program, a corridor, or a segment. "The Dashboard has linked complex SANDAG and Caltrans construction, finance, and schedule data," Boda says.

By simplifying and streamlining the process for gathering and displaying information, the Dashboard assists staff at all levels of the participating agencies in tracking the progress of the Early Action Program. The agencies expect to derive other benefits from the Dashboard as well. Staff productivity, for example, is expected to increase as a result of savings in time, improved communication, and superior data used to track the program.

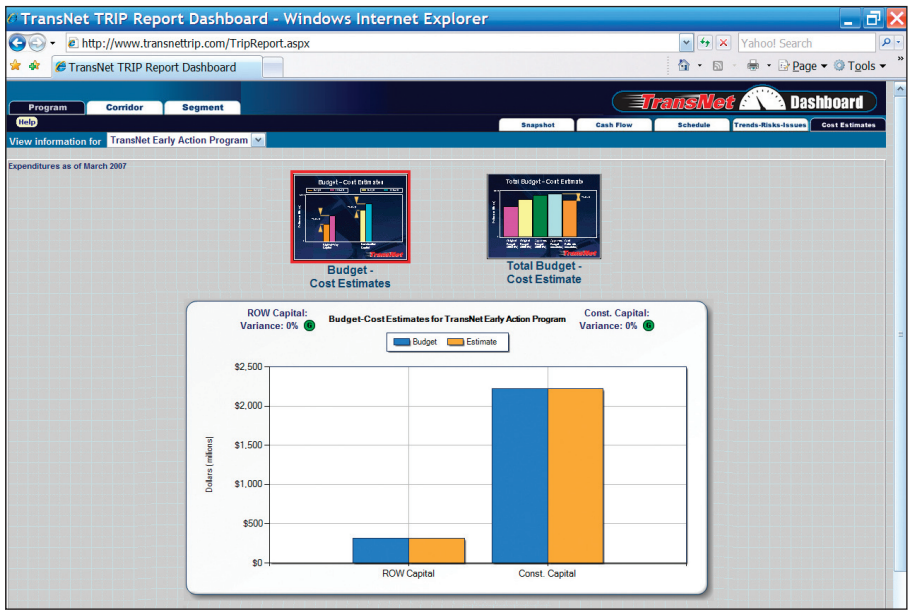
"The Dashboard serves as an early warning allowing management to be more proactive and fix the problem at the earliest possible stage," Boda says. The information available on the system "helps early identification of variances and allows for decisions and team actions to address and correct these variances," Boda says. In this way, he notes, the Dashboard "minimizes surprises."

Like any database, the Dashboard requires proper maintenance of data to ensure its effectiveness. Given the complexity of project funding, complications can arise. Therefore, SANDAG and Caltrans staff members realize the importance of keeping the database as straightforward as possible.



SANDAG/Caltrans

As pictured in this screen shot of a bar graph, the Dashboard depicts the status of the overall Early Action Program and its various components by comparing current and baseline schedules.



SANDAG/Caltrans

This Dashboard screen shot shows a bar graph comparison of current and baseline cost estimates, indicating the percentage variance.

Dashboards in Other States

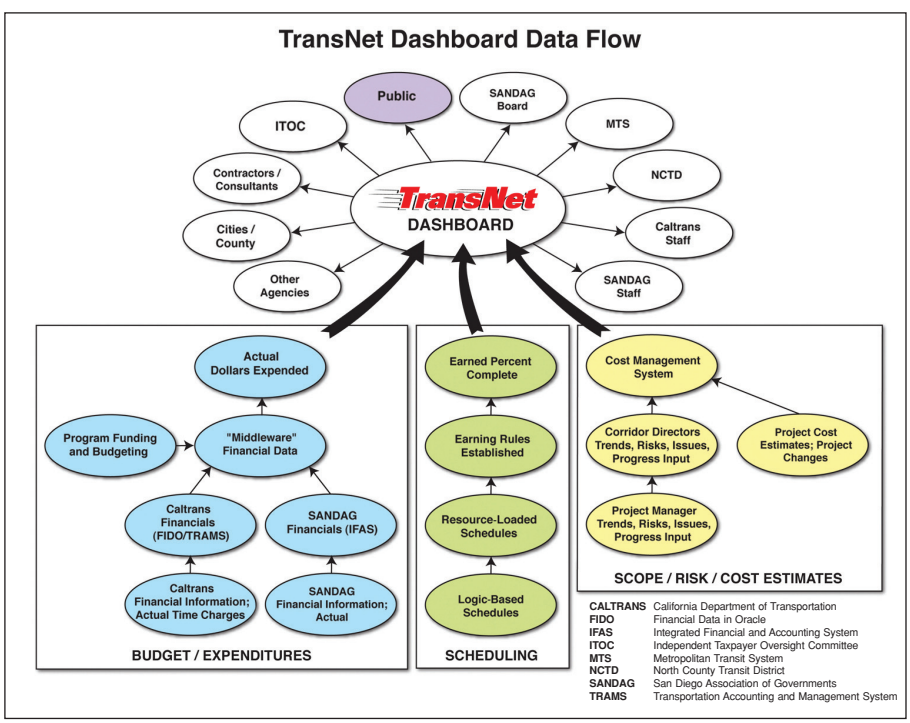
Some other States and localities also use Dashboards for public accountability and project management:

- Florida Department of Transportation: www.dot.state.fl.us/planning/ftp/default.htm
- Louisiana Department of Transportation and Development: www.timedla.com
- Maryland Department of Transportation: www.e-mdot.com/Planning/Plans%20Programs%20Reports/Reports/Attainment%20Reports/Final%202004%20Attainment%20Report.pdf
- Minnesota Department of Transportation: www.dot.state.mn.us/dashboards
- Missouri Department of Transportation: http://search.mo.gov/search?q=cache:sqQAMKQxI_AJ:www.modot.mo.gov/about/documents/Tracker_PDF_Jan07/January07.pdf+performance+measures&access=p&output=xml_no_dtd&ie=UTF-8&client=modot&num=10&site=modot&proxystylesheet=modot&oe=UTF-8
- New York City Mayor's Office of Operations: www.nyc.gov/html/ops/html/mmr/mmr.shtml
- Ohio Department of Transportation: www.dot.state.oh.us/BusinessPlan0607
- Sightline Institute: www.sightline.org/research/cascadia_scorecard
- Virginia Department of Transportation: http://dashboard.virginiadot.org
- Washington State Department of Transportation: www.wsdot.wa.gov/accountability

"Caltrans is looking at expanding the Dashboard statewide," Haven says. In particular, the Dashboard's communicative power likely would lend itself well to projects that the State conducts as part of the transportation bond measure passed by California voters in 2006, Haven notes.

A powerful tool for communication and program management, the Dashboard is expected to ensure continued public trust in the TransNet Program. "This type of transparent information shared among all stakeholders truly promotes the stewardship of this critical transportation program for the residents of San Diego," Boda says.

The system also may serve other public agencies seeking to convey critical information on transportation projects to the public, while improving communication among project participants and enhancing project oversight. "Public agencies and the elected officials who guide them often lose sight of the 'goal,'" Valle says. "A Dashboard keeps you focused on specific goals, measurements, and your 'customers.' Nothing shows up on the Dashboard that each one of us involved doesn't think, 'How will the public perceive that?' A Dashboard system keeps all connected to the goals, the customers, and the tools necessary to deliver a project."



SANDAG/Caltrans

A powerful communication tool that uses the Internet to provide real-time information on crucial items such as project budgets, cost estimates, and schedules, the TransNet Dashboard also functions as a sophisticated program management tool, as this data flowchart shows.

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Allan Kosup is the corridor director for improvements on S.R. 76 and I-5 for Caltrans. He has a bachelor's degree in civil engineering from the University of California, Irvine.

Bart Desai, P.E., is a vice president in HNTB's San Diego office and project manager for the firm's on-call contract with SANDAG for the TransNet Program. He holds a bachelor's degree in civil engineering from India's University of Bombay.

Donna Huey is a vice president in PBS&J's Orlando office and heads the firm's Information Solutions National Business Sector. She received a bachelor of science degree from the University of South Florida.

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Selecting Overcoats For Bridges

FHWA researchers test the corrosion resistance of various paint systems for steel structures.

by Shuang-Ling Chong and Yuan Yao

"Of the nearly 200,000 steel bridges in the United States, about 10 percent require rehabilitation to prevent corrosion," says Chief Scientist Steven B. Chase of the Federal Highway Administration (FHWA). Removing rust and repainting a steel bridge is no small job. In fact, the California Department of Transportation (Caltrans) estimates that full removal of paint can cost as much as $35 per square foot. Because old paint typically includes lead, which is hazardous to human health and the environment, full paint removal requires abrasive blasting, dust containment, environmental monitoring, and waste removal and disposal. Worker health and safety must be protected as well.

To keep costs down while maintaining the service conditions of the Nation's steel bridges, Caltrans and many other State departments of transportation are turning to overcoats—applying a new coating on top of the existing one(s)—as an alternative to removing old paint.

"We're overcoating the majority of our steel bridges," says Senior Chemical Testing Engineer Andy Rogerson with Caltrans. The department maintains nearly 800 steel bridges statewide. Most have a red, lead-based primer coat, which for the most part is performing well, Rogerson says. When the topcoats start to fail, Caltrans applies waterborne primers and acrylic latex topcoats or, for harsher coastal climates, three-coat, moisture-cured urethane (MCU) overcoat systems.

Cost is the main advantage. Overcoat applications cost the agency $6 to $10 per square foot—nearly two-thirds less than the cost of full removal. "If rust covers less than 20 percent of a bridge, then we'll keep the lead primer and do an overcoating," Rogerson says.

But how well do these overcoat materials work in the long term? And under what circumstances do they perform most effectively? As new coatings emerge, such as new products with low levels of volatile organic compounds (VOCs), those will need to be evaluated for performance.

Between 2004 and 2006, to fill the need for data on the latest overcoat products, researchers at the FHWA Turner-Fairbank Highway Research Center (TFHRC) conducted an inhouse study to evaluate how various overcoat materials perform when they are applied to different types of aged steel substrates.

The FHWA researchers and their contractor staff selected six lead-free and low-VOC materials to apply over coated, aged, and rusted surfaces. Using a cyclic, accelerated testing method, they studied the

(Above) A worker on a steel bridge over Salmon Creek in northern California is power-tool cleaning the surface in preparation for overcoating, which is a less costly alternative to the traditional practice of enclosing sections of bridge for abrasive blasting, disposing of the removed paint, and repainting. *Photo: Caltrans.*

overcoat systems in the laboratory and through field exposures, evaluating performance by assessing surface failures and rust creepage developed at scribes (scratches made through the overcoat surface down to the steel substrate). Comparing the results yielded a number of insights into overcoat performance when applied to the three types of substrates.

Experimental Procedures

Most aging steel bridges are covered with one of two types of coating systems: (1) a two-coat system with an alkyd primer and topcoat (both coats could contain lead or just the prime coat) and (2) a two-coat system with an inorganic zinc (IOZ)-rich primer and a vinyl topcoat. Therefore, the researchers chose to study the performance of overcoats when applied to both types of coating systems and to a rusted steel base, cleaned using power tools according to the Society for Protective Coatings' (SSPC) specification SSPC-SP3.

To set up the study, the researchers created rectangular steel test panels measuring 10.0 by 15.0 by 0.48 centimeters (4.0 by 6.0 by 0.19 inches). To prepare the substrates, they applied two coats of lead-based alkyd paint to some of the test panels, which had been cleaned using solvent according to specification SSPC-SP1.

For the samples that would have the IOZ/vinyl coating system as a base coat, they applied the IOZ/vinyl paint to steel panels that were prepared according to specification SSPC-SP5, involving white metal blast cleaning (removing rust or foreign matter by blowing abrasives against the steel surface). The dry film thickness for the IOZ was 100 microns (4 mils), while the vinyl thickness was 115 microns (4.6 mils). Next the researchers subjected the test panels to 3,360 hours of cyclic, artificial weathering according to ASTM International testing standard ASTM D5894. After the weathering was complete, the researchers removed the panels from the test chamber, pressure-washed them with 21 megapascals, MPa (3,000 pounds per square inch, psi), of potable water, and air-dried them.

