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U.S. Department of Transportation
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Public Roads

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

July/August 2011 www.fhwa.dot.gov Vol. 75, No. 1

Articles

Page 2

Page 23

Page 30

Departments

Front cover—The Maine Department of Transportation used rigidified fiber reinforced polymer (FRP) tube arches, an emerging bridge technology, in the construction of the new Perkins Bridge in Belfast, ME, in 2010. Here, the composite arch tubes have been installed on concrete footings. Next, the arches will be topped with FRP deck panels and filled with self-consolidating concrete to create the arch bridge superstructure. For more information, see "Emerging Bridge Applications" on page 23 in this issue of PUBLIC ROADS. *Photo by Daniel J. Bannon, Advanced Infrastructure Technologies.*

Back cover—This aerial shows the rehabilitated Bridge of Lions in St. Augustine, FL. Before its renovation, the historic bridge was considered structurally deficient and functionally obsolete. The Florida Department of Transportation (FDOT) completed a major rehabilitation in 2010, which included replacing the superstructure, providing wider travel lanes, and installing handrails and light poles reminiscent of the originals from 1927. For more information, see "Preserving Yesterday While Designing for Tomorrow" on page 16 in this issue of PUBLIC ROADS. *Photo by Mark W. Toigo, FDOT. Aircraft courtesy of the St. Johns County, FL, Sheriff's Office.*

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Guest Editorial

Preserving History at FHWA

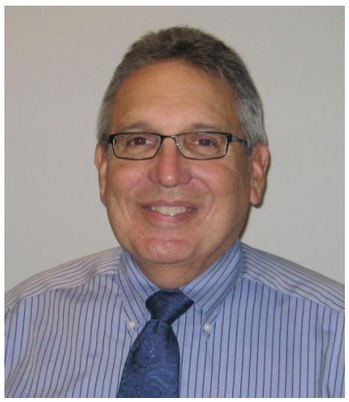
The recent history of the United States of America is one of pride in diverse cultures. For Native Americans, history and culture are especially intertwined. The Federal Highway Administration (FHWA) recognizes the importance of preserving that connection by ensuring that the requirements of the National Environmental Policy Act and The National Historic Preservation Act of 1966 are carried out on the Nation's transportation projects. These laws and their implementing regulations are intended to ensure the preservation of historical and sacred sites, while safeguarding the environment.

FHWA's Federal Lands Highway Program provides financial resources and transportation engineering services for the planning, design, construction, and rehabilitation of the highways and bridges that provide access to traverse Federal and tribal lands. The program's vision is to create the best transportation system while balancing the values attached to those lands.

Organizations such as the American Association of State Highway and Transportation Officials have critically acclaimed the program for innovations in the design and construction oversight of transportation projects so that they are built with minimum impact on the surrounding land, the cultural history, and the local environment. For example, Federal Lands undertook a project on the Hopi Reservation to remove overhanging and unstable rocks that threatened a community's only access road. The area was a sacred site, but with close cooperation and partnering with the Hopi leaders, the project was completed successfully.

One of the methodologies utilized by the Federal Lands Highway Program is context sensitive solutions. This collaborative, interdisciplinary approach requires that the design of a transportation project or facility fit its physical setting while preserving scenic, aesthetic, historic, community, and environmental resources.

Jointly administered by the Federal Lands Highway Program and the Bureau of Indian Affairs, the Indian Reservation Roads Program provides funding to tribes to carry out transportation projects. Currently, 565 tribes within the United States are federally recognized. The preservation of their tribal cultures is critical to the success of the design and construction of any project funded through the Indian Reservation



Roads Program. Since the passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, many tribes are carrying out their Indian Reservation Roads Program directly with FHWA. As a result, FHWA has become deeply involved with all aspects of tribal transportation.

For example, FHWA supports tribes in their road-building and maintenance activities through the Tribal Technical Assistance Program, which facilitates the transfer of valuable skills and knowledge to the tribal transportation workforce. FHWA also continues to play a role in the annual National Tribal Transportation Conference, which this year will be held in Nashville, TN, in November. (For more information on the conference, see the advertisement on the inside back cover of this issue.) Understanding, appreciating, and respecting tribal sovereignty and culture have never been more important.

For more on the importance of safeguarding cultural resources, see "Preserving Yesterday While Designing for Tomorrow" on page 16 in this issue of PUBLIC ROADS. The article provides insight into the tools and methods that various departments of transportation are using to help identify and protect cultural resources.

Native Americans have a history unlike any other in America, and their lands should always be considered sacred and sovereign whenever a project is undertaken on or near them.

Robert Sparrow
Indian Reservation Roads
Program Manager
Office of Federal Lands Highway
Federal Highway Administration

Growing Gracefully

by Gretchen Stoeltje

(Above) Hutto, TX's downtown East Street, as it looks today, with two-story commercial establishments, embodies the historical appearance that the city's leadership is trying to preserve, while accommodating the community's exponential population growth by making sustainable transportation improvements. *Photo: M Kim Soucek, TxDOT.* **(Inset) Hutto's downtown East Street in 1890.** *Photo: City of Hutto.*

A proactive approach to accommodating population increase is bringing sustainability and transportation improvements to small-town Texas.

Hutto is a formerly tiny farm town in central Texas with a population that numbered only 1,250 in the year 2000. Flat land, an affordable cost of living, and good schools make Hutto an ideal place to farm, live, and raise a family. However, Hutto is located more than 20 miles (32 kilometers) from the region's major workplaces in Austin and, a decade ago, was accessible mainly by congested Interstate 35 (I–35). Given these transportation difficulties of accessibility and congestion, Hutto did not attract many newcomers.

