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INNOVATOR

Accelerating Innovation for the American Driving Experience

The safety edge calls for a tapered edge between the pavement and the graded shoulder.

Inside This Issue:

Safety Edge Catches On as Life-Saving Technique

An asphalt paving technique called the safety edge is gaining momentum across the country as state transportation departments strive to protect motorists from run-off-the-road crashes. The Federal Highway Administration recommends that states use the safety edge technique—particularly on two-lane roads with unpaved shoulders.

The safety edge calls for the interface between the roadway pavement or paved shoulder and the graded shoulder to be paved at an optimal angle to minimize vertical drop-off and provide a safer roadway edge. In other words, the edge of the pavement tapers down into the shoulder instead of dropping off vertically. The recommended angle of the taper is about 30 to 35 degrees from horizontal.

The newest Highways for LIFE Vanguard Technology, the safety edge is not an extra procedure, but merely requires a slight change in the

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Simple Bridge Design Uses High-Performance Materials

A simplified design for a bridge on a rural road in Vermont is expected to produce a structure that will last 80-plus years, cut construction time by reducing activities to a bare minimum and lessen maintenance needs. The public will benefit from the faster construction time, lower maintenance costs and improved safety of a wider bridge.

The $2.84 million bridge project, on U.S. Route 2 over the Winooski River in East Montpelier, received a Highways for LIFE grant of $568,255 because of its innovations and reduced construction time. The balance of the project is being funded with federal economic stimulus funds through the American Recovery and Reinvestment Act of 2009.

"Our goal is to simplify the design to the greatest extent possible while using high-performance materials, resulting in a structure that takes less time to construct and requires less maintenance," said Mark Richter, construction maintenance engineer with the Federal Highway Administration's Vermont Division.

He said the simpler design results in fewer construction activities and a shorter construction time, reducing

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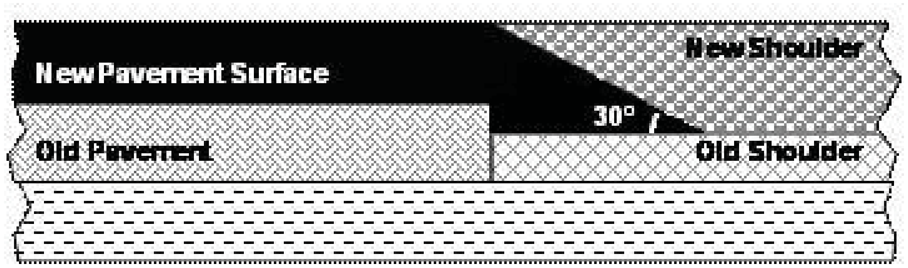


On the safety edge, the pavement tapers upward from the edge at a 30-to 35-degree angle.

paving equipment and has little impact on project costs. In addition, the safety edge improves the consolidation of the pavement near the edge, enhances pavement durability, and mitigates pavement drop-off until the contractor can pull the graded shoulder up over the tapered edge.

The Vanguard Technology initiative uses dedicated teams, marketing techniques and designated funding to deploy high-payoff innovations quickly and broadly. The safety edge team is developing a marketing plan with goals, implementation tactics and communication tools to move the technology into mainstream use across the country. Other Vanguard Technologies are road safety audits, prefabricated bridge elements and systems, precast concrete pavement systems and techniques for making work zones work better.

Fewer Fatalities

"We believe the safety edge is a focused solution that will reduce fatalities on rural two-lane roads where run-off-the-road crashes are most prevalent," said Chris Wagner, pavement and materials engineer at the FHWA Resource Center. "The safety edge also shows great promise in increasing the durability of the outside pavement edge, thereby increasing the service life of the pavement."

Wagner estimates that the safety edge has been used by about 15 state departments of transportation, including those in Alabama, California, Georgia, Indiana, Iowa, Missouri, New York, Texas and Utah. "We recently completed a demonstration project in Iowa, and they now want to use it on two more projects," said Wagner. "And the Georgia DOT uses it on all their overlay projects."