To create the third type of substrate (hereafter referred to as SSPC-SP3 surfaces), the researchers cleaned the remaining test panels according to SSPC-SP5 specifications and placed them outdoors for 6 months to produce a natural layer of corrosion. Then the researchers cleaned the surfaces to the SSPC-SP3 standard using a power tool (a needle gun). All three sets of panels then were painted with the six candidate overcoat materials. A 5.0-centimeter (2.0-inch) diagonal scribe was made on each set of panels.

For each test, the researchers used three scribed replicate panels of each coating system. For the laboratory test, they cycled the panels through freezing, ultraviolet light (UV)/condensation, and salt-fog/dry-air conditions a total of eight times over a period of 4,000 hours. The researchers alternated the hot salt fog, generated with a 5 percent by weight solution of sodium chloride (NaCl), with ambient air at 1-hour intervals during the third phase of each cycle. After each 500-hour test, the researchers examined and/or measured both the surface conditions and the rust creepage at the scribe.

Next, the researchers traced, scanned, area integrated, and calculated the creepage area of rust at the scribe for each panel. To find the average rust creepage, the researchers used the following equation: average rust creepage = A/2L, where A is the integrated area surrounding the scribe line (both sides) and L is the length of scribe line. (They used the areas on both sides of the scribe line to make the calculation more statistically meaningful.)

For each triplicate of panels, they obtained two values using ASTM D7087-05a (a standard test method for an imaging technique to measure rust creepage at the scribe on coated test panels subjected to

Description of Coating Systems

Base System	Lead Alkyd/ Lead Alkyd (125/125 µm)[a], (5/5 mil)	IOZ/Vinyl (100/115 µm), (4/4.6 mil)	SSPC-SP3 Steel	
Artificial Weathering	ASTM D5894, 3,360 hours	ASTM D5894, 3,360 hours	None	
Cleaning Method	A	A	B	
				Overcoat System
System Number	1		12	Alkyd/Silicone Alkyd (50/50 µm) (2/2 mil) [450/410 g/L][b]
	2	7	13	MCU/MCU (125/50 µm) (5/2 mil) [340/340 g/L]
	3	8	14	Sealer/MCU/MCU (40/75/75 µm) (1.6/3/3 mil) [340/340/340 g/L]
	4	9	15	HB Acrylic/HB Acrylic (175/175 µm) (7/7 mil) [5/5 g/L]
	5	10	16	CSA/CSA (175/175 µm) (7/7 mil) [323/323 g/L]
	6	11	17	Sealer/Epoxy/Epoxy (10/100/75 µm) (0.4/4/3 mil) [85/195/195 g/L]

[a] Dry film thickness.
[b] VOC content.
A: High-pressure washed with 21 MPa (3,000 psi) potable water and air-dried.
B: Power-tool cleaned to SSPC-SP3 using a needle gun.

Laboratory Testing Conditions

Every 500-hour cycle included the following tests:

1. Freeze: 68 hours
   - Temperature: –23°C (–10°F)
2. UV/Condensation: 216 hours (9 days)
   - Test cycle: 4-hour UV/4-hour condensation cycle
   - UV lamp: UVA-340
   - UV temperature: 60°C (140°F)
   - Condensation temperature: 40°C (104°F)
3. Cyclic salt-fog: 216 hours (9 days)
   - Test cycle: 1 hour wet/1 hour dry
   - Wet cycle: 5 percent NaCl solution; fog introduced at 35°C (95°F)
   - Dry cycle: Air purged to test chamber at ambient temperature

corrosive environments). Then the researchers plotted the average rust creepage from the scribe, namely scribe creepage, which is defined as the average rust creepage measured from the scribe line. The researchers obtained the scribe creepage values by taking the average of six rust creepage values representing three scribed panels with two test values for each coating material.

In addition, using standard methods, the researchers measured the gloss, adhesion strength, and pencil hardness of the samples before and after the laboratory test.

Chemical and Physical Properties

All the overcoat materials tested during the study had high percentages of solid content, ranging from 66 to 89 percent by weight, which means the materials have low VOC content. The pigment content, as a part of the solid, ranged from 41 to 80 percent by weight of the dry film, with the exception of zero or a low amount found in the epoxy and MCU sealers, respectively. The researchers found that most of the pigment fractions contained a significant amount of aluminum, phosphorus, iron, and zinc, which are effective elements for protecting steel from corrosion. Further, they found that both the elastomeric high-build (HB) acrylic and calcium sulfonate (CSA) contain zinc phosphate, a proven anticorrosive pigment.

The researchers measured the pencil hardness of the six overcoat materials according to the ASTM D3363 method. In the pencil hardness test, the "H" stands for hardness, the "B" stands for blackness, and "HB" refers to hard and black pencils. The scale ranges as follows from softest to hardest, with "F" falling at the middle of the hardness scale: 6B, 5B, 4B, 3B, 2B, B, HB, F, H, 2H, 3H, 4H, 5H, and 6H. The alkyd showed hardness of HB on the pencil hardness test; the two-coat MCU (MCU2), three-coat MCU (MCU3), and epoxy all showed the hardness of 2H. CSA and HB acrylic, however, were very soft, with a hardness of 6B.

Laboratory Tests

As a result of the laboratory testing, the researchers found that the alkyd, MCU2, and MCU3 overcoat materials were more resistant to the UV lamp, retaining 40 to 60 percent of their original gloss (or shine), while the epoxy retained only 20 percent of its gloss. Even though HB acrylic and CSA retained 70 to 80 percent of their gloss, both had very low gloss before the test. High gloss retention is important for ensuring and maintaining coating appearance over time.

Nearly all the overcoat systems retained their adhesion strength values after the test, meaning a reduced chance for moisture, oxygen, or salts to penetrate through the coating film to cause corrosion. The measured adhesion strength is the strength needed for the weakest point to fail in a coating system. The researchers measured the adhesion strength using ASTM D4541 (a

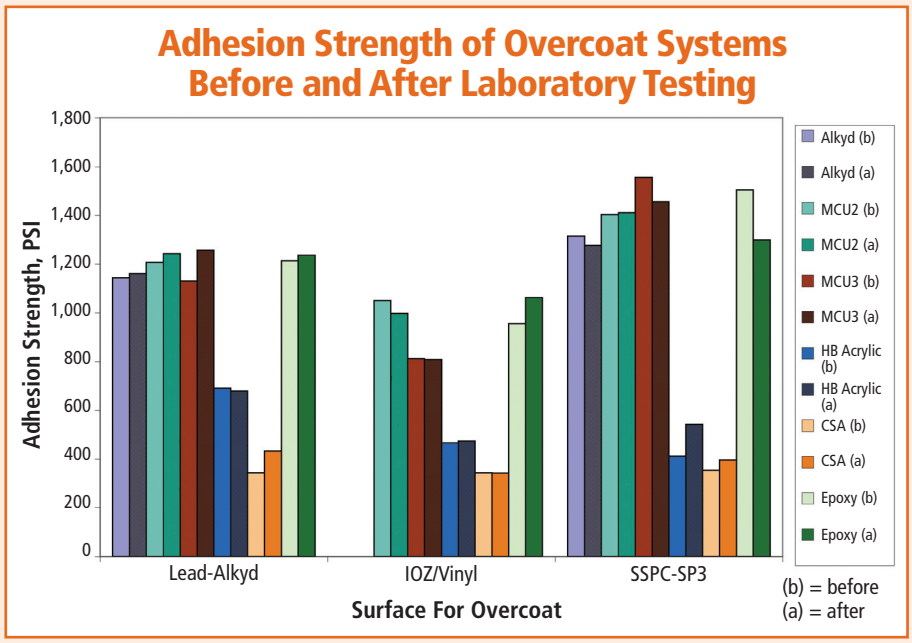
Chemical Composition of Overcoat Materials

Overcoat Material		Alkyd	MCU	MCU Sealer	HB Acrylic	CSA	Epoxy	Epoxy Sealer
Solid Content, Percent by Weight of Wet Film		67.5	87.0	76.1	66.2	74.02	83.1	89.0
Pigment Content, Percent by Weight of Dry Film		71.0	79.9	19.7	40.6	48.0	68.9	0
Elemental Content, Percent of Total Metals	Na		16.2		11.7	12.1		
	Mg	13.2	2.1		1.3	0.2		
	Al	16.2	9.6	100	5.0	2.3	5.9	
	Si	42.8	9.4		3.5	1.0	85.9	
	P				11.5	5.9		
	K	3.1	0.8					
	Fe		10.5		0.6	8.4		
	Zn		51.4		33.6	50.8		
	Ca	2.7			11.3	17.5		
	Ti	21.0			19.2	0.5	8.2	
	S				2.4	0.3		
Film Thickness, µm (mil)		100 (4)	175 (7)	190 (7.6)	350 (14)	350 (14)	185 (7.4)	

standard test for the pull-off strength of coatings) both in the laboratory and in the field. Most of the coating systems had high adhesion strength, except two elastomeric coatings (HB acrylic and CSA) that had adhesion strength of only 2.8 to 3.5 MPa (400 to 500 psi). The researchers found that the majority of the failures during the adhesion test were cohesive failures (which means breaks within the layers, rather than breaks between layers) within the lead-based alkyd and IOZ primer layers themselves. The observed cohesive failures suggest strong adhesion of most of the overcoat materials to the basecoat surfaces. Conversely, they found that the CSA and HB acrylic overcoats showed cohesive failures indicating that they have low mechanical strength themselves. For overcoats on the SSPC-SP3 surfaces, the researchers observed adhesive failures (breaks between layers) between the steel and overcoat primer for all cases, indicating weak adhesion between steel and the overcoats.

Surface failure. Only one of the panel surfaces, system 1 (panel numbers 160 and 167), showed a surface failure, in this case some rust-through. These panels are SSPC-SP3 surfaces with overcoats of two coats of alkyd. The researchers concluded that this rust-through failure may have been caused by the thinness of the overcoat film—only 100 microns (4 mils), as recommended by the manufacturer for overcoating. All the other overcoat materials were applied at a thickness of at least 175 microns (7 mils) over SSPC-SP3 surfaces.

Based on these results, the researchers concluded that coating thickness plays a critical role in development of surface rust-through. But at the same time, system 1 exhibited only a small amount of rust creepage at the scribe. Normally, a poorly performing coating would show both severe surface failure and large rust creepage at the scribe. These unexpected results suggest that there is no direct correlation between surface performance and scribe performance for overcoat systems. In theory, surface performance depends on the thickness of the coating film, but rust creepage developed at the scribe is affected by adhesion and the corrosion resistance of the primer.



This bar chart shows the adhesion strength of overcoated systems before and after the 4,000-hour laboratory test. The substrates were aged lead-alkyd, aged IOZ/vinyl, and rusty steel surfaces that were power-tool cleaned. *Source: FHWA.*

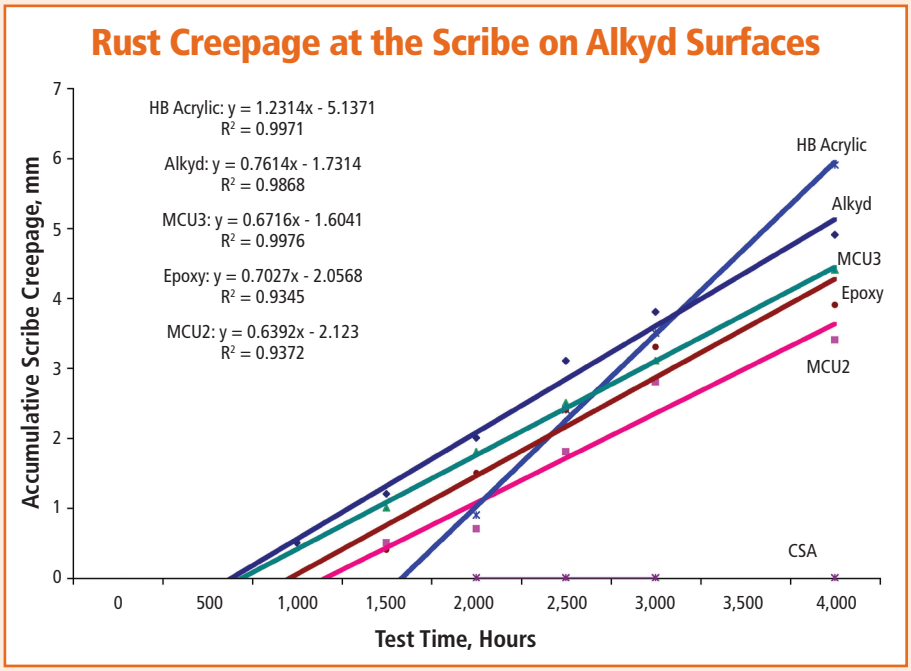
Scribe failure. The scribe rust creepage developed by all the overcoat systems grew linearly with time. The performance results of the various coating materials over lead-based alkyd, IOZ/vinyl, and SSPC-SP3 surfaces after the 4,000-hour laboratory test were as follows.