Change came when State and local planners, stakeholders, the public, and the Federal Highway Administration (FHWA) worked together to determine the final route for a new toll road, State Highway 130 (SH 130). The new highway now passes just 2 miles (3.2 kilometers) west of the downtown, and the intersection with U.S. 79 is the town's gateway. Hutto's new accessibility drew a flood of commuter residents, and by 2010 the Texas State Data Center estimated it was one of the fastest growing cities in the State, home to 17,227 people in 2006.

Hutto had become a bedroom community for central Texas workers looking for the fast-disappearing, small-town good life. Without new commercial or retail development, however, the town struggled to support its burgeoning population. In response, Hutto began to channel its growth, reorienting itself through a strategic, proactive planning process. That planning led to new design guidelines tailored to the community, new planning codes, and innovative agreements with developers. Armed with these tools, Hutto took on two significant challenges that other towns in the State may well face in the near future: a major population increase and a paradigm shift in transportation.

One of Hutto's guiding principles is to shift the balance between people and vehicles in the built environment. Practically speaking, that means planning mixed-use neighborhoods where residents can live and work without commuting long distances by car.

"What it means is traditional neighborhoods and transit-oriented development, with wide sidewalks, bicycle paths, and pedestrian trails," says Mary Meyland, director of the Office of Strategic Policy and Performance Management at the Texas Department of Transportation (TxDOT). "It means not having to drive to Austin or the nearby town of Round Rock for every daily need, and it means accommodating the single-occupant, combustion engine vehicle without being defined by it."

Monoculture Development

If the Hutto community initially did not hear opportunity knocking, housing developers did. From 2004 to 2007, Hutto boomed with new single-family residential housing. Cul-de-sacs and dead-end streets sprouted on former farmland. Until 2007, when development slowed somewhat, it was all the town could do to review subdivision permits, according to Matthew Lewis, the city's former director of community development.

Hutto's planning staff began to analyze the kind of growth that was changing the city. They commissioned the 2008 *Hutto, Texas Commuter Report*, which found that 89 percent of the town's residents were commuting to work an average of 44 miles (71 kilometers) round-trip every day.

The city planners realized that SH 130 had created the potential for massive economic development, but the growth so far was limited to single-family residential development. The town was attracting young middle-class families, but not their parents or grandparents and

Shown here is the intersection of U.S. 79 and SH 130, the new toll road.
Photo: Hutto Economic Development Corporation.

This typical car-dependent suburbia is what Hutto is trying to complement with new codes and ordinances for future development. *Photo: M Kim Soucek, TxDOT.*

not people to provide services to the families. Hutto offered reasonably priced housing but not enough commercial or retail businesses to develop the tax base a growing municipality needs for services and infrastructure. Monoculture development was threatening Hutto's ability to support its new population.

One Housing Option, Two Mobility Problems

Where Hutto had essentially one housing option, it had two related transportation problems. First, long commutes—mainly involving motorists traveling alone—impose a variety of costs on a community: Air quality declines because of carbon emissions, roads suffer wear and tear, and drivers lose time away from their families. The Hutto commuter report found that residents spent $50 per week on fuel, tolls, parking, and other expenses directly related to commuting. Furthermore, the commuters spent another $117 per week outside Hutto on meals, entertainment, services, and retail purchases.

Creating jobs in Hutto could help to staunch the flow of dollars out of the city as well as return personal time lost to commuting. It also might help to increase property values. A 2008 report, *Driven to the Brink: How the Gas Price Spike Popped the Housing Bubble and Devalued the Suburbs*, by an organization called CEOs for Cities, measured the relationship between gasoline prices and real estate values. The study found that a house 1 mile (1.6 kilometers) closer to the center of Austin was worth $8,000 more than a house 1 mile farther away. The report showed that each minute a house's location shaved off an average commute increased the house's value by $4,700. So while commuting long distances costs homeowners money spent at the gas pump and time lost in traffic, it also costs them in lower property values.

Hutto's second transportation problem lies in inflexible roadway design. Pressures growing on one high-speed road, U.S. 79, and two rural highways are demanding changes and improvements to the town's transportation network. Formerly located on the edge of town, U.S. 79 and farm-to-market roads 685 and 1660 are becoming major arteries leading into the center of town. They now serve different travelers and needs than they were originally designed for.

Built along the Union Pacific railroad tracks, U.S. 79 once defined the southern boundary of Hutto's main street and original residential neighborhood. A major U.S. highway, the route was designed to carry high-speed regional traffic in a relatively rural context. With the real estate boom, however, new residential development began growing south of U.S. 79. Hutto was quickly becoming a small town with a high-speed rural highway running through it.

"Highway 79 needs to be tamed," says William Guerin, a Hutto city planner. "There are few pedestrian crossings, no sidewalks, and although

The Problem With Sprawl

In a 2000 treatise on American urban planning, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream*, planners Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck define sprawl development as an artificial and financially unsustainable invention of the post-World War II era. The authors contend that because the layout of typical suburban neighborhoods geographically separates daily activities, residents are forced to travel farther than required in traditional neighborhoods. Sprawl typically supports only one kind of transportation—the automobile—and generates more traffic than traditional neighborhoods do. It also requires a disproportionate amount of publicly funded roadway and other infrastructure, such as pipes and conduit for gas, water, and electricity. These expensive and inefficient planning choices contribute to the failure of new growth "to pay for itself at acceptable levels of taxation," according to the authors.

the speed limit has been reduced, that may need to be reexamined for further reduction." Growth is demanding changes such as turn lanes, traffic lights, and easy access to retail stores. Similarly, the areas along routes 685 and 1660, now serving much denser residential and business communities than originally planned for, may need to undergo comparable changes.

"In a time when transportation resources were cheap, clean, and available, land use planning that favored the family-sized, combustion-engine vehicle was acceptable," says TxDOT's Meyland. "But when gasoline becomes expensive, air polluted, and funding for transportation infrastructure hard to come by, being saddled with only one transportation option that is expensive and arguably unsustainable can limit a community's chances for economic growth."