Crash data show that roadway departures account for 53 percent of fatal crashes. When a tire drops off a paved surface, sometimes just inches from the travel lane, a driver can have difficulty reentering the roadway if the pavement edge is nearly vertical—especially if the height difference is significantly more than 2 inches (50.8 millimeters). When the driver drifts off the pavement and tries to steer back on, the nearly vertical edge can cause "tire scrubbing," a condition that may result in oversteering. The driver can lose control of the vehicle and crash into oncoming traffic, roll over or hit a fixed object.

Safety Edge Evolution

The safety edge concept was developed in 2003 through discussions between Wagner and Frank Julian of the FHWA Resource Center's Safety and Design team. Previous research by a Texas Transportation Institute team led by Dr. Don Ivey indicated that a tapered transition between the paved roadway and the unpaved shoulder would help errant vehicles maintain control as they reenter the travel lane.

Wagner and Julian began formulating ideas on how to create such a tapered edge at the pavement–graded shoulder interface. Wagner had experience at the National Center for Asphalt Technology with using a tapered wedge concept to create longitudinal joints in asphalt pavements along the lane line joint. That experience provided a starting point for developing the safety edge.

At that point, Wagner and Julian began partnering with the Georgia DOT Office of Maintenance. Office staff such as Director Bryant Poole and Project Manager Lynn Bean were involved in the design and planning of a project to study the constructability of a safety edge on a resurfacing project.

Poole was instrumental in planning and coordinating the project, and Bean was a key player in building the project and developing the hardware the Georgia DOT used to form the safety edge. Industry was also a partner in the concept, and two companies now produce and sell a shoe that attaches to the paver and forms the safety edge.

For more information on the safety edge, go to safety.fhwa.dot.gov/roadway_dept/pavement/fhwasa09023.

You can also contact Frank Julian at (404) 562-3689 or frank.julian@dot.gov, Chris Wagner at (404) 562-3693 or christopher.wagner@dot.gov, or Cathy Satterfield at (708) 283-3552 or cathy.satterfield@dot.gov.

An excavator fitted with a hydraulic hammer demolishes the old bridge.

traffic disruption by two months. The project also replaces a functionally obsolete bridge, trimming Vermont's inventory of deficient bridges.

The new bridge will be a single 122-foot (37-meter) span integral abutment bridge. The roadway will consist of two 12-foot (3.6-meter) driving lanes with a 10-foot (3-meter) shoulder on each side.

Construction of the bridge is expected to take 120 days, enabling the state to open it to traffic in one construction season. The entire project, which will require more time for completion of additional construction activities, is scheduled to finish in June 2010.

Integral Abutment

With an integral abutment, the deck and backwall for the steel girders will be cast as one monolithic concrete section. The ends of the steel bridge girders will be cast into the backwall.

Integral abutments, Richter said, are a relatively new development in bridge design. They have no expansion joints between the girders and the abutment, and no bearing pads for the beams to rest upon. Historically, bridge expansion joints have been a high-maintenance item and a source of intrusion for corrosive deicing chemicals.

The superstructure will use five weathering steel girders (no paint) with a bare (no membrane or overlay) high-performance concrete deck reinforced with solid stainless steel rebar. There will be no curbs and the bridge railing system will be pedestal-mounted.

The result, according to the Vermont Agency of Transportation's Highways for LIFE grant application, will be "a bridge with no deck membrane and pavement that can rut and pothole, no joints that can fall into disrepair and leak, no scuppers that can clog, no curbs that will retain salt-laden runoff and accelerate deck deterioration, no bearings that can corrode and freeze, and no beam paint system that can fail. Ideally, this is a bridge built without most of the items that so often require significant maintenance."

Traditionally, Vermont has used a hot-mix asphalt pavement overlay and a membrane to protect bridge decks from salt corrosion. When bridge decks are salted in the winter, the chloride can penetrate the concrete, reach the carbon reinforcing steel and corrode it. The standard treatment is to use a torch-applied membrane with a hot-mix asphalt overlay on the membrane. In the past couple of years, VTrans has been reevaluating its pavement and membrane policy and is considering the use of "bare" concrete decks for some bridges.