For the samples with coatings applied over the aged lead-based alkyd surface, the performance of the overcoat materials at the scribe was best for CSA and decreased respectively for MCU2, epoxy, MCU3, alkyd, and HB acrylic. With the exception of CSA as the standout performer, the remaining overcoat materials showed similar defects at the scribe.

For the overcoat materials applied to the aged IOZ/vinyl surfaces, CSA performed the best at the scribe, followed in decreasing order by epoxy and HB acrylic, then MCU2 and MCU3. In fact, the researchers determined that MCU2 and MCU3 were somewhat unsuitable for overcoating IOZ/vinyl surfaces.

And for the SSPC-SP3 surfaces, the steel panels that were allowed to rust and then power-tool cleaned, the researchers ranked the coating performance in decreasing order of effectiveness: CSA; then alkyd; followed by MCU3, epoxy, and MCU2; and, finally, HB acrylic. The researchers concluded that these results

Panels 160 and 167 are lead-based alkyd surfaces that used alkyd paint as an overcoat. Following the 4,000-hour laboratory testing, these samples showed rust-through spots on the surface, which may be due to the thinness of the overcoat.



Shown here is the rust creepage at the scribe developed by various coating materials over aged alkyd surfaces after the laboratory test. All the rust creepage at the scribe increased linearly over time. The HB acrylic overcoated system developed the most rust creepage at the scribe, while the CSA system developed zero rust creepage after the 4,000-hour laboratory test. *Source: FHWA.*

show CSA has a unique high affinity to less perfect steel surfaces and provides high resistance to corrosion.

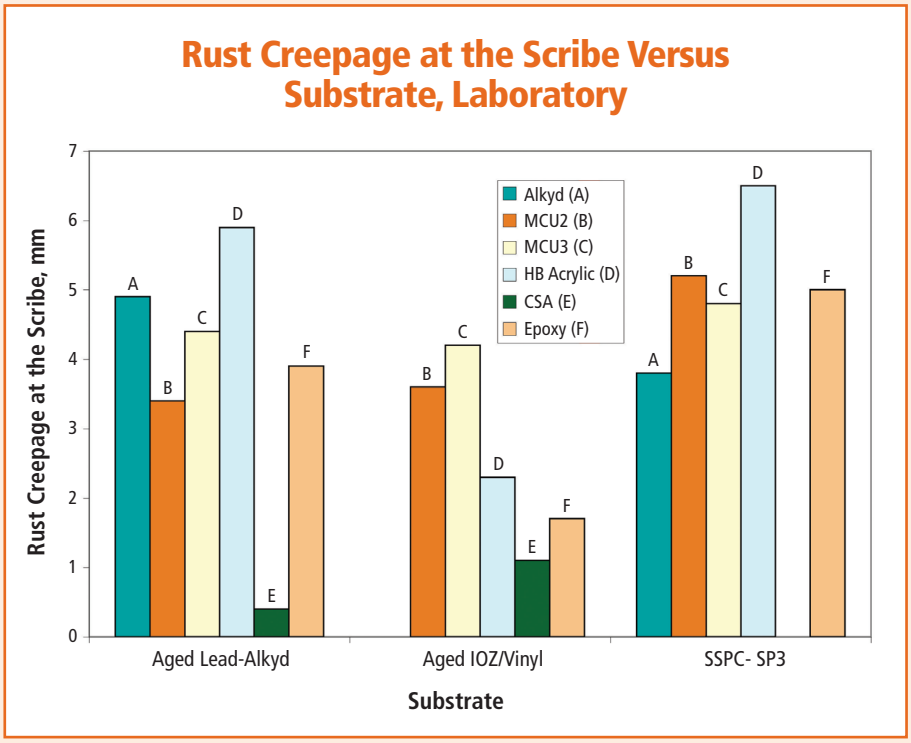
Comparing the results for the rust creepage at the scribe obtained from the three overcoated substrates, the researchers found that CSA performed the best, even though it has low gloss and a tendency to pick up dirt. These characteristics indicate that CSA could be a practical choice for use in areas where corrosion prevention is more important than appearance. The test data further revealed that the performance of the other overcoat materials varies by type of substrate.

Outdoor Tests

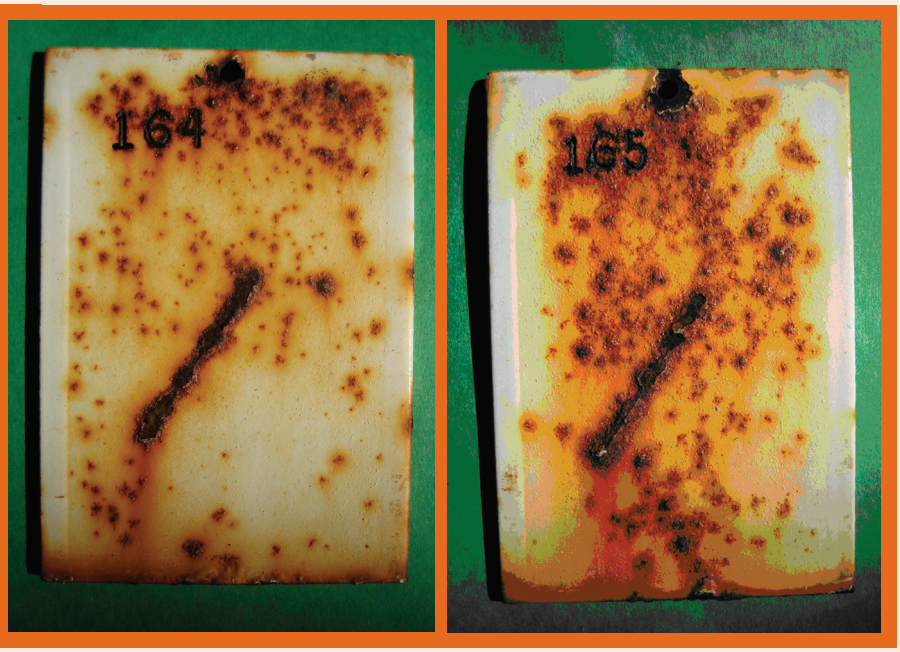
Concerning performance of the overcoats under real-world conditions, the researchers found that most of the paints lost 80 to 90 percent of their gloss after the 24-month outdoor exposure at Sea Isle City, NJ. HB acrylic was the best performer, losing only 70 percent of its gloss. The high-intensity UV light at Sea Isle City might be the cause of these significant gloss reductions.

Surface failure. System 1 (alkyd, panel numbers 164 and 165) showed severe rust-through, performing much worse than it did in the laboratory test, possibly due to the harsh conditions at the outdoor site. In addition, system 2 (MCU2, panel numbers 174 and 175) developed 8VD (very dense, size 8 blisters as defined in ASTM D714) blistering, a failure mode the researchers did not observe following the laboratory test. The researchers expect that this blistering could lead to coating delamination or rusting over time. The panels with MCU3 overcoats, however, did not show blistering—a difference in performance that the researchers say indicates the effectiveness of using the sealer prior to applying the two-coat MCU over lead-based alkyd.

Scribe failure. After the 24-month exposure, all the coating systems started to show linear growth in rust creepage at the scribe with exposure time. For the lead-based alkyd substrates, the researchers found that MCU2 and MCU3 did not perform as well at the scribe as other overcoat materials in the salt-rich, high-UV environment. HB acrylic, CSA, alkyd, and epoxy, however, all performed about the same—better than MCU2 and MCU3. The pan els with CSA overcoats developed rust creepage in similar amounts to the panels coated with the other materials; apparently the CSA did not soften the alkyd substrate to increase



This figure shows the rust creepage at the scribe developed on the three different substrates using overcoats of various materials. The CSA overcoat system showed the least amount of rust creepage at the scribe for each type of substrate. *Source: FHWA.*



Panels 164 and 165 show the coating condition of lead-based alkyd covered with an alkyd overcoat after 24 months of exposure outdoors in New Jersey. The panels show severe rust-through spots on the surfaces.

the adhesion of the lead-based alkyd to the steel surface at the outdoor exposure site. The researchers concluded that CSA might have lost its softening power because its solvent evaporated faster under the hot temperatures at the exposure site.

No rust creepage occurred at the scribe for any of the panels with the IOZ/vinyl basecoat. IOZ takes a long time, usually weeks or even months, to cure and cures more completely at the scribe in an outdoor environment due to the availability of moisture and air ventilation. Recognizing this characteristic, the researchers expect that extended exposure to outdoor conditions will cure the IOZ primer further and thereby increase the protection it offers to steel.

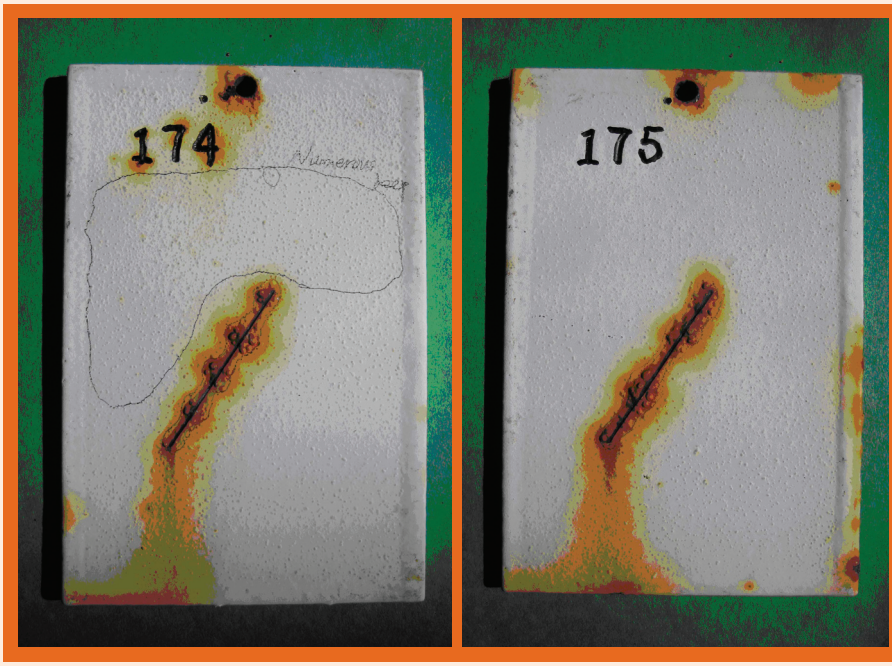
When placed over the SSPC-SP3 steel surface, the epoxy performed three times worse than the other overcoat materials at the scribe and exhibited 17 millimeters (0.67 inch) of rust creepage after 24 months of outdoor exposure. This large creepage may be caused by the fact that epoxy chalks badly under the high-intensity UV light at Sea Isle City. At the scribe, the edge of the entire epoxy layer over the SSPC-SP3 steel surface was exposed to UV light, so the chemical composition of the chalked epoxy changed, thereby losing its ability to protect the steel surface. Again, CSA was the best performer.