Meyland goes on to say that in the same way that diversification protects financial investments or agricultural crops, diversification in housing and transportation options protects communities. New development codes that promote mixed-use communities and several transportation options can provide current and future residents, spanning several generations and income brackets, with alternatives to high gasoline prices and time lost to commuting. Those improvements, in turn, can lead to a high quality of life and long-term economic health for a community. That is the path Hutto has chosen.

New Urbanism Comes to Hutto

At first glance Hutto seems an unlikely candidate for the context sensitive planning principles of smart growth and new urbanism. Design concepts such as mixed-use neighborhoods and pedestrian mobility appear to be a big leap for this once-agricultural community with deep historical roots.

Yet those are some of the principles Hutto is pursuing to maintain its history and culture. Sensitive to the community's concerns about the changes already taking place, Hutto's planning staff began working with consultants to create a SmartCode to shape future growth. SmartCode is a regulatory approach that assigns planning rules based on six "transect zones" that span rural to urban uses and four transitional uses in between. Planners can customize SmartCodes to reflect a community's culture and its citizens' preferences. Hutto hopes this approach will support a new paradigm: growing gracefully.

Hutto's Guerin notes that public involvement was the most important contribution to the city's planning success. "We started our public involvement process in 2006 when we began public planning meetings, developer and landowner workshops, and other meetings where we were able to hear the community's priorities about growth," says Guerin. "That process culminated in a design charrette we held in November 2008."

The charrette yielded a first draft of the Unified Development Code, a revision of Hutto's Code of Ordinances. The unified code includes an overlay of the SmartCode and the Heart of Hutto Old Town Master Plan, codifying the community's vision for its future downtown. The charrette also produced a master plan for a mixed-use development, Shiloh at Jake's Bridge, that will adhere to the SmartCode and resulted from collaboration between the developer and surrounding landowners. At that point, Hutto had articulated a vision for its future.

The town, its citizens, and its private sector can define and control many of the land use changes they want to make. For transportation, however, a municipality rarely works alone. Many of the designs that Hutto would like to implement on U.S. 79 require the collaboration of State, regional, and Federal transportation officials, specifically TxDOT; Williamson County, where Hutto is located; the Capital Area Metropolitan Planning Organization; and FHWA.

Redesigning U.S. 79 through Hutto as a high-capacity urban street rather than a high-speed rural highway would help realize the community's hopes for a new downtown with a walkable, mixed-use, neighborhood environment. Design elements such as pedestrian

By transforming Hutto into a mixed-use, pedestrian-friendly town, officials expect that residents will be more inclined to patronize local establishments like the café shown here rather than driving to Austin for meals and entertainment. *Photo: Hutto Economic Development Corporation.*

As U.S. 79 enters downtown, large trucks like this one contrast with Hutto's historic character. *Photo: M Kim Soucek, TxDOT.*

crossings and slip roads would make it possible to accommodate motorists, pedestrians, and shoppers in one transportation facility.

Slip roads are defined in Hutto's SmartCode as outer vehicular lanes of a thoroughfare, designed for slow speeds while inner lanes carry higher speed traffic. Inner and outer lanes are separated from each other by a planted median. When slip roads run next to parking lanes, they can facilitate safe parking and dropping off and picking up of passengers. Other transitional design elements, such as traffic signals and reduced lane widths, also characterize these urban thoroughfares.

Scott Polikov, president of Gateway Planning Group, Inc., which was closely involved in the downtown redesign, says, "If Hutto and TxDOT can partner to enhance the redevelopment momentum created in the downtown through the long-term redesign and reinvention of U.S. 79—as envisioned

Although the population of Hutto is changing, the land around the city continues to be ideal for farming. *Photo: Todd Boyum.*

in the downtown plan and code for the city—a new partnership paradigm will have been created for fast-growing communities in exurban areas bisected by highways."

Urban Thoroughfares Committee

To promote the sort of flexibility in highway design needed to redefine routes like U.S. 79 at Hutto, the Texas Transportation Commission created the Urban Thoroughfares Committee in October 2007. Representatives of local and Federal agencies (including FHWA), private sector planners and engineers, academics, and TxDOT staff comprise the committee.

The committee's charge is to support context sensitive smart growth and new urbanism in project development, bringing in stakeholders early in the process and cultivating projects that satisfy the purpose and needs of the community as a whole. Additional goals include enhancing safety for transportation users and the surrounding community; meeting the needs of various modes of travel, including foot traffic, bicycling, public transportation, and vehicles; adding lasting value and excellence to transportation facilities; and preserving scenic, historical, aesthetic, and environmental resources.

The committee completed its first phase of work in early 2009, resulting in significant revisions to TxDOT's *Project Development Process Manual*, which planners and engineers follow when developing transportation facilities. Those changes took effect in June 2009 following FHWA's approval.

The revisions provide specific, mandatory instructions for more robust, collaborative practices in the early planning stages of urban transportation projects. Previously, TxDOT directed planners to determine a community's urban transportation needs by modeling travel demand, a measurement based on traffic flow and demand. The revised manual mandates that planners now consider not only roadway projects but also sustainable street and transit networks. In addition, they must consult no fewer than seven specific local parties and sources to identify community needs.