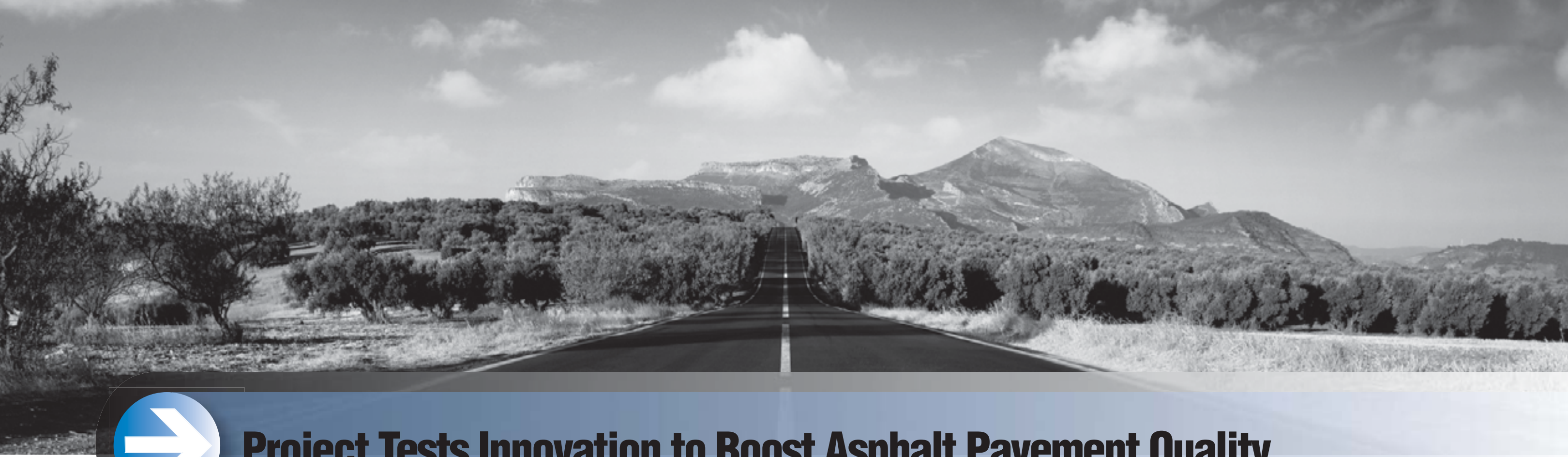
High-Performance Concrete

This new deck will consist of concrete containing fly ash, a cementitious material that reduces the permeability of the deck. VTrans has run tests to optimize the mix design of the high-performance concrete, Richter said. Through the mix design process, the agency found that just fly ash can be used, no silica fume, to optimize the performance of the high-performance concrete on this project.

Typically on bridges like this, VTrans uses a two-rail curb-mounted steel bridge rail. Such a design requires the use of curbs, which adds construction time because the deck must cure before the contractor can add the curbs. But this bridge will have no curbs; water will simply wash off the deck. The bridge will use the New York three-rail flush-mount rail to simplify construction and eliminate the need for through-deck scuppers.

The bridge could be a prototype for other rural bridges over streams and rivers—places with no people, automobiles or railroads underneath, said Richter. For bridges with traffic underneath, engineers must design to control the water to keep icicles from forming and dropping onto traffic below.

For more information, contact Mark Richter at (802) 828-4423 or mark.richter@fhwa.dot.gov.



Project Tests Innovation to Boost Asphalt Pavement Quality

Good compaction of newly applied hot-mix asphalt helps assure a crack-free paved surface and longer-lasting roadway, but in the past compaction was tested on hardened asphalt. A new device, undergoing tests under a Federal Highway Administration program, analyzes compaction during the paving process so problems can be fixed while the asphalt is still pliable.

Highways for LIFE provided a grant to Haskell Lemon Construction Co. of Oklahoma City, Okla., to refine and test its Intelligent Asphalt Compaction Analyzer. The project is part of the Technology Partnerships program, which offers funds to private industry to move innovations with potential to boost highway quality or safety or cut construction congestion from late-stage prototypes to commercial products.