Take-Away Lessons

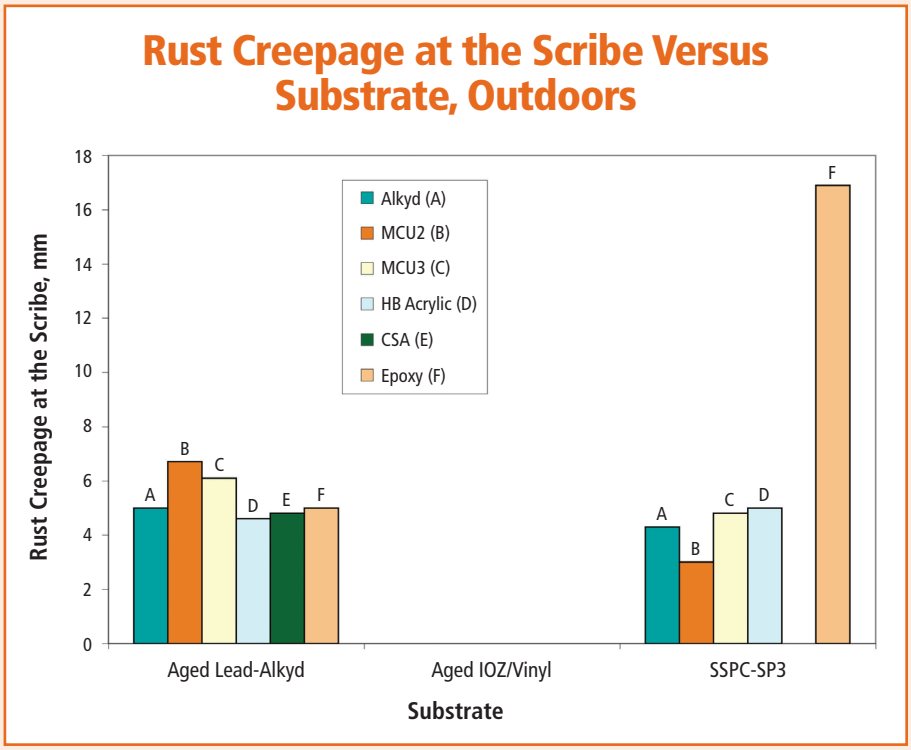
Comparing the performances of the various coating materials when applied to the three substrates and exposed to both laboratory and outdoor testing led to a number of key findings. Although rust creepage developed at the scribe and grew linearly over time for each sample, the overcoat materials performed differently though applied to the same primer substrates. The difference in performance depended upon the wetting or penetrating properties of the individual overcoat material, which contains different types and amounts of solvent and resins with varying penetrating power. The longer the overcoat material takes to cure, the more solvent is available to soften the coating substrate and thereby increase the primer's adhesion to steel. As a result, the researchers concluded that the difference in the amount of rust creepage at the scribe was due to the variability in primer adhesion.

Further, through these tests, the researchers summarized the following findings for overcoat strategies.

1. For aged lead-based alkyd surfaces, CSA, MCU2, epoxy, and MCU3 are better performing overcoat materials than alkyd and HB acrylic in the laboratory environment.



Panels 174 and 175 show the coating condition of SSPC-SP3 surfaces covered with an MCU2 overcoat after exposure outdoors for 24 months. The panels show small blisters all over the surfaces, which are a precursor to eventual corrosion or rust.



This figure shows the rust creepage at the scribe on the three different substrates with various overcoat materials when the panels were exposed to real-world conditions outdoors in New Jersey for 24 months. The overcoated lead-alkyd system developed 5–6 millimeters (0.19–0.24 inch) of rust creepage at the scribe. The IOZ/vinyl system did not develop any rust. For the SSPC-SP3 steel surface, epoxy was the poorest performer in terms of rust creepage. *Source: FHWA.*

However, HB acrylic, CSA, alkyd, and epoxy are better than MCU2 and MCU3 for outdoor applications with high-intensity UV light. CSA, on the other hand, did not protect the scribe in the laboratory as well as it did outside.

2. For aged IOZ/vinyl surfaces, CSA, epoxy, and HB acrylic perform better than MCU2 and MCU3 in the laboratory. However, the performances of all the overcoats were much better outdoors, where the researchers found no rust creepage at the scribe for any of the coated panels after 24 months of exposure to the corrosive elements.
3. For SSPC-SP3 steel surfaces, CSA performs the best, while alkyd, MCU3, epoxy, and MCU2 are more effective than HB acrylic in the laboratory. The 50-micron (4-mil)-thick layer of alkyd overcoat used in this study proved insufficient to protect the steel surface from corrosion; therefore, the researchers recommend a thicker film of at least 175 microns (7 mils) if possible. CSA is also the best performer outdoors; however, the epoxy overcoat performed quite poorly after 24 months of outdoor exposure.

Overall, CSA performed the best on all three substrates. However, it is a soft material that picks up dirt easily. Given these strengths and weaknesses, the researchers advise bridge owners to use their best judgment in deciding whether to use CSA as an overcoat material.

Additional insight: "Stay on top of the surface preparations or the overcoat could fail prematurely," says Rogerson from Caltrans. "Soluble salts, such as sulfates, nitrates, and chlorides, within the base coatings can lead to blistering in the overcoats applied over them. With some acrylic latex coatings, we've had to clean and test for the amount of soluble salt on the steel, and sometimes do an additional cleaning step to make sure the overcoat sticks."

Rogerson adds, "Continued research is important to prove the longevity of overcoats and ensure compliance with the latest VOC requirements. In California, we're continuing to see the maximum allowable VOC content level drop. The limit is 250 grams per liter (2.08 pounds/gallon) VOC content in northern California, but just 100 grams per liter (0.83 pounds/gallon) in the Los Angeles area. And the numbers keep changing. With 35 air pollution control districts in the State, from an owner's perspective it becomes difficult to keep on top of the different rules and definitions. For that reason we're trying to meet the most stringent requirements and use those statewide."

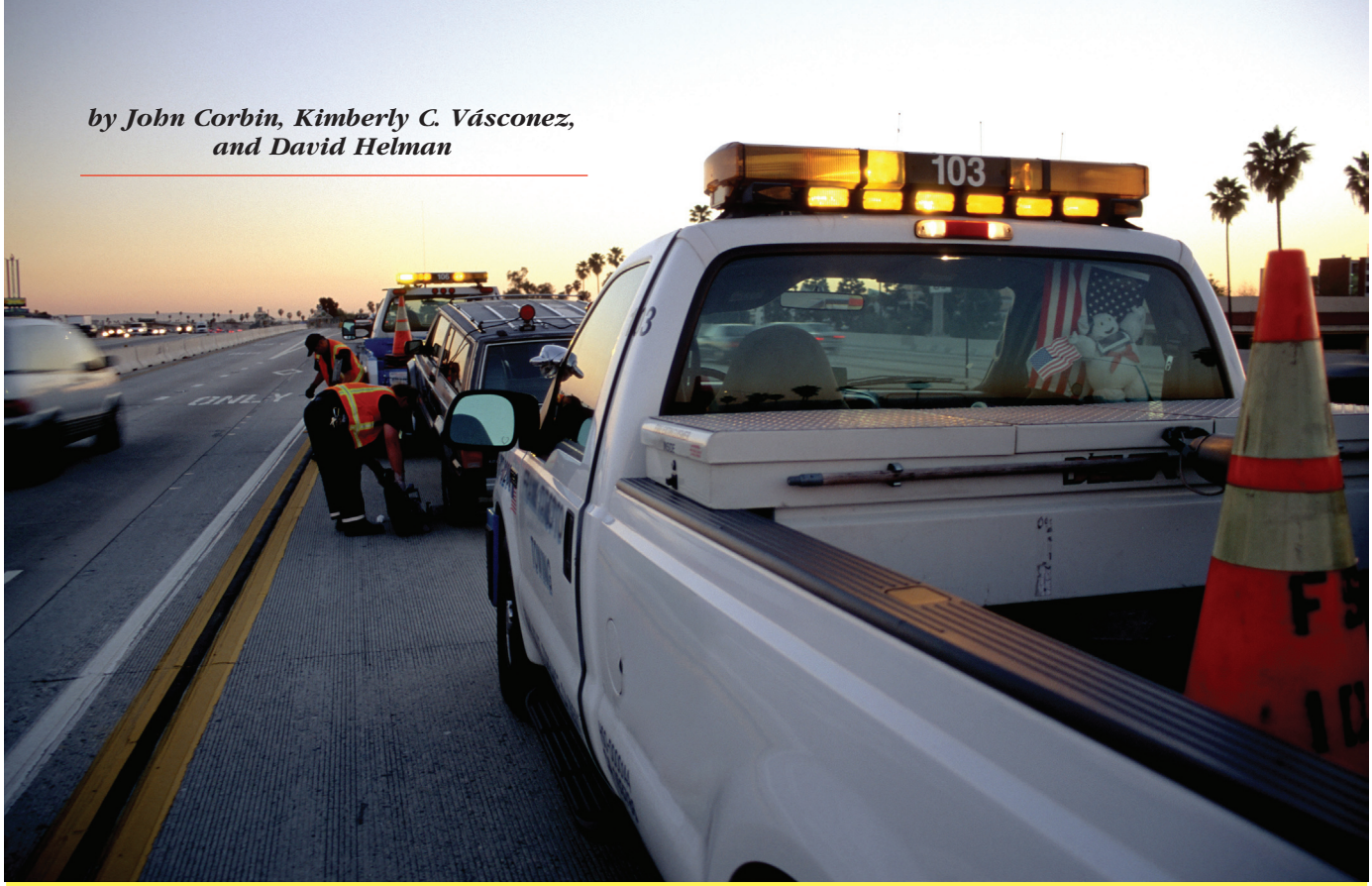
The degree of surface failure for each system assessed during this study will be measured by electrochemical impedance spectroscopy, and the test data will be published at a later date.

Dr. Shuang-Ling Chong, recently retired from FHWA, is a senior chemist with more than 30 years' experience in various fields of chemical research. She joined FHWA in 1989 and studied generic types of bridge coatings, including low-VOC coatings, MCUs, waterborne coatings, two-coat systems, and one-coat bridge materials. She also conducted research on leaching of blasted paint residues, chloride testing methods, and failure analyses. Chong served as manager of the Coatings and Corrosion Laboratory at TFHRC until her retirement in April 2007. She was a member of numerous industry and standards organizations, including SSPC, ASTM, the Transportation Research Board, and the American Chemical Society.

Yuan Yao is a senior chemist with SaLUT, Inc. Since 1994 she has been an onsite contractor in the TFHRC Coatings and Corrosion Laboratory. She has supported many chemistry and coating projects, applying a range of testing and analytical techniques to performance evaluations of various coating types.

For more information, please visit www.tfhrc.gov or contact Yuan Yao at 202-493-3092, yuan.yao@fhwa.dot.gov. To view additional figures summarizing the results from this study, please visit the PUBLIC ROADS Web site at www.tfhrc.gov/pubrds/pubrds.htm.

by John Corbin, Kimberly C. Vásconez, and David Helman



Unifying Incident Response

Transportation and public safety organizations collaborate with the private sector to promote safe, coordinated, and efficient management of traffic incidents.

In May 2006, the U.S. Department of Transportation (USDOT) announced the *National Strategy to Reduce Congestion on America's Transportation Network*, also known as the Congestion Initiative. The strategy acknowledges that "congestion is one of the single largest threats to [the Nation's] economic prosperity and way of life" and costs the United States an estimated $200 billion per year.

(Above) Improving incident response will ease congestion and more effectively protect response teams like the one shown here. *Photo: Igor Karon, Shutterstock®.*

From minor incidents to multicar crashes with fatalities, traffic incidents constitute a growing national concern, costing time and revenue for motorists and businesses, and—all too often—taking the lives of drivers, occupants, and responders. Traffic incidents account for 25 percent of congestion on U.S. roadways and are challenging to address because their location, timing, and intensity cannot be anticipated. In fact, the nonrecurring nature of traffic incidents not only affects travel times but also disrupts system reliability, turning a routine 15-minute errand into a 45-minute wait. Every minute that a freeway lane remains blocked during peak travel time results in 4 minutes of delay, during and even well after the lane is cleared.

Further, traffic incidents are starting to affect business efficiency. "A delayed delivery can be a disaster for today's supply chains," says Douglas G. Duncan, president and CEO of FedEx Freight®. "Congestion will roll back the savings in logistics and inventory costs that American businesses have achieved in recent years through 'just-in-time delivery,' and make American companies less competitive worldwide."

Beyond congestion delays, public safety and transportation professionals responding to roadway incidents

Benefits of Traffic Incident Management

- Congestion relief
- Economic savings
- Fuel savings
- Personnel savings (law enforcement, EMS, and fire) through faster, more efficient clearance of incident scenes, freeing responders for other duties
- Operational efficiency
- Emissions reductions
- Potential secondary crash reductions
- Faster incident detection, verification, and dispatch and response time
- Reduced mortality
- Reduced injuries from secondary incidents
- Increased customer satisfaction

can be at high risk for serious injuries or fatalities. As roads grow more congested, the risk increases, as evidenced by U.S. Department of Labor (DOL) statistics showing an upward trend in the numbers of incident responders struck and killed by vehicles every year. The DOL's Bureau of Labor Statistics reported that 372 responders died in 2006 in "struck-by" incidents—when responders are struck by passing vehicles while they are working at an incident scene—up from an annual average of 369 for 2001–2005. Struck-by incidents accounted for 7 percent of the total number of fatal occupational injuries in 2006.