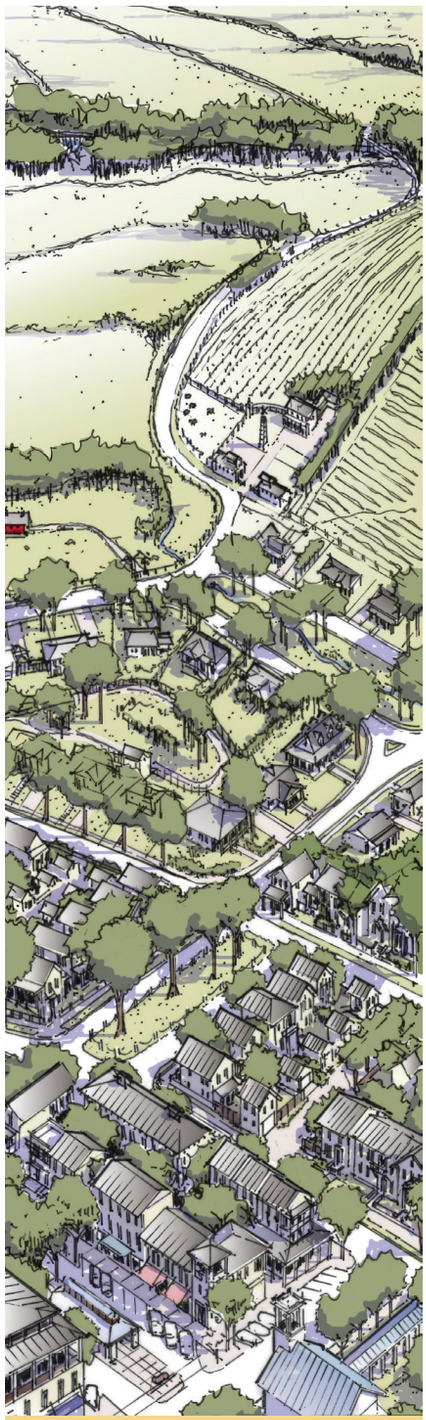
Value Capture

Significantly, the new guidelines also encourage arrangements that support alternative funding options and long-term sustainability of transportation facilities. The U.S. Department of Transportation defines sustainable transportation as "effective and efficient system performance, with positive impacts on the social quality of life, economic competitiveness, and the preservation of the natural environment."

Perhaps an even broader definition may apply here: the ability of an activity to continue by its reliance on renewable resources. In this sense, TxDOT's new planning guidelines direct planners to seek practices that replenish the funding sources for delivering transportation and do not rely on motor fuel taxes alone to continue. Context sensitive solutions, the manual suggests, can promote public and private partnerships to provide funding for operation and maintenance of projects, create funding for future projects, and optimize return on public resources such as local tax bases.

In a new subsection on funding alternatives, the manual lists seven nontraditional options to consider when initiating a project, such as value-capture mechanisms. These

Traffic like this on U.S. 79 is Hutto's reality today, while the grain elevators in the background suggest the different needs that the highway was originally designed to serve. *Photo: M Kim Soucek, TxDOT.*



This artist's rendering shows rural agricultural uses and urban density, plus various uses in between. *Source: PlaceMakers, LLC.*

innovative public financing mechanisms include public improvement districts, tax increment reinvestment zones, and other special districts or public-private agreements.

In a November 2008 *Status Report*, the Urban Thoroughfares Committee explains that value-capture mechanisms recognize that changes in a transportation facility's access, noise, aesthetics, safety, or reliability affect a parcel of land, and "with each transportation investment some marginal improvement or marginal decline occurs in the value of the surrounding land." A value-capture tool recaptures a portion of the value increase and returns it to the public facility that contributed to that increase. The return occurs either indirectly through land-related taxes or fees, or directly through onsite improvements that benefit the community generally.

Capturing Value in Hutto

Hutto incorporated a value-capture mechanism in the master plan for The Crossings of Carmel Creek, a future mixed-use development straddling SH 130 at its intersection with U.S. 79. Plans for the 466-acre (189-hectare) development include commercial and retail space, multifamily residences, row houses, parks, open space, and hotels. The master plan also promotes sustainable transportation: The Crossings is a transit-oriented development with a rail station slated for the southeastern corner of the intersection. The development also is pedestrian oriented, with plans for sidewalks and bicycle facilities, so that the various transportation modes are within walking distance of most of the homes and businesses.

From the outset, the development agreement for The Crossings supported multimodal, sustainable transportation under the Texas Local Government Code. The code authorizes municipalities to create and administer economic development programs and make grants of public money for projects that contribute to the economic well-being of the State. Toward that end, the statute allows municipalities to partner with a wide range of public and private entities.

The Crossings is designed to capitalize on its proximity to major transportation facilities, SH 130 and U.S. 79. Part of the economic well-being that the development is designed to support is the quality and sustainability of the transportation projects associated with it. Specifically, percentages of the sales and hotel occupancy tax revenues arising from the development will go back to the developer to fund roadways, sidewalks, and pedestrian and bicycle paths. The performance-based, incentivized agreement puts the burden on the developer to create a high-quality development where people want to live and spend money.

"This development has not, as so many have, tried to turn its back to the road," says Lewis. "Rather, it has embraced it, and celebrated that embrace both in its physical design and in the mechanisms of interdependence that should provide mutual benefit between road and community in the years to come."

Whether The Crossings goes forward as planned—the parcel has changed hands more than once since it was drawn up as a Planned Unit Development—the lessons learned from the planning process have advanced other developments in Hutto. For example, Shiloh at Jake's Bridge has begun taking shape around similar principles. The Shiloh plan is still in the early stages, but the developer and city planners have discussed funding tools similar to those used for The Crossings, says Hutto planner Guerin. In addition, the Shiloh developer will receive a 50 percent reduction in building fees in return for opting into the SmartCode.

Neither of these communities has broken ground. Yet the principles they adhere to are already generating attention and market value for the region. Envision Central Texas presented its 2009 Community Stewardship Award for Public Planning and Policy to the city of Hutto for its Heart of Hutto Old Town Master Plan and SmartCode. The Texas chapter of the American Planning Association presented its 2009 Current Planning Award to Hutto for the SmartCode.

The mixed-use, master-planned developments are creating buzz for the SH 130 corridor as well. In a 2010 update on the metropolitan Austin area, the Marcus & Millichap Real Estate Investment Services predicted that developments like Hutto's in the SH 130 corridor are emerging as competition for the Austin housing market. "When the State's economy rebounds, those developments will be well positioned to thrive when new residents and businesses begin seeking homes in growing central

Texas," says Michael Watson, regional manager at Marcus & Millichap.