The analyzer, designed to fit on a vibratory compactor, consists of sensors and computational devices that measure the density of the warm asphalt pavement layer in real time, according to Dr. Sesh Commuri, associate professor of engineering at the University of Oklahoma, who developed the concept.

Using neural network technology, a data modeling approach that mimics biological nervous systems, the system analyzes patterns in the vibration of the rollers on the compaction equipment to determine the compaction level being achieved. By viewing information displayed on a monitor, the equipment operator can adjust the compaction level during the paving process, which saves time, labor and money.

"It takes the guesswork out of the job," Commuri said. "The operator can make any necessary adjustments before the road is complete, which potentially improves its quality."

Working with Haskell Lemon and Volvo Road Machinery of Shippensburg, Pa., Commuri developed a research prototype of the compaction analyzer. Initial test results showed that the asphalt density estimated by the system compared well with density measured in cores extracted from hardened asphalt mix, a traditional method for verifying asphalt compaction.

Commercial Prototype

The first phase of evaluation under the Technology Partnerships program involved developing and testing a commercial prototype of the compaction analyzer on Oklahoma Department of Transportation construction projects. The project team identified an electronic control module in a rugged enclosure suitable for long-term use on paving jobs and integrated the software application.

The team added a temperature sensor, odometer, vibration switch, travel direction sensor and GPS sensor to the system and incorporated an automatic calibration system. It also developed a user display so the equipment operator could visually monitor compaction progress in real time.

The prototype was tried out during the construction of hot-mix asphalt pavements at five locations across Oklahoma. The sites, chosen to represent typical projects, involved full-depth construction as well as rehabilitation of existing pavements. The projects also featured a variety of soil types and asphalt mixes.

The field tests evaluated the ease of calibrating the compaction analyzer and the accuracy of measurements compared to densities measured from cores extracted from the pavements. The evaluation found that the calibration procedures were easy for the equipment operator to use and the calibrated equipment could estimate asphalt mix density in real-time with an accuracy suitable for construction quality control in the field. Test results showed that the density estimated by the compaction analyzer compared well with the density measured from roadway cores, with a mean error of less than 1 pound per cubic foot.

Rigorous Tests

The second phase of testing, now under way, involves systematic, rigorous testing of the commercial prototype. Compaction analyzers were installed on five vibratory rollers for use by Haskell Lemon crews in Oklahoma. In addition, the analyzer is being tested on about 15 construction projects in states around the country.

As part of this testing phase, comparative studies are being conducted on the quality of construction with and without the use of the Intelligent Asphalt Compaction Analyzer technology. The impact of the technology on work crew productivity is also being analyzed.

The goal of the Technology Partnerships project, according to Commuri, is to develop what was once a research prototype into an easy-to-use, cost-effective commercial product that will save construction time and costs and result in longer-lasting asphalt pavement.

For more information on Technology Partnerships, visit www.fhwa.dot.gov/hfl/tech.cfm, or contact Julie Zirlin at (202) 366-9105 or julie.zirlin@dot.gov. For details on the Intelligent Asphalt Compaction Analyzer, contact Sesh Commuri at (405) 325-4302 or scommuri@ou.edu.

Photo credit: Haskell Lemon

The Intelligent Asphalt Compaction Analyzer measures asphalt pavement density in real time, allowing equipment operators to fix problems before the asphalt hardens.

Closer Look: Innovation Saved Time, Money on Virginia Project

A follow-up study on the Virginia Highways for LIFE project to replace and widen a half-century-old bridge found that accelerated construction techniques saved months of traffic backups and more than $2 million—about 58 percent—over the cost of conventional practices.

The project also met performance goals for safety, construction congestion and user satisfaction, according to *Virginia Demonstration Project: Rapid Removal and Replacement of U.S. 15/29 Bridge Over Broad Run Near Gainesville, VA*, a report on the 2008 project. The Virginia Department of Transportation used prefabricated bridge elements constructed off-site and assembled on-site during weekend closures to speed construction of the three-span, two-lane southbound bridge in a historic area near Washington, D.C.

Originally, the construction plan called for installing 12 prefabricated superstructure segments during 12 nighttime closures, during which one traffic lane would stay open. Concerns about the construction schedule and how the segments would fit together led the contractor to propose a new scheme: Set up two detour routes and replace the segments during three weekend full closures, one span per weekend.