Improving safety for response personnel and clearing incidents as quickly as possible are the focus of a new multidisciplinary initiative known as the National Unified Goal (NUG) for Traffic Incident Management. The NUG brings major stakeholders together to speed clearance of traffic incidents without compromising responder safety—in fact, to *increase* responder safety while addressing the congestion issue.

Responding to the Challenge

"Effective transportation operations are as much a part of a highway system as smooth pavement and well-maintained bridges," says Federal Highway Administration (FHWA) Associate Administrator for Operations Jeffrey F. Paniati. Traffic incident management (TIM) is essential to the efficiency and safety of highway systems and to USDOT efforts to alleviate congestion. "The safe and quick clearance of traffic incidents will reduce congestion and improve mobility on our highways and will improve safety for motorists and incident responders," says Paniati. TIM is one of the key focus areas to help alleviate congestion under the operational and technological improvements component of USDOT's Congestion Initiative. (See www.fightgridlocknow.gov for more information.)

Responders must work together efficiently to accomplish the many tasks necessary to clear incidents quickly and safely, reduce traffic congestion, and safeguard responders and motorists. In major incidents—those most likely to cause extended traffic delays—these tasks

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More than 20 percent of firefighter deaths occur on roadways. The firefighter here—standing in the road and dousing a burning car—is just feet away from fast-moving traffic.

Proposed NUG Strategies

Applying the motto "Working Together for Improved Safety, Clearance, and Communications," NTIMC developed 18 strategies to promote the 3 goals that comprise the NUG. NTIMC's mission statement states: "The NTIMC is committed to working together to promote, develop, and sustain multidisciplinary, multijurisdictional TIM programs to achieve enhanced responder safety; safe, quick traffic incident clearance; and more prompt, reliable, interoperable communications."

Crosscutting Strategies

Strategy 1. TIM partnerships and programs. TIM partners at the national, State, regional, and local levels should work together to promote, develop, and sustain effective TIM programs.

Strategy 2. Training. TIM responders should receive multidisciplinary National Incident Management System training and TIM training.

Strategy 3. Goals for performance and progress. TIM partners should work together to establish and implement performance goals at the State, regional, and local levels for increasing the effectiveness of TIM, including methods for measuring and monitoring progress.

Strategy 4. TIM technology. TIM partners at the national, State, regional, and local levels should work together for rapid and coordinated implementation of beneficial new technologies for TIM.

Strategy 5. Effective TIM policies. TIM partners at the national, State, regional, and local levels should join together to raise awareness regarding proposed policies and legislation that affect achievement of the NUG objectives of responder safety; safe, quick clearance; and prompt, reliable traffic incident communications.

Strategy 6. Awareness and education partnerships. Broad partnerships should be developed to promote awareness and education regarding the public's role in safe, efficient resolution of incidents on the roadways.

Objective 1: Responder Safety

Strategy 7. Recommended practices for responder safety. Recommended practices for responder safety and traffic control at incident scenes should be developed and widely published, distributed, and adopted.

Strategy 8. Move-over/slow-down laws. Drivers should be required to move over and/or slow down when approaching traffic incident response vehicles and personnel on the roadway.

Strategy 9. Driver training and awareness. Driver training and awareness programs should teach motorists how to react to emergencies on the roadway to prevent secondary incidents, including injuries and deaths of traffic incident responders.

Objective 2: Safe, Quick Clearance

Strategy 10. Multidisciplinary TIM procedures. TIM partners at the State, regional, and local levels should develop and adopt multidisciplinary procedures for coordination of TIM operations, based on nationally recommended practices and procedures.

Strategy 11. Response and clearance time goals. TIM partners at the State, regional, and local levels should commit to achieve goals for traffic incident response and clearance times (as a component of broader goals for more effective TIM—see Strategy 3).

Strategy 12. 24/7 availability. TIM responders and resources should be available around the clock.

Objective 3: Prompt, Reliable Incident Communications

Strategy 13. Multidisciplinary communications practices and procedures. Traffic incident responders should develop and implement standardized multidisciplinary communications practices and procedures.

Strategy 14. Prompt, reliable responder notification. All traffic incident responders should receive prompt, reliable notification of incidents to which they are expected to respond.

Strategy 15. Interoperable voice and data networks. State, regional, and local TIM stakeholders should work together to develop interoperable voice and data networks.

Strategy 16. Broadband emergency communications systems. National TIM stakeholders (working through NTIMC) should work together to reduce the barriers to developing and integrating broadband emergency communications systems (both wired and wireless).

Strategy 17. Prompt, reliable traveler information systems. TIM partners should encourage development of more prompt and reliable traveler information systems that will enable drivers to make travel decisions that reduce the impacts of emergency incidents on traffic flow.

Strategy 18. Partnerships with news media and information providers. TIM partners should join with news media and information service providers to provide prompt, reliable incident information to the public.

generally involve public safety responders responsible for emergency medical services (EMS), emergency communications personnel, fire and rescue services, law enforcement, transportation workers, towing and recovery staff, and public information specialists. Each discipline has a distinct mission and role on the scene, which can make coordination challenging.

In 2004, the National Traffic Incident Management Coalition (NTIMC) formed to coordinate between these disparate disciplines. The coalition's 19 member organizations then created the NUG to serve as a strategic roadmap for activities aimed at improving safety for response personnel and clearing incidents as quickly as possible. Specifically, the NUG provides a framework for coordinating the major stakeholders at an incident site to speed clearance of traffic incidents while improving responder safety. The coalition's expectation is that coordinated operations with clear lines of responsibility will *increase* responder safety while addressing the congestion issue. This partnership marks the first time such a broad coalition of traffic incident responders has collaborated to produce policies to address common concerns.

What Is the NUG?

In November 2006, FHWA funded and sponsored an NTIMC conference in Newport Beach, CA, to obtain input from designated stakeholders on a draft NUG that was developed over a 1-year period. Developed under the leadership of NTIMC and with input from organizations representing traffic incident responders across the country, the NUG constitutes a national policy with three major goals: responder safety; safe, quick clearance of incidents; and prompt, reliable, and interoperable communications.

NTIMC encourages State and local transportation and public safety agencies to adopt this unified, multidisciplinary policy because it has the potential to dramatically improve the way traffic incidents are managed on U.S. roadways.

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Like police, fire, and emergency medical personnel, tow truck operators, such as the one shown here, often find themselves in harm's way due to the nature of their jobs.

The possibility of enhancing responders' safety at incident scenes is a key motivator of support for the NUG. "The safety of firefighters is a big issue in the fire service," said David Daniels, chairman of the Safety, Health, and Survival Section of the International Association of Fire Chiefs, during the 2006 NTIMC conference, where invited delegates provided input on a preliminary draft of the NUG. "We are very interested in the opportunity to partner with other incident responders for safety."

Harriet Cooley, executive director of Towing and Recovery Association of America, Inc., added: "We lose [tow operator] lives in the line of duty at the same rate as other responders. Responder safety is a top priority for our industry."

Sustained, strategically planned partnerships build and maintain accountability for the transportation, first responder, towing, and law enforcement organizations managing traffic incidents at the scene. TIM programs will continue to be key to the NUG's success at the State, regional, and local levels.

Successful TIM programs address mobility through the adoption of performance measurements. Recognizing that you can't manage what you can't measure, FHWA and NTIMC are collaborating to create national metrics that will help responders develop their own programmatic and incident response goals and commit to them in written agreements. Once partnerships have common, consistent, and reliable methods for measuring incident duration, they will have a means to establish common response goals (such as clear the incident within 90 minutes) and then to measure the relative benefit of different strategies and tactics deployed to attain the goal.

Other NUG strategies promote responder safety through establishing full-function service patrols; encouraging safe, quick clearance of incidents through the adoption of laws and policies; and recommending integrated, interoperable incident communications through intelligent transportation systems (ITS) technologies, such as integrating computer-aided dispatch systems into traffic management centers for more effective communication among responders.

Responder Safety

A critical step toward improving responder safety is adopting and enforcing "driver removal," "move-over," and "authority removal" laws. Driver removal laws require motorists involved in minor crashes, without apparent or serious injuries and where vehicles are still drivable, to move their vehicles out of travel lanes to safer locations, such as the road shoulder, before exchanging information or waiting for law enforcement or towing response. About 50 percent of the States have some form of driver removal law, also called "move-it" or "steer it, clear it" laws, but the laws vary widely in wording, coverage, and sanctions.

Move-over laws require drivers passing an incident to move over and slow down for emergency vehicles and responders on the roadway. FHWA and NTIMC agree that definitions of "emergency vehicles" and "emergency responders" must include all traffic incident responders, both public and private sector, including State department of transportation (DOT) service patrols. (More information about move-over laws is available at www.respondersafety.com.)

A third type of law, known as authority removal laws, provides authorization for predesignated public agencies to remove disabled or wrecked vehicles and spilled cargo and other property that interferes with the normal flow of traffic. In 2008, FHWA and NTIMC will undertake an effort to increase awareness of driver responsibilities to comply with these State laws or policies and to encourage more consistency in move-it (driver removal) laws from State to State. FHWA will publish an informational document on clearance laws including move-it, move-over, and authority removal laws that will contribute to greater responder safety and aid in quick clearance of incidents.

Another key to improving responder safety is development of recommended practices that are acceptable to all responding disciplines at the incident scenes. Through multidisciplinary TIM training, NTIMC will promote these practices, which might include safe, quick clearance for responders; prompt, reliable responder notification; the National Incident Management System (NIMS); and full-function service patrol operations—vehicular units and transportation personnel that patrol assigned routes, usually on freeways, and provide a variety of services from motorist assistance to full incident response.

Driver training and awareness also are essential to improving responder

safety. AAA, an NTIMC member organization in the process of ratifying the NUG, is launching a public education campaign to promote driver awareness of move-over laws and other ways that motorists can prevent secondary incidents. Secondary incidents involving emergency responders can take many forms, but they typically occur when responders working at the scene of a traffic incident are struck by passing vehicles.

Safe, Quick Clearance Of Incidents

Although public safety responders support the concept of quick clearance, they are concerned that the need to clear the road quickly must not impede their abilities to safely and efficiently carry out their missions of treating patients, controlling fire hazards, enforcing traffic laws, and investigating crash scenes.

The NUG's strategies for safe, quick clearance reflect those proposed by FHWA and provide guidance and techniques to clear roads more efficiently without sacrificing safety or other missions, such as EMS, law enforcement, crime scene investigation, motorist assistance, and fire safety. "The International Association of Chiefs of Police's Highway Safety Committee, part of an organization of more than 21,000 police executives from countries around the world, cares about this issue, and we are participating in the NUG," chairman of the committee Earl Sweeney said at the 2006 NTIMC conference.

To ensure safe, quick clearance, all organizations that are part of traffic incident response need to have 24/7—or round-the-clock, every day—capacity. Although fire, law enforcement, EMS, and towing responders already are available 24/7, transportation agencies often do not have response capabilities or service patrols available outside of regular business hours. Consequently, incident responders must manage traffic incidents without the transportation agency's resources and capabilities, or they need to wait for transportation personnel who are offduty but oncall to report to the scene. FHWA and NTIMC recognize the resource challenges facing State transportation agencies as they move toward providing 24/7 traffic incident response. Staffing and outfitting service patrol vehicles will need to be implemented incrementally over time.

"A serious commitment to responder safety and a true partnership between first responders and transportation organizations addressing roadway incidents implies 24/7 availability of onscene traffic control and motorist assistance," says FHWA's Paniati. FHWA and State DOT officials are building a strong case for this 24/7 availability on interstates and other high-volume transportation facilities. Traffic control during

Tim Breen for FHWA

At this busy traffic circle in Washington, DC, a car and driver involved in a crash, and a responding police car, have moved out of the roadway—the goal of State move-over laws and an emphasis of the NUG.