Early Adapters

Other Texas communities could soon face the same two transportation-related challenges Hutto is already addressing. First, the State population is expected to increase by as much as 37 percent by 2020. That number pales compared to Hutto's 1,120 percent increase over the last 10 years. Nevertheless, accommodating that much change requires serious planning, forethought, and willingness to change in order to avoid the congestion that results from population growth and to enjoy sustainable, high-quality living.

Second, Texas towns also might have to change a transportation pattern that is no longer sustainable. "The era of the single-occupant vehicle, driven over roads funded with motor fuels tax, could be coming to an end," says Ron Hagquist, operations research analyst in TxDOT's Strategic Policy and Performance Management Office. "This tax model has been slowly failing because the tax remains fixed while the cost to build and maintain roads continues to rise. The popularity of hybrid vehicles, which use less gas than conventional models and therefore generate less tax revenue, also is reducing the effectiveness of this funding mechanism."

Further, adds Hagquist, the U.S. oil supply is increasingly unstable because of market volatility and fears that the resource itself is near exhaustion and could become prohibitively expensive. Finally, climate change also could raise the cost of maintaining roadways, as increasing extremes of temperature and more frequent submersion from coastal storms and flooding accelerate pavement deterioration. "All those influences point to the need for alternatives to traditional transportation funding and more transportation mode options," says Hagquist.

Given those scenarios, the changes in TxDOT's *Project Development Process Manual* are not insubstantial: They direct planners to pursue sustainable funding models that support transportation facilities from their inception and that do not rely on the motor fuels tax alone for construction and maintenance. The fact that Hutto already has begun implementing some of these models, with several transportation alternatives to the automobile, means it will be better prepared than other communities for changes in the transportation sector.

Hutto is planning a sustainable community supported by transportation alternatives, with nontraditional, self-sustaining funding mechanisms, and flexible zoning laws that can change with the community. Hutto can be a community where several generations can live comfortably and drive, bus, walk, or bike to work and play. If small towns are the laboratory where U.S. planners can rediscover the art of town planning, as some policymakers have suggested, Hutto could prove to be a leader.

This artist's rendering of a design for a large, single-family home is modeled after a traditional Texas farmstead. Perfect for horse lovers, the farmstead approach allows for outbuildings for stables, studios, or utility buildings. *Source: PlaceMakers, LLC.*

This rendering shows a mixed-use neighborhood of Hutto's imagined future, inspired by the Texas Hill Country. Retail and restaurants take advantage of the pedestrian environment, and the covered market building on the square serves as a community gathering spot. *Source: PlaceMakers, LLC.*

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New Cost Estimating Tool

by Karen White and Ralph Erickson

Planning for future highway construction requires estimating project costs and funding resources that can be reasonably expected to be available in the timeframe for the proposed improvements. Estimates are part of including projects in programs such as the statewide and metropolitan transportation improvement programs. After projects are in the plans, State highway agencies typically prepare a set of engineering plans, specifications, and estimates for the work to be accomplished. The procurement and installation of these materials become the State-defined bid items for the construction contract.

Construction companies interested in the work submit bids in which the price associated with each item includes the cost of the material itself; all other associated costs for moving, placing, and installing the material; and a component of profit and overhead associated with each item. Clearly, in this usage, bid items include all associated costs for materials, labor, equipment, and a proportional share of project overhead and profit.

For decades, the Federal Highway Administration's (FHWA) tool for determining the expected purchasing power of the financial resources available to highway agencies was the Bid Price Index (BPI), which was a compilation of nationwide data on highway construction prices. Transportation planners employed the BPI for estimating the costs of road-building projects, and FHWA used it in various analyses. But the BPI imposed excessive paperwork requirements on State departments of transportation (DOTs) and needed more data sources in order to calculate trends and perform statistical analysis.

Between 2006 and 2010, FHWA developed and deployed a new approach to generate cost compilations. The new National Highway Construction Cost Index (NHCCI) is replacing

Transportation planners take note: the National Highway Construction Cost Index is replacing the Bid Price Index as the national barometer for analyzing road-building price movements.

The new National Highway Construction Cost Index (NHCCI) includes bid prices from construction projects such as this one on Trail Ridge Road near Grand Lake, CO, in Rocky Mountain National Park.

the BPI as the national database for determining the purchasing power of road-building resources. The new tool provides an understanding of historical and recent price trends in highway construction.

"For various reasons, State transportation agencies didn't use the BPI, so we knew improvements were needed," says King W. Gee, associate administrator of the Office of Infrastructure at FHWA. "The new NHCCI addresses a number of issues. This index is important to contracting agencies that are trying to develop an accurate estimate of the cost of new projects."

Origin of the Bid Price Index

In 1933, the Bureau of Public Roads (now known as FHWA) began compiling and issuing the quarterly BPI as a continuing record of nationwide construction costs, published as graphs and tables. Using recorded price trends, FHWA then extended the index back to 1922, when highway construction in the United States had reached sufficient nationwide volume and become standardized enough to provide a fairly reliable basis for comparing construction costs and price movements.

The BPI was calculated using data obtained from the award of contracts by State transportation agencies on Federal-aid highway projects, excluding contracts on the Federal-aid secondary system. Beginning in 1977, FHWA sought to reduce the paperwork burden on States by collecting data only on contracts greater than $500,000 on the National Highway System. Until 2007, FHWA collected the data on form FHWA–45, entitled Bid Price Data, and form FHWA–47, entitled Statement of Materials and Labor used by contractors on highway construction involving Federal funds. Form FHWA–45 recorded information on bid prices for major work items on Federal-aid highway construction contracts. Form FHWA–47 recorded quantity data on labor and materials used on those contracts.