The change got the project back on schedule and assured its on-time completion. Using full lane closures reduced risk because the prefabricated segments were fitted together one span at a time. And using full lane closures and prefabricated bridge elements instead of conventional construction techniques enabled the Virginia DOT to cut the impact on drivers from 100 days of navigating a work zone to three weekends of traveling on detours.

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Roundabouts enhance safety and cut congestion at intersections by slowing vehicle speeds and reducing traffic conflict points.

Web Seminar Explains Modern Roundabouts

The roundabout of today is different from older types of circular intersections, different even from roundabouts of a decade ago as practices for this modern intersection continue to evolve.

A Web conference, part of the monthly "Innovations" series sponsored by Highways for LIFE and the National Highway Institute, explained roundabouts, including what operational advantages they provide, when they are appropriate alternatives to traffic signals and stop signs, and how transportation professionals can overcome implementation barriers and negative public perceptions about roundabouts.

Modern roundabouts are safer for a variety of reasons, Mark Doctor, safety and geometric design engineer with the Federal Highway Administration Resource Center, told seminar participants. One is the simple physics of slower entry speeds, which lessen the likelihood and severity of collisions, he said. Considering vehicle paths and the conflicts those paths create, a traditional intersection has 32 potential conflict points while a roundabout has just eight.

At a roundabout, entering traffic yields to traffic already in the circle and, when there's a gap, veers to the right to enter. Traffic then circulates counterclockwise around a center island to reach the desired exiting roadway and again veers right out of the circle. All movements are essentially made via right turns into and out of the one-way circulatory roadway. Eliminating the direct conflict from left turns provides a much safer intersection, Doctor said. A roundabout also has 50 percent fewer conflict points between vehicles and pedestrians, and those are at slower speeds.

Locations where roundabouts may be particularly appropriate, according to Doctor, include intersections with a high crash rate or higher crash severity; intersections with complex geometry, skew angles or more than four approaches; rural intersections with high-speed approaches; freeway interchange ramp terminals; closely spaced intersections; intersections with high U-turn movements; and intersections near schools.

Congestion Relief

In one case study, Brian Walsh, state traffic design and operations engineer with the Washington State Department of Transportation, described the experience of a high school with about 1,500 students. The road serving the school had a stop sign on the approach to a moderately busy five-lane arterial roadway.

With each student and bus driver attempting to enter the arterial from a stopped condition, it took a typical driver almost 20 minutes to exit the parking lot and turn onto the arterial, Walsh said. After a roundabout was built, the time for the typical driver to go the same distance and turn onto the arterial roadway dropped to between 45 seconds and 1.5 minutes.

While relieving congestion is important, safety is the number one priority for most state highway agencies, according to Walsh. "There are so many locations in this country where roundabouts would create instant safety benefits," he said. "Roundabouts can eliminate many safety issues almost entirely if designed correctly."

Citing statistics from before-and-after studies of roundabouts by the Insurance Institute for Highway Safety, Doctor indicated that roundabouts decrease total intersection vehicle crashes by 39 percent, injury crashes by 76 percent, and fatal or incapacitating crashes by 89 percent. Roundabouts also reduce traffic delays by 75 percent, the study found.

Public Perceptions

The public appreciates the advantages of roundabouts, but usually not at first, Doctor said. In one study Doctor cited, 78 percent of respondents had a negative or very negative perception (while 14 percent had a positive perception) before local roundabouts were built versus 0 percent negative or very negative (and 77 percent positive or very positive) afterwards.

Before local roundabouts were built, according to another study, 31 percent of drivers were in favor and 63 percent were strongly opposed. After roundabouts were in place, 63 percent favored the change and 15 percent were strongly opposed.

"Sometimes, to get your first roundabout project through it takes a little perseverance," Doctor said. "The lesson that has been learned is that you can expect public opposition, but once you get your first roundabout in, the subsequent ones come a lot quicker."