David Andrew Gilmour, Shutterstock®

One goal of the NUG is to improve communications among responders, who, like the police and medical vehicles shown here, often have to jostle for position to address incidents.

nighttime work zone operations is particularly important. Many State and local highway authorities are conducting their work zone operations overnight to reduce the impacts of construction on motorists. But nighttime operations can increase the danger to construction workers due to reduced visibility, speeding, and drunk driving. As a result, full-function service patrols and emergency services increasingly are being called to work zones to address incidents at night.

In addition, cost-benefit studies indicate a clear advantage to establishing these full-function service patrols. For example, in 2004 the Florida Department of Transportation (FDOT) sponsored a study to evaluate the cost-effectiveness of the FDOT Road Ranger program, which was established in 1999 to assist disabled vehicles along congested freeway segments and to provide quick detection, verification, and removal of freeway incidents. The results of the analysis revealed a net benefit due to reductions in incident delays and fuel consumption. The overall benefit-to-cost ratio for the program was 25.8 to 1, with individual districts reporting benefit-to-cost ratios ranging from 2.3 to 1 to 41.5 to 1. More information on this study and other examples of positive cost-benefit ratios for service patrol programs around the country are available on USDOT's Intelligent Transportation Systems Joint Program Office Web site at www.its.dot.gov.

FHWA and NTIMC encourage State and local transportation authorities to establish full-function service patrols, including full-time dispatch triage capabilities, in their largest metropolitan areas and to move toward 24/7 services in other areas where practical. FHWA and NTIMC will release a handbook in 2008 to provide technical assistance to State and local authorities in building effective service patrols that serve as extensions of the community's first-response capabilities.

Prompt, Reliable, and Interoperable Communications

Incident communications involve complex technical and institutional issues, yet are essential to achieving TIM goals. Technical problems include: (1) nonstandard communications system architectures that make it difficult to share information across disciplines and jurisdictions, (2) implementation of wireless emergency location technologies so cell phone users can call 9-1-1, and (3) a lack of broadband spectrum.

The following institutional issues also pose challenges: (1) a lack of uniform procedures and policies for incident notification across all disciplines, and (2) a lack of standardized procedures and policies for onscene communication across disciplines.

The NUG calls for developing and implementing standardized, multidisciplinary practices and procedures to improve communications at traffic incidents. These strategies include the following:

- Developing systems and procedures for prompt, reliable notification of responders regarding incidents to which they are called.
- Encouraging State, regional, and local TIM stakeholders to work together to build interoperable voice and data networks.
- Promoting more prompt and reliable traveler information systems that will enable drivers to make more responsive travel decisions, reducing the impacts of emergency events on traffic flows.
- Encouraging TIM partners to partner with news media and information service providers to provide prompt, reliable incident information to the public. FDOT and the Florida Highway Patrol, for example, have built strong relationships with the media, as have TIM teams in the Atlanta, GA, area, and in the Houston, TX, metropolitan area.

NUG Adoption

Nearly all of the 19 NTIMC member organizations, as well as some State and regional organizations, have ratified the NUG. (See "Organizations That Have Ratified the NUG" on page 29.)

"Within AASHTO, I have made the NUG one of my key objectives," says Victor Mendez, president of the American Association of State Highway and Transportation Officials (AASHTO). "We are committed to supporting its implementation through the individual States. The NUG is an important, high-level program for AASHTO that will allow us to accomplish many positive outcomes."

FHWA's Paniati agrees: "The NUG will play a critical role in structuring improvements to TIM efforts, facilitating more efficient responses, reducing congestion, and creating safer working environments for responders

Organizations That Have Ratified the NUG

Fully Ratified:

American Association of State Highway and Transportation Officials
Association of Metropolitan Planning Organizations
American Traffic Safety Services Association
Association of Public-Safety Communications Officials International, Inc.
Cumberland Valley Volunteer Fireman's Association Emergency Responder Safety Institute
I–95 Corridor Coalition
International Association of Fire Chiefs
International Fire Service Training Association
Institute of Transportation Engineers
Intelligent Transportation Society of America
National Association of State EMS Officials
National Emergency Number Association
National Volunteer Fire Council
Towing and Recovery Association of America, Inc.

Quasi-Ratified (endorsed at a policy committee level and optimistic about full endorsement soon):

AAA
International Association of Chiefs of Police

Action Pending (in the process of pursuing approval):

American Transportation Research Institute

Other Endorsements (non-NTIMC-member organizations that have formally endorsed the NUG):

Hampton Roads Highway Incident Management Committee
Hampton Roads Fire Safety Officials Committee
National Fallen Firefighters Foundation
Washington State Fire Fighters' Association

around the country. We at FHWA strongly encourage all agencies involved in traffic incident management to adopt the NUG."

John Corbin, P.E., PTOE, is chairman of NTIMC and AASHTO's Traffic Incident Management Task Force, and cochair of the Institute of Transportation Engineers' Traffic Incident Management Committee. He is the State traffic engineer for the Wisconsin Department of Transportation. Before that he served as an engineer and program manager for traffic engineering and traffic management initiatives in metropolitan Milwaukee, WI. He has a bachelor's degree in transportation engineering from the University of Wisconsin-Milwaukee and a master's in civil and environmental engineering from the University of Wisconsin-Madison.

Kimberly C. Vásconez is team leader for the Emergency Transportation Operations program at FHWA. Her team covers TIM, planned special events, and evacuation and movement coordination planning. She is on several Transportation Research Board panels related to evacuations and serves as the secretariat for the AASHTO Emergency Response Planning Practices Task Force of the Special Committee on Transportation Security. A professional emergency manager, Vásconez worked for 14 years for the Federal Emergency Management Agency and the U.S. Department of Homeland Security and 4 years with the U.S. Agency for International Development's Office of U.S. Foreign Disaster Assistance before joining FHWA in 2005. She holds a master's degree in public and international affairs from the University of Pittsburgh and a bachelor's in journalism from Indiana University of Pennsylvania.

David Helman is manager of the TIM Program for FHWA. He is a founder and ex officio member of NTIMC's Steering Committee and played a key role in aligning NTIMC's NUG with the TIM elements of the Congestion Initiative. Before joining FHWA, Helman was a safety programs engineer for the West Virginia Department of Transportation. He holds bachelor's degrees from the University of Illinois and Rockford College, and a master's degree in civil engineering from West Virginia University.

For more information, contact John Corbin at 608-266-0459 or john.corbin@dot.state.wi.us, or David Helman at 202-366-8042 or david.helman@fhwa.dot.gov. For State TIM actions, see www.transportation.org/sites/ntimc/docs/Institutional%20Models.pdf.

Dan Bruno

The NUG provides a framework for law enforcement, fire, EMS, transportation, towing, and 9-1-1 responders to work together more safely and efficiently at incident scenes such as this one on a highway in St. Louis County, MO.

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

Traffic Deaths Decrease on U.S. Highways

USDOT announced that traffic deaths on U.S. roads decreased slightly in 2006 according to preliminary figures, but it cautioned that far too many lives continue to be lost. USDOT projected that the number of road deaths declined nationwide from 43,443 in 2005 to 43,300 in 2006.

The preliminary 2006 fatality numbers released project a 2006 fatality rate of 1.44 deaths per 100 million vehicle miles traveled, down from 1.45 in 2005. During the same period, injuries dropped from 2.7 million in 2005 to 2.54 million in 2006, a decrease of 6 percent. The preliminary figures also show that between 2005 and 2006, overall alcohol-related fatalities increased 2.4 percent from 17,525 to 17,941; pedestrian deaths dropped slightly, from 4,881 to 4,768; and fatalities from large truck crashes dropped from 5,212 to 5,018, a 3.7 percent decline.

USDOT collects the crash statistics from the 50 States and the District of Columbia to produce the annual traffic fatality report. The final 2006 report, pending completion of data collection and analysis, became available in late summer 2007. The preliminary report is available at www-nrd.nhtsa.dot.gov/Pubs/810755.PDF.

Emergency Relief Designated for MacArthur Maze

In May 2007, USDOT announced that the Federal Highway Administration (FHWA) Emergency Relief (ER) program will appropriate an initial $2 million in Federal funds to repair the damaged MacArthur Maze overpass in northern California's East Bay. The MacArthur Maze highway overpass melted and then collapsed on April 29, 2007, due to a gasoline tanker fire, rendering two freeways unusable.

The $2 million is a first installment of funds that will give crews the support they need to begin construction. Additional Federal dollars are expected to follow once the full project cost is determined. USDOT officials pledged that the Federal Government will continue to be a close partner with the State to do everything possible to restore the bridge.

Through its ER program, FHWA reimburses States for expenses associated with transportation emergency situations. Projects paid for by the funds include rebuilding or replacing damaged bridges, highways, lighting, guardrails, and signs; creating detours; and removing debris.

FHWA Presents Awards for Utility Relocation and Accommodation

FHWA recently announced the winners of the 2007 Excellence in Utility Relocation and Accommodation Awards. The FHWA biennial awards program honors State departments of transportation (DOTs), cities, companies, and individuals that excel in improving utility relocation and accommodation practices and demonstrate exemplary implementation on surface transportation improvement projects.

The Michigan Department of Transportation (MDOT) was recognized for innovation in the category Projects Under $100 Million in the 2007 Excellence in Utility Relocation and Accommodation Awards. When replacing the I–96 bridge (shown here) in Kent County, MDOT achieved significant cost savings by using a sensing device and alarm attached to the crane to facilitate construction around active utility lines. *Photo: MDOT Grand Rapids Construction Office.*

The 2007 awards recognize outstanding innovations that have advanced FHWA policies significantly. This year's winners demonstrate exemplary practices in five categories: Incentives for Utility Relocation, Innovation, Project Management, Leadership, and Outstanding Individual Contributions. The award recipients were honored during the American Association of State Highway and Transportation Officials/FHWA 2007 Right of Way and Utility Subcommittee Conference in Orlando, FL, from April 29–May 3, 2007.

To read more about innovative programs, procedures, practices, technologies, teamwork, collaborative efforts, and projects from around the country, download the awards brochure at www.fhwa.dot.gov/utilities/2007awards.pdf.

Policy and Legislation

New Freight Program Will Allow U.S. Trucks Into Mexico

During a visit to truck inspection facilities in El Paso, TX, in February 2007, USDOT officials announced that U.S. trucks will, for the first time, be allowed to make deliveries in Mexico under a yearlong pilot program to expand cross-border trucking operations. U.S. trucking companies will be able to make deliveries into Mexico while a select group of Mexican trucking companies will be allowed to make deliveries beyond the 32–40 kilometer (20–25 mile) commercial zones currently in place along the Nation's southwestern border.

It was noted that USDOT has put in place a rigorous inspection program to ensure the safe operation of Mexican trucks crossing the border. U.S. inspectors will conduct inperson safety audits to ensure that participating Mexican companies comply with U.S. safety regulations.

The new demonstration program was designed to simplify a process that currently requires Mexican truckers to stop and wait for U.S. trucks to arrive at the border and transfer cargo. This process wastes money, increases the

cost of goods, and leaves trucks loaded with cargo idling inside U.S. borders. Additionally, under current rules, U.S. trucks are not allowed into Mexico because the United States did not implement the safe cross-border trucking provisions of the North American Free Trade Agreement.

Following the February visit, USDOT published additional details about the safety standards and inspection program in the *Federal Register* on June 8, 2007. The notice includes comprehensive information about the program, including pre-authorization safety audits of Mexican trucking companies conducted by U.S. auditors in Mexico. The notice also details specific measures already in place to protect public health and safety—including roadside inspections, safety ratings, compliance reviews, hours-of-service rules, and civil penalties—as well as English-language proficiency requirements and a review of U.S. motor carrier safety laws and corresponding Mexican regulations.

For more information, visit http://dmses.dot.gov/docimages/p101/472439.pdf.

Technical News

USDOT Announces New Life-Saving Technology for Vehicles

In a move that could ultimately save up to 10,000 lives each year on U.S. roadways, the Nation's top transportation official announced plans to make new crash prevention technology standard equipment on every new passenger vehicle sold in America by 2012. On April 5, 2007, during a tour with automakers at the New York International Automobile Show, USDOT officials announced the final rule to require Electronic Stability Control (ESC) on all new passenger vehicles. ESC uses automatic computer-controlled braking to keep drivers from losing control on slippery roads or in emergency maneuvers, with the potential in many cases to prevent deadly rollovers.