How the BPI Was Used

FHWA used the data provided on the two forms as input to the BPI, which was published quarterly in the *Price Trends for Federal-Aid Highway Construction*. In addition to States applying the pricing information, the BPI was used in the following publications:

- *Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance* (biennial report to Congress)
- *Highway Statistics* (an annual FHWA report)
- *Our Nation's Highways* (an FHWA report)
- Special studies of various material prices by FHWA and other organizations

FHWA also used the BPI in developing responses to policy issues related to employment and materials usage. In addition, the Bureau of Economic Analysis used the BPI as a price deflator in the production of the National Income and Product Accounts, which include many of the key aggregate variables, such as wages and market value of goods, used to describe the U.S. economy.

Concerns About the BPI

However, the BPI underwent criticism from within FHWA and from the U.S. Government Accountability Office (GAO) in its report *GAO-04-113R Comparison of States' Highway Construction Costs.* GAO recommended "that the Secretary direct the Federal Highway Administrator to determine whether it would be useful and feasible to collect and disseminate other [S]tate construction cost data that could supplement or supplant FHWA's bid price data."

This recommendation accelerated efforts underway at FHWA to discontinue and replace the index. The agency had found several reasons to question the tool. First, forms FHWA–45 and FHWA–47 created an excessive paperwork burden on the States. Form FHWA–47 required States to convert inputs into standard units that often did not match the units used in construction bids. For example, bituminous material on Form FHWA–47 was reported in gallons, but many States' bid items were based on area measurements rather than material quantities, thus requiring a conversion to meet the form's requirements.

Second, the reporting forms were not timely because they were due after completion of highway projects so all price changes could be integrated. Unfortunately, this requirement reduced responses to the survey because most State DOTs tended to move onto the next

Comparison of New FHWA Highway Construction Cost Index to Retired Bid Price Index

Shown is a comparison of the quarterly percent change in NHCCI compared to the quarterly percent change in the BPI. This graph allows trend analysis using the year-to-year (or quarter-to-quarter) percent change. The NHCCI does not display the strong quarterly spikes seen in the BPI. The NHCCI represents actual contract bids, which occur year round, as opposed to contract completion, which is strongly seasonal. *Source: FHWA.*

Recent increases in the price of asphalt are easily incorporated in the NHCCI. Here, workers are unloading asphalt for a road repair.

project rather than finishing Federal paperwork on completed projects.

Third, GAO contacted 12 States and found that they did not use the BPI because the DOTs collected more detailed information than what was included in the Federal index. The GAO report reinforced what many at FHWA believed: that few States actually used the BPI data.

Furthermore, the quality of the BPI data was below U.S. Department of Transportation standards as expressed in the 2003 *Guide to Good Statistical Practice in the Transportation Field*. Reviews of data reported on forms FHWA–45 and FHWA–47 showed uneven data quality. The process used to develop the BPI did not allow statistical examination, and only limited data review was possible.

In April 2007, FHWA discontinued the collection of forms FHWA–45 and FHWA–47 because of the data quality issues and concerns about the work burden on States. The final BPI report was for the fourth quarter of calendar year 2006.

Development of the Replacement

Coordinated research into a replacement for the BPI began in 2000. FHWA evaluated 14 databases but found none that could be used to replace the BPI or serve as the basis for creating a new tool. An outside review by an FHWA contractor proposed a new detailed data collection process with broader scope than forms FHWA–45 and FHWA–47 but with fewer data providers. FHWA rejected this proposal as being both too costly to implement and presenting a small likelihood of success given the regulatory hurdles to issuing new surveys.

Ultimately, FHWA decided to purchase a database from Oman Systems, Inc. (OSI) to provide construction cost data for the NHCCI. This database captures Web postings by States on bids submitted on highway construction contracts and contains all States except Alaska and Hawaii. Some States have data in the database back to the mid-1990s, but others start in 2000 or later.

Steve Hemphill of the New Mexico Department of Transportation says that he uses the database to "sort through historical prices for bid items by date, district, geographic region, size of project, quantity window, etc., for mean and standard deviation information." The detail available makes it a robust database for creation of a price index.

National Highway Construction Cost Index

The new NHCCI quarterly construction cost index is replacing the BPI with data collected starting March 2003. At that point, that database's owner was gathering information from 45 States, including the largest ones. The NHCCI overlaps with the BPI for 2003 through 2006, but the two datasets and index structures do not match closely enough to allow for a continuous index. However, the NHCCI does allow analysis of annual and quarterly price changes.

For FHWA's purposes, the relevant information included with each pay-item is State, bid price, unit of measure, general expenditure category, and date the contract was awarded. The NHCCI combines prices of individual goods and quantity weights to track the percentage change in prices over time for a particular selection of goods and services. Implicitly, the quality of goods and services represented in a given timeframe is assumed to be constant. In the NHCCI, individual goods in the data are represented by "pay-items" for successfully bid contracts. Pay-item definitions differ from one State to another, but FHWA overcomes this problem by holding definitions constant within each State and then

The bid prices used in the NHCCI include full costs to put road items in place, such as this crane lifting a girder into place on a bridge under construction.

The NHCCI pay-items include labor. These workers are spreading concrete on a road project.

creating the national index, which does not compare State prices but does arrive at a national average. The differences in State-defined pay-items mean that a user could not compute comparable State indexes.

The NHCCI procedures are different from those used by the U.S. Department of Labor's Bureau of Labor Statistics (BLS) to create the former Producer Price Index (PPI) for Highway and Street Construction. For that index (discontinued in July 2010), BLS contacted input sellers such as steel and cement manufacturers to obtain their current sale prices. BLS then employed the Bureau of Economic Analysis benchmark input-output relationships to construct the PPI for highway and street construction. Therefore, the NHCCI could be thought of as a construction (or output) cost index, whereas the PPI was a sales (input) price index.