For more information on roundabouts, visit http://safety.fhwa.dot.gov/intersection/roundabouts. It includes a link to "Roundabouts: A Safer Choice" (FHWA-SA-08-006), an informational brochure geared to the public.

To register for future "Innovations" Web conferences and view recordings of past sessions, including the roundabouts seminar, go to www.nhi.fhwa.dot.gov/about/innovationseries.aspx.

Closer Look: Innovation Saved Time, Money on Virginia Project, continued

Cost Savings

A key aspect of Highways for LIFE demonstration projects is quantifying the value of the innovations used. An economic analysis of the Virginia project showed that using traditional construction methods would have cost about $262,100 less than accelerated construction techniques. In addition, using full lane closures over three weekends added $426,096 in vehicle operating costs.

But using accelerated construction techniques generated big savings in the cost of traffic delays that would have occurred using conventional techniques: about $2.7 million. That put the project's net savings at nearly $2.1 million, far greater than the cost increase for using prefabricated bridge elements.

In addition, the new bridge is expected to be more durable because it was built with prefabricated superstructure elements and high-performance materials, which should produce lower life-cycle costs for the bridge.

Project Goals

Highways for LIFE projects include performance goals in areas such as safety, congestion and user satisfaction. The goals define the desired result while encouraging innovative solutions, raising the bar in highway construction.

On the Virginia project, no worker injuries were reported during construction. Six incidents involving motorists with flat tires occurred during construction because of a temporary patch on the abutment backwall, but no injuries or other vehicle damage occurred. That means the project safety goals were met. In the future, the widened bridge deck and updated railings are expected to lower crash and injury rates.

The project far exceeded its goal to cut construction impact on motorists by 50 percent compared to traditional construction methods. Using conventional cast-in-place construction would have affected motorists for about 100 days and caused daily rush-hour backups of 1.5 to 2 miles (2.4 to 3.2 kilometers). Travel time studies showed that although the detours during the three weekends of full lane closures produced a delay of 9,461 vehicle-hours, it was significantly less than the 720,000 vehicle-hours of delay that would have resulted from conventional construction.

The project also achieved user satisfaction aims. The Virginia DOT worked closely with a local group, the Buckland Preservation Society, to address residents' concerns about the construction process and its effect on the area's historic integrity. The agency and society signed a memorandum of agreement requiring the use of accelerated construction methods for the bridge replacement. The bridge was widened toward the median rather than the outside edge to prevent extension of the existing bridge or roadway beyond the shoulder and into adjacent historic properties.

For more information on the Virginia and other Highways for LIFE demonstration projects, contact Mary Huie at (202) 366-3039 or mary.huie@dot.gov.

CALENDAR

American Association of State Highway and Transportation Officials Annual Meeting, Oct. 22–26, 2009, Palm Desert, Calif. Information at www.transportation.org/meetings/181.aspx.

Association of Metropolitan Planning Organizations Annual Conference, Oct. 27–30, 2009, Savannah, Ga. Register at www.ampo.org/content/index.php?pid=200.

Design-Build Conference and Expo, Nov. 5–7, 2009, Washington, D.C. Go to www.dbia.org/conferences/expo.

American Concrete Institute Fall Convention, Nov. 8–12, 2009, New Orleans, La. Information at www.concrete.org/Convention/Fall-Convention/Front.asp.

World Steel Bridge Symposium, Nov. 17–20, 2009, San Antonio, Texas. Details at www.aisc.org/contentNSBA.aspx?id=20090.

American Concrete Pavement Association Annual Meeting, Nov. 30–Dec. 4, 2009, Orlando, Fla. See www.acpa.org/Events_and_Programs/Events/46thAnnualMtg/index.html.

Transportation Research Board Annual Meeting, Jan. 10–14, 2010, Washington, D.C. Visit www.trb.org/AnnualMeeting2010/Public/AnnualMeeting2010.aspx.

Annual Transportation and Highway Engineering Conference and Exhibit, Feb. 23–24, 2010, Urbana, Ill. Information at www.theconf.com.

International Conference on Road Safety on Four Continents, March 22–24, 2010, Abu Dhabi, United Arab Emirates. Details at www.vti.se/templates/Page____11111.aspx.

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