USDOT officials likened the ESC technology to airbags and seatbelts in its capacity to save lives.

The final rule will require all manufacturers to begin equipping passenger vehicles with ESC starting with model year 2009 (September 2008) and to have the feature available as standard equipment on all new passenger vehicles by the 2012 model year (September 2011). The agency estimates ESC will save between 5,300 and 9,600 lives annually and prevent between 156,000 and 238,000 injuries. The estimated average cost of ESC is approximately $111 per vehicle, assuming the model already features antilock brakes.

The final rule and the accompanying regulatory analysis are available at www.safercar.gov/esc/Rule.pdf. For more information on ESC technology, visit http://nhtsa.gov/portal/site/nhtsa/menuitem.012c081c5966f0ca3253ab10cba046a0.

ROBOFlagger™ Takes a Stand for Work Zone Safety in Washington State

A new kind of worker recently joined the ranks of the Washington State Department of Transportation's (WSDOT) construction crews: the ROBOFlagger™. Remotely controlled by a human flagger behind traffic safety barriers, ROBOFlagger is an automated flagging device that features red and yellow lights and a gate arm that lifts and lowers. The device is WSDOT's latest tool to make work zones safer for both drivers and crews by removing human flaggers from the direct line of traffic.

In March 2007, WSDOT tested the ROBOFlagger for the first time on a construction project where crews installed 1.9 kilometers (1.2 miles) of guardrail on U.S. 2 just west of Monroe, WA. Workers closed one lane of U.S. 2 each night while a pair of ROBOFlaggers helped alternate traffic through the work zone.

WSDOT

The ROBOFlagger, shown here, enables WSDOT flaggers to direct traffic from a safe distance away from the direct line of traffic.

"This is a great project for us to test out the ROBOFlagger," says Carl Barker, assistant project engineer. "We're working at night, when visibility is low, and we're alternating traffic on a two-lane highway. We'll be able to see how the ROBOFlagger works in these conditions, and how drivers and our crews respond to it."

As they are for other States, work zones are a real concern for WSDOT. Between 1999 and 2005, there were 47 work zone deaths in Washington State and 4,444 work zone injuries. Speeding and inattentive driving are two major reasons for work zone collisions, and flaggers are the most at-risk workers.

For more information on the U.S. 2 project and the ROBOFlagger, visit the WSDOT Web site at www.wsdot.wa.gov/News/2007/02/27_Roboflagger.htm.

WSDOT

Public Information and Information Exchange

TRB Offers State DOT Research Projects Online

The Transportation Research Board (TRB) recently created a new Web site as part of its Research in Progress (RiP) database. The site, found at http://rip.trb.org/browse/lmap.asp, enables users to easily find transportation research projects initiated by individual States.

The RiP database is populated, in part, by authorized users from each State DOT. The database now contains more than 9,500 current or recently completed national and international transportation research projects. In addition to the new State-specific information, the RiP Web site enables users to search the entire database by various fields, browse project records by subject, use a directory to search for individuals and organizations, and subscribe to receive e-mail notification of new RiP records in specific subject areas.

TRB

NATIONAL HIGHWAY INSTITUTE

Training Update

by John J. Sullivan IV

Improving Program Delivery at NHI

Throughout its 37-year history, the National Highway Institute (NHI) has strived to provide high-quality training that addresses the full life cycle of the highway transportation system. Over the years, with the development of new technologies and training strategies, NHI has adapted and adopted industry best practices to continue improving its offerings, delivery mechanisms, and customer satisfaction. In 2005, NHI conducted several focus groups to solicit feedback from customers, and over the last 2 years, the training program initiated a series of key program improvements.

Pursuing continuous improvement on courses and instruction. In 2006, NHI began using scannable evaluation forms and online host surveys to enable course participants and hosting organizations to provide feedback on NHI courses and instructors. By monitoring this valuable feedback, NHI stays abreast of customer satisfaction and identifies potential for improvement. "We apply the feedback by updating courses and working with instructors to improve delivery," says Ann Gretter, NHI marketing director. NHI shares summaries of customer satisfaction and instructor satisfaction with the transportation training community via its quarterly e-newsletter *Learning in Progress.*

NHI is proud to report that in fiscal year 2007, it averaged 4.31 on a 5-point scale for course satisfaction and 4.42 on a 5-point scale for customer satisfaction with NHI instructors. In addition, in 2006, NHI increased the number of instructor-led training sessions held across the United States by 12 percent.

Offering low-cost transportation training. According to NHI research, one of the most common reasons transportation professionals cite for why they are unable to attend its courses is because of travel costs and scheduling issues. To reduce costs and save customers time, NHI modernized its distance learning platforms by implementing Adobe® Acrobat® Connect™ and Adobe® Presenter. This technology is helping NHI expedite development of more learning content, and NHI now is expanding the distance learning opportunities. Currently NHI offers seven Web-based and Web-conference training modules and plans to launch at least 10 more over the next year. Current distance learning opportunities are listed on the homepage of the NHI Web site.

Improving communication about new and updated courses. In 2006, NHI launched 24 new courses and updated 5 existing offerings. To ensure that the transportation community is aware of new and updated trainings, NHI now lists new courses prominently on its homepage, distributes one-page course summaries broadly to the transportation training community, and places new course announcements in transportation-related publications such as PUBLIC ROADS and *Focus.*

NHI now offers certificates of accomplishment to help transportation professionals like this one receiving a certificate hone their skills in select disciplines.

Providing new tools and resources via the NHI Web site. Based upon customer and partner feedback, NHI recently modernized its Web site. Customers now can purchase materials via the NHI store using credit card payment. Organizations hosting courses now have the option to sell "public seats" so customers can enroll in sessions and pay online. In addition, new "advanced search" features enable site visitors to tailor their inquiries to new parameters such as searches by State, session location, knowledge level, and date ranges.

Providing recognition for customers' ongoing professional development. In 2006, NHI began offering certificates of accomplishment to support transportation professionals as they learn, build, and refine their skills in a variety of topic areas. The certificates of accomplishment represent suites of complementary NHI courses—bundled together—that enable participants to enhance their depth and breadth of knowledge and expertise in specific disciplines. NHI's first certificates of accomplishment are available in the areas of work zone safety, incident management, and relocation under the Uniform Act.

"The NHI training team is dedicated to serving the transportation community," Gretter says. "We encourage hosts, participants, and partners to continue providing feedback so we can address concerns and continue improving our training."

To provide comments to the NHI Training Team, please visit the NHI Web site at www.nhi.fhwa.dot.gov or e-mail nhitraining@dot.gov.

John J. Sullivan IV is associate editor for PUBLIC ROADS.

Internet Watch

by Brittany Boughter

Tools of the Traffic Analysis Trade

Using the appropriate tool effectively can make all the difference. When it comes to tackling the Nation's growing congestion problem, highway officials can use the "Traffic Analysis Tools" Web site, developed by the Federal Highway Administration's (FHWA) Office of Operations, to solicit guidance on choosing the right tool for the job. Available at http://ops.fhwa.dot.gov/trafficanalysistools/index.htm, the site offers information to help the transportation community evaluate, optimize, and simulate the operation of transportation facilities and systems.

The site features several traffic analysis tools—software-based analytical procedures and methodologies that support different aspects of traffic and transportation analysis. The tools can help evaluate innovative transportation management concepts, improve the decisionmaking process, decrease time and costs for evaluation and design, reduce risk and disruption to traffic caused by field experimentation, guide evaluation of design and operational improvements, and monitor the performance of transportation facilities and systems. The Web site houses the following products: Next Generation SIMulation (NGSIM), Dynamic Traffic Assignment (DTA), Corridor Simulation (CORSIM/TSIS), Intelligent Transportation Systems (ITS) Deployment Analysis Systems (IDAS), and the *Traffic Analysis Toolbox*.

The FHWA "Traffic Analysis Tools" Web site.

Fully Loaded Toolbox

In May 2006 *The Urban Transportation Monitor* conducted a national survey to obtain information and opinions on the best tools and resources in the urban transportation industry. The results, published in the June 9, 2006, issue, featured responses from transit, traffic engineering, and transportation planning staff, among others. When asked, "What do you consider to be the best handbook in the field of traffic engineering?" transportation professionals ranked FHWA's *Traffic Analysis Toolbox* in the top nine. Over a year later, the multivolume toolbox continues to serve the transportation industry with its guidance on traffic analysis tools and the challenges and limitations of using each one.

Site visitors can download and reference all three volumes—*Traffic Analysis Toolbox Volume I: Traffic Analysis Tools Primer* (FHWA-HRT-04-038), *Traffic Analysis Toolbox Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools* (FHWA-HRT-04-039), and *Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software* (FHWA-HRT-04-040).

"A Microsoft® Excel® file automates the decision process associated with the second volume, making the framework useful for other traffic studies and features," says Grant Zammit, an FHWA traffic management/system operations specialist. "The third volume provides a framework or process that follows a statement of work built around seven tasks to support the effective application of microsimulation."

Market-Ready Applications

The "Traffic Analysis Tools" Web site also hosts two market-ready technologies, DYNASMART-P and IDAS. DYNASMART-P is a dynamic traffic assignment analysis tool that operates on the Microsoft® Windows® platform. Transportation engineers and planners can use DYNASMART-P to address complex operations and planning issues. DYNASMART-P also overcomes the limitations of traditional static assignment and simulation models by using advanced traffic modeling techniques to capture the dynamics of congestion formation and dissipation associated with variations in time and network conditions. IDAS is software developed by FHWA for use in planning ITS deployments. State, regional, and local planners can use IDAS to estimate the benefits and costs of ITS investments. IDAS can predict relative costs and benefits for more than 60 types of ITS investments.

"We currently are developing an overview presentation that will focus on the benefits of traffic analysis and include references to the market-ready technologies DYNASMART-P and IDAS," Zammit says.

Tried and True

Future upgrades to the Web site will offer testimonials from practitioners and decisionmakers on how these traffic analysis tools have benefited their efforts. According to Zammit, the tools available on the site equip the transportation community to address the Nation's congestion problem. "The 'Traffic Analysis Tools' Web site," he says, "provides techniques that support traceable, reproducible, credible, and effective decisions."

To view the "Traffic Analysis Tools" Web site, visit http://ops.fhwa.dot.gov/trafficanalysistools/index.htm. For more information, contact Grant Zammit at 404-562-3575 or grant.zammit@fhwa.dot.gov.

Brittany Boughter is a contributing editor for PUBLIC ROADS.

Communication Product Updates

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

Below are brief descriptions of products recently developed by the Federal Highway Administration's (FHWA) Office of Research, Development, and Technology. All of the reports are or will soon be available from the National Technical Information Service (NTIS). In some cases, limited copies of the communications products are available from the FHWA's 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 R&T publications from FHWA, visit FHWA's Web site at www.fhwa.dot.gov, the Turner-Fairbank Highway Research Center's Web site at www.tfhrc.gov, the National Transportation Library's Web site at http://ntl.bts.gov, or the OneDOT information network at http://dotlibrary.dot.gov.

Seismic Retrofitting Manual for Highway Structures: Part 1—Bridges
Publication No. FHWA-HRT-06-032

This report is the first of a two-part publication entitled *Seismic Retrofitting Manual for Highway Structures.* Part 1 of this manual draws from previous FHWA publications on this subject, including *Seismic Retrofitting Manual for Highway Bridges* (FHWA-RD-94-052), published in 1995. Revisions to the 1995 manual include current advances in earthquake engineering, field experience with retrofitting highway bridges, and the performance of bridges in recent earthquakes. The report is the result of several years of research, with contributions from a multidisciplinary team of researchers and practitioners.

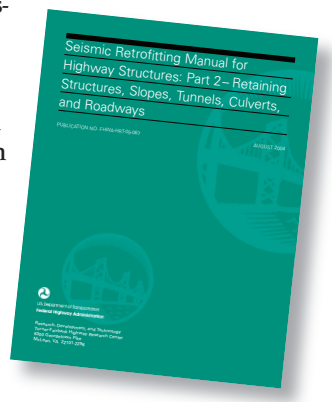
In particular, a performance-based retrofit philosophy is introduced similar to that used for the performance-based design of new buildings and bridges. Included are performance criteria for two earthquake ground motions with different return periods, 100 and 1,000 years. In terms of earthquake ground motion, the event with the lower-level motion and short return period requires a higher level of performance than the event with the upper-level motion and longer return period. The publication recommends performance criteria according to bridge importance and anticipated service life, with more rigorous performance required for important, relatively new bridges, than for standard bridges at the end of their useful life.