The NHCCI differs from both the PPI and BPI since it uses a Fisher index methodology, which embodies the idea that, for a fixed market basket, changing relative prices will lead to changes in the relative quantities being purchased in the basket as entities make substitutions within an item category. This concept is easily illustrated by an analogy to grocery shopping. When a shopper notices that blueberries have doubled in price, the consumer will shift to another choice, say bananas. Over time, then, the market basket is changing, and the Fisher index recognizes this explicitly by using the average market basket rather than a fixed base-year market basket. The BPI attempted to account for the changes in the market basket of construction goods by updating the market basket of highway construction materials every 10 years. This process was so time-consuming that the BPI's market basket had not been updated since 1987.

Both FHWA's BPI and NHCCI reflect the changing mix of inputs over time. Since the final product measured by the NHCCI is highway construction, it is appropriate that the index reflect a mix of inputs. FHWA intends to monitor how the mix of goods in the NHCCI changes over time. One of the advantages of the Fisher index is that the market basket is updated throughout the index, removing the inherent bias that would otherwise occur if the mix of goods changes over time. A description of the mathematics of a Fisher index is available at www.fhwa.dot.gov/ohim/nhcci/math.cfm.

Businesses use the NHCCI to gauge the market. "An output price measure such as the NHCCI is valuable for demonstrating that highway costs may be escalating much faster than consumer prices or even a broad producer price index," says Ken Simonson, chief economist for The Associated General Contractors of America. "In addition, some contractors may use the index to compare the change in their bid prices [relative] to the overall market."

Construction Cost Index Data

Price indexes are only as good as the data employed to construct them. The proprietary database used to build the NHCCI contains a large volume of data on State roadway projects. The universe of data is larger than the BPI's, which covered only Federal-aid contracts over $500,000 on the National Highway System. The NHCCI is intended to cover all highway projects and therefore arrive at an average cost index for all road construction.

FHWA's objective in constructing a highway cost index is to provide a measure that is useful not only as a national cost index for constructing highways, but also as an index that the States can use to gauge differences in their relative cost experiences for highway construction. The NHCCI is not intended to replace State-specific cost indexes, which offer two key advantages. First, they help States monitor how quickly unit costs are rising to better match budget appropriations with actual expenditures. Second, they provide States with better information for planning and budgeting a statewide program of projects.

State DOTs and metropolitan planning organizations (MPOs) are responsible for developing the Statewide Transportation Improvement Programs (STIP), the Transportation Improvement Programs (TIP), and metropolitan transportation plans (MTP) that identify projects that they propose for Federal aid funding. The STIP/TIP and MTP contain project cost data and revenue estimates. Since 2007, the project cost data and revenue estimates in these documents are required to be reported in year of expenditure (YOE) dollars. The NHCCI provides information that planners and project staff can utilize to track cost trends and develop reasonable project cost estimates for use in the programming documents and the long-range transportation plans. The NHCCI provides the States and MPOs a source of data where project construction cost trends can be evaluated and used to estimate future project costs in YOE dollars.

Given the relevant indexing and economic theory, the requirements for the data are the following:

- Consistent and specific product characteristics so that price comparisons over time compare apples to apples rather than excavation in corn fields to excavation in mountains. Consistency is fundamental to creating a well-defined cost index and involves taking care in specifying what constitutes an individual product. FHWA used the guidelines developed by BLS to further inform its data analysis (www.bls.gov/ppi/ppifaq.htm). To summarize, BLS treats products that are characterized by different price determinants as distinct products. BLS has a large staff of industry experts and statisticians to design survey questionnaires to isolate different products and evaluate the responses.
- Continuity in the time series for the individual pay-items so that there are few breaks in the series. Mathematically, the index methodology requires prices and quantities to be available in consecutive periods. The requirement arises because the index computes the average change in price between consecutive periods. Products that are purchased infrequently or are inherently unique, such as traffic control devices, cannot be included in the index since prices are not comparable quarter to quarter.
- A sufficiently large or representative set of goods so that the resultant index is relevant for those who make the real budget decisions. The proprietary dataset has an advantage because it represents a virtual universe of FHWA's items of interest—the components of State highway costs. The wealth of data in the database enables FHWA to use alternative methods to arrive at the same objective: a reliable indicator of highway construction costs that can be used for both general cost comparisons and for States to gauge changes in their costs against national averages. FHWA's approach is to eliminate pay-items that may be defined too broadly or have statistical properties that imply variable price-determining characteristics.

Edits Used to Improve Data Quality

FHWA's approach to creating the NHCCI attempts to reliably reflect changes in the prices of the underlying goods. To achieve this goal, FHWA procedures first eliminate three categories of data.

The first is *nonstandard pay-items* that have the same pay-item number but different pay-item descriptions (or units of measure) from project to project. For example, on one project an item is described as Control Survey, and on another project in the same State, the description is Cleaning Existing Paved Ditch. These types of pay-items, even if they fit all the statistical criteria, cannot be included due to the differing types of work from project to project.

The second category of data is eliminated because of *unit of measure problems* that make it difficult to track price changes. Many of these are lump sum items where the quantity of the item is listed as "1." The prices bid on these types of items generally are not related to any specific price trend but rather are due to other factors such as project type, duration, location, size, and traffic patterns.

The third eliminated category consists of *suspect pay-items* in the historical databases grouped into 31 predefined work categories. Some of these categories relate to aspects of a contract such as startup costs and incentives. As with the units of measure problems, some categories relate to groups of pay-items that generally are not related to any specific price trend but rather relate to the project type, location, and size. These categories are mobilization and alternates, bonuses, and time.

Additional statistical edits eliminate pay-items that are unlikely to have consistent price-determining characteristics. These edits include removing pay-items that are not represented for eight or more quarters and those that represent outliers.

Effect of the Edits On the Data

Most of the changes in value and number of observations come from the edit that removed pay-items without eight or more quarters of data. This edit is recomputed each quarter so that, as a pay-item becomes more pervasive, it will be included in the index. This is a major advantage of using a chained-index. A chained-index utilizes expenditure data in adjacent time periods to reflect any substitution that highway departments make across item categories in response to changes in relative prices.