The report gives minimum recommendations for screening, evaluating, and retrofitting according to an assigned Seismic Retrofit Category. Bridges in Category A need not be retrofitted, whereas those in Category B may be assessed without a detailed evaluation, provided they satisfy certain requirements. Bridges in Categories C and D require more rigorous consideration and retrofitting. The report also describes various retrofit strategies and explains a range of related retrofit measures in detail, including restrainers, seat extensions, column jackets, footing overlays, and soil remediation.

The NTIS order number for this publication is PB2007-109043.

Seismic Retrofitting Manual for Highway Structures: Part 2—Retaining Structures, Slopes, Tunnels, Culverts, and Roadways
Publication No. FHWA-HRT-05-067

The second of a two-part publication entitled *Seismic Retrofitting Manual for Highway Structures,* Part 2 includes new procedures for determining the seismic vulnerability of important highway system structures—namely, retaining structures, slopes, tunnels, culverts, and roadways. Guidance provided includes instructions on screening for potential seismic vulnerabilities, conducting a detailed evaluation, and describing strategies for retrofit design. In addition, discussion classifies each structure by type, construction, or expected performance. The discussion benefits transportation personnel because different types of a given structure (e.g., different types of retaining walls) may have different failure modes, requiring somewhat different approaches to seismic vulnerability screening, detailed evaluating, and retrofitting.



The NTIS order number for this publication is PB2007-109044.

Material Property Characterization of Ultra-High Performance Concrete
Publication No. FHWA-HRT-06-103

Ultra-high performance concrete (UHPC) exhibits exceptional strength and durability characteristics that make it well suited for use in highway bridge structures. This material can exhibit compressive strength of 193 mega-

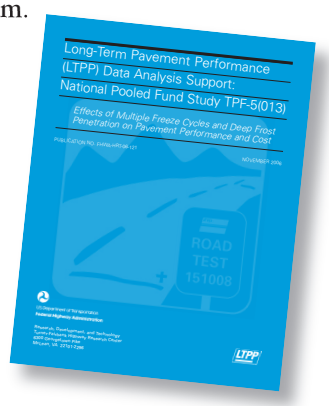
pascals, MPa (28 kilopounds per square inch, ksi), tensile strength of 9.0 MPa (1.3 ksi), significant tensile toughness, elastic modulus of 52.4 gigapascals, GPa (7.6 ksi), and minimal long-term creep or shrinkage. It also can resist freeze-thaw and scaling conditions with virtually no damage, and it is nearly impermeable to chloride ions.

This report presents the results from a large suite of material characterization tests completed to quantify the behaviors of commercially available UHPC. The characteristics captured within UHPC fall under four different curing regimes. This study focused on strength-based behaviors (e.g., compressive and tensile strength), long-term stability behaviors (e.g., creep and shrinkage), and durability behaviors (e.g., chloride ion penetration and freeze-thaw).

The document is available online at www.tfhrc.gov/structur/pubs/06103/index.htm. The NTIS order number for this publication is PB2007-101935.

Long-Term Pavement Performance (LTPP) Data Analysis Support: National Pooled Fund Study TPF-5(013): Effects of Multiple Freeze Cycles and Deep Frost Penetration on Pavement Performance and Cost
Publication No. FHWA-HRT-06-121

The objectives of this study are to: (1) quantify the effects of frost penetration on pavement performance in climates with deep sustained frost compared to environments with multiple freeze-thaw cycles; (2) investigate the effect that local adaptations have on mitigating frost penetration damage; and (3) estimate the associated cost of constructing and maintaining pavements in freezing climates. The approach consisted of modeling various pavement performance measures using both climatic and nonclimatic input variables and performance data collected as part of the LTPP program.



The publication defines five climatic scenarios in terms of climatic input variables for the models. The study predicts performance measures for each of the climatic scenarios and compares performance at a 95-percent confidence interval to determine statistically significant differences. Participating pooled fund States discussed standard specifications, standard designs, average life expectancies, and construction costs specific to each State highway agency (SHA). These data, along with information acquired through literature review of SHA standard practices, also summarize the mitigation of frost-related damage. Discussion and comparison of the life-cycle cost analysis for each climatic scenario uses predicted performance to determine average life and average agency construction costs for standard pavement sections. The study also includes an explanation of the use of performance models for local calibration as required in the National Cooperative Highway Research Program *Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures*, along with the possible application of the performance models in pavement management systems.

The document is available online at www.fhwa.dot.gov/pavement/ltpp/pubs/06121/index.cfm. The NTIS order number for this publication is PB2007-103344.

Conferences/Special Events Calendar

Date	Conference	Sponsor	Location	Contact
November 7–9, 2007	International Conference on Optimizing Paving Concrete Mixtures and Accelerated Concrete Pavement Construction and Rehabilitation	Federal Highway Administration (FHWA), Transportation Research Board (TRB), American Association of State Highway and Transportation Officials, American Concrete Pavement Association, Cement Association of Canada, Concrete Reinforcing Steel Institute, Georgia Department of Transportation, International Society for Concrete Pavements, and Portland Cement Association	Atlanta, GA	Shiraz Tayabji 410-997-0400 stayabji@CTLGroup.com www.fhwa.dot.gov/pavement/concrete/2007CPTPconf.cfm
December 2–4, 2007	Transportation Finance Summit	International Bridge, Tunnel and Turnpike Association	Washington, DC	Cheryle Arnold 310-260-4792 carnold@ibtta.org www.ibtta.org/Events/eventdetail.cfm?ItemNumber=2398
December 5–7, 2007	2nd Annual National Urban Freight Conference 2007	U.S. Department of Transportation METRANS Transportation Center, and California Department of Transportation	Long Beach, CA	Marianne Venieris 562-985-2877 mvenieris@uces.csulb.edu www.metrans.org/nuf/2007
January 13–17, 2008	TRB 87th Annual Meeting	TRB	Washington, DC	Linda Karson 202-334-2934 lkarson@nas.edu www.trb.org/meeting
February 3–5, 2008	2008 National Conference of Regions	National Association of Regional Councils	Washington, DC	Fred Abousleman 202-986-1032 fred@narc.org www.narc.org
March 2–5, 2008	GeoAmericas 2008—The First Pan-American Geosynthetics Conference and Exhibition	International Geosynthetics Society, Industrial Fabrics Association International, and North American Geosynthetics Society	Cancun, Mexico	Beth Wistrcill 651-225-6956 bbwistrcill@ifai.com www.geoamericas.info
March 9–12, 2008	GeoCongress 2008: The Challenge of Sustainability in the Geoenvironment	Geo-Institute of the American Society of Civil Engineers and TRB	New Orleans, LA	Prof. Krishna Reddy 312-996-4755 kreddy@uic.edu http://content.asce.org/conferences/geocongress2008/index.html
March 30–April 2, 2008	ITE 2008 Technical Conference and Exhibit	FHWA and Institute of Transportation Engineers (ITE)	Miami, FL	Heather Talbert 202-289-0222 ext. 138 htalbert@ite.org www.ite.org/meetcon/index.asp

2008

FHWA & FTA Transportation Planning Excellence Awards

Cosponsored by the American Planning Association

The Federal Highway Administration and Federal Transit Administration's 2008 Transportation Planning Excellence Awards Program

Nominations are sought for the 2008 Transportation Planning Excellence Awards Program. This is your opportunity to recognize outstanding projects, processes, groups, or individuals across the country for their work in developing, planning, and implementing innovative transportation planning practices.

Award categories:

- Education and Training
- Freight Planning
- Homeland and Personal Security
- Linking Planning and Operations
- Modeling and Technology Applications
- Planning Leadership
- Public Involvement and Outreach
- Safety Planning
- Transportation and Land Use Integration
- Transportation Asset Management Program
- Transportation Planning and Environment
- Tribal Transportation Planning

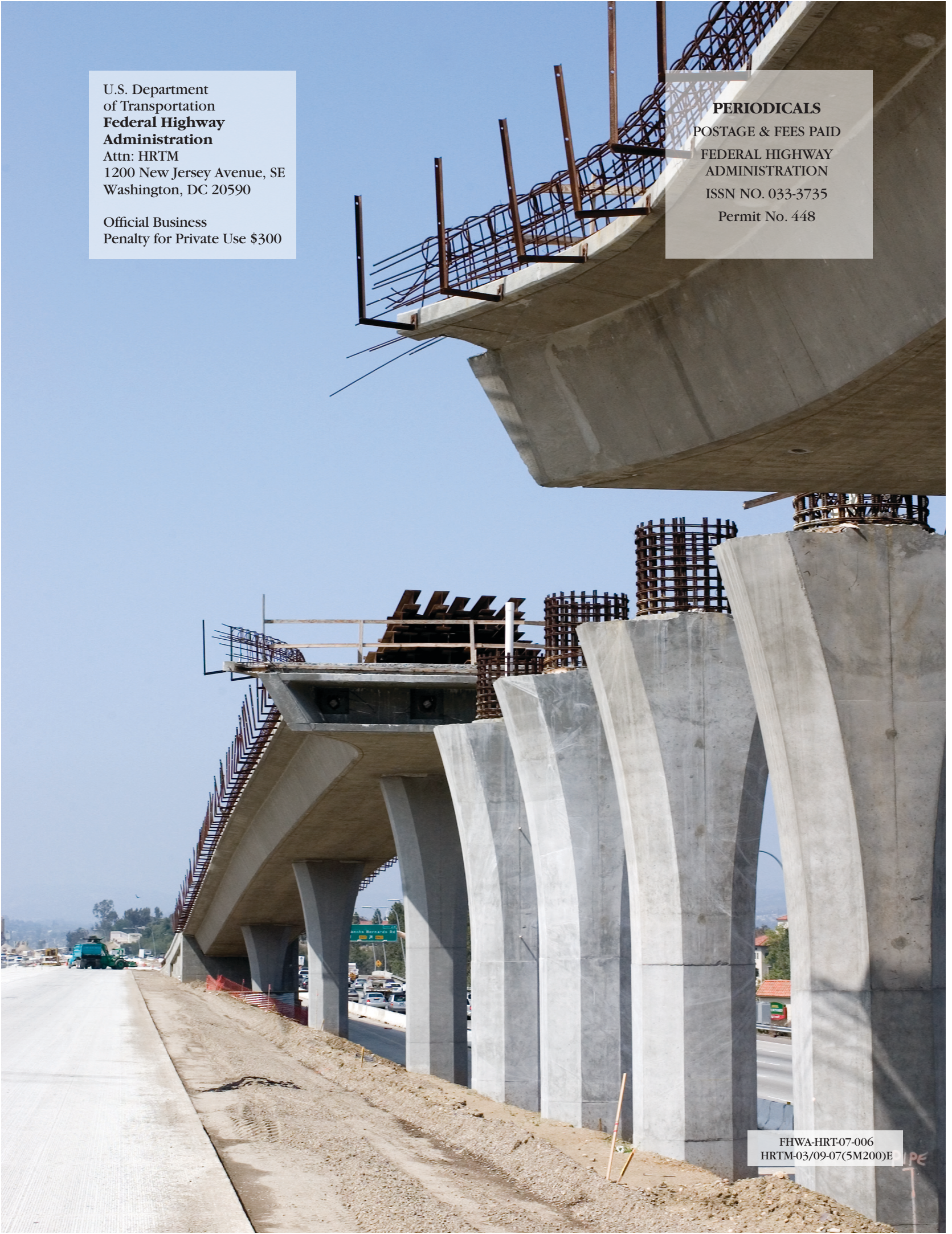
Entries will be judged on the basis of:

- Innovation
- Community and Public Involvement
- Partnerships and Collaboration
- Multimodalism
- Equity
- Sustainability
- Demonstrated Results/Effectiveness/ Replication/Transferability

Winning entries will be selected by an independent panel of judges representing diverse backgrounds and expertise. Entries and all supplemental materials must be submitted by February 29, 2008. Awards will be presented in the summer of 2008.

Additional information is available at **www.fhwa.dot.gov/planning/tpea/index.htm.**

For further information, call the FHWA Office of Planning at 202–366–0106 or the FTA Office of Planning & Environment at 202–366–5653.



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