A construction bid will include thousands of individual bid items, as suggested in this photograph of heavy machinery being used to shift construction materials into place.

Price trends of unique construction items and design-build bids are beyond the scope of the current NHCCI. The offsite-fabricated bridge segment being installed here is an example of a unique pay-item.

Data tests show that losses due to the edits leave about 40 percent of the value of all available pay-items in the final database. Another feature to note is that shares of the various categories in total value do not change much from the initial share for all retained pay-items. Only three categories change by more than 1 percent, leaving the final basket of pay-items with a similar makeup to the basket made up of all pay-items in the bid.

The number of observations falls by almost 430,000 after all the edits are incorporated. Note that the number of observations declines by a much larger percentage than the value, which indicates that the pay-items lost through the edits tend to be low-priced items.

Overall, the effect of the edits on the data, although large, still leaves a useful dataset for constructing the NHCCI. The dollar value of the retained pay-items database is large relative to the unedited database, with almost $70 billion of the initial $170 billion still available for index computation. Further, the distribution over the expenditure categories, which will determine the weights in the NHCCI, is largely unaffected by the edits. Similar statistical analysis could not be performed on the data provided by the BPI, highlighting another advantage the NHCCI has over the discontinued index.

Future Research

Although the NHCCI offers many improvements, further advances are desirable. Additional research will focus on the following areas:

1. Monitoring how the NHCCI performs with updated data, particularly related to input substitution over time.
2. Developing methodology and a software application to derive subindexes based on category groupings, such as excavation, reinforcing steel, structural steel, structural concrete, structures, asphalt, etc.
3. Developing software applications to provide indexes by project types, such as capital improvement and maintenance, if possible to identity these in the dataset, and analyzing how different project types perform over time.
4. Further investigating the randomness of the items excluded from the dataset.
5. Investigating combining the proprietary database and American Recovery and Reinvestment Act of 2009 dataset to identify and analyze selected characteristics.
6. Asking States to review and possibly better define some items within the dataset to reduce data edits.

The NHCCI is intended as a price index that can be used both to track pure price changes associated with highway construction costs and to convert current-dollar expenditures on highway construction to real- or constant-dollar expenditures.

Although many States maintain excellent cost indexes, the NHCCI provides a national view for use in models associated with the *Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance* report and will be published in the annual *Highway Statistics*. FHWA will continue working with State DOT partners to enhance and improve forecasting techniques that are relevant and useful for project cost estimates.

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Ralph Erickson is leader of FHWA's Highway Funding and Motor Fuel Team in the Office of Highway Policy. He began his career with the agency as an economist in 1975 and has worked on projects providing development and implementation of new highway policy directions. Erickson served as chair of the Transportation Economics Committee of the Transportation Research Board from 1992 to 1998. He holds a B.A. in history from Otterbein University with economics graduate work at the University of Maryland-College Park.

For quarterly updates to the NHCCI and background materials with additional information, see www.fhwa.dot.gov/ohim/nhcci/index.cfm, or contact Karen White at 202-366-9474, karen.white@dot.gov, or Ralph Erickson at 202-366-9235, ralph.erickson@dot.gov.

Preserving Yesterday While Designing For Tomorrow

by Mack Frost and Jeanette Mar

Legislation and diligent planning help transportation agencies participate in safeguarding U.S. history.

(Above) Maryland State Highway Administration (SHA) Deputy Administrator Doug Simmons participates in excavations at the Indian Queen Tavern site in Bladensburg, MD. The town was an early transportation nexus on the East Coast for the movement of goods and people by river, rail, and road. *Photo: Julie M. Schablitsky, Maryland SHA.*

Just as families pass heirlooms from generation to generation to preserve their own heritage, the Federal Government is responsible for preserving archaeological sites, structures, and properties deemed important to the culture and history of the United States.

Archaeologists, architectural historians, and other cultural resource managers are in the business of managing the Nation's historic sites. These resources include items, structures, and places of archaeological, architectural, and historical significance. The term "cultural resources" applies not only to buildings, paintings, and sculptures but also to archaeological sites and traditional cultural properties.

Aggressive development in the United States has taken a toll on cultural resources. Between 1900 and 2011, the population of the United States more than quadrupled from 76 million to 311 million people. During that time, the numbers of homes, subdivisions, and road miles grew significantly to accommodate the population.

To avoid, minimize, or mitigate the effects of highway projects on historic sites, transportation and resource professionals at the Federal and State levels apply a number of tools and best practices. Included are geographic information systems (GIS) and programmatic agreements to streamline the review process while protecting the country's heritage.

Legislation: The Roots of Historic Preservation

Legislation aimed at setting aside natural lands as public park and conservation land in the United States is rooted in the American Antiquities Act of 1906. As described in the United States Code (Title 16 U.S.C. 431–433), the act authorizes the President to designate historic landmarks, historic and prehistoric structures, and other objects on public lands as having historic or scientific interest. The statute outlines the Government's right to permit examination and excavation of sites and collect objects of antiquity for research and preservation purposes. The law also tasks Federal agencies with establishing rules and regulations to carry out the provisions of the act. The 1906

legislation also includes penalties—fines or imprisonment—for theft of or damage to antiquities.

The National Historic Preservation Act of 1966 (as amended) established a procedural requirement for all Federal agencies to follow. And the Department of Transportation Act (DOT Act) of 1966 established a regulatory requirement that made avoidance and preservation of historic properties a responsibility of the U.S. Department of Transportation (USDOT). A special provision of the DOT Act, known as Section 4(f) (Title 23 U.S.C. 138), set restrictions on the use of land from publically owned parks, recreational areas, wildlife and waterfowl refuges, or publicly and privately owned historical sites for transportation projects. Specifically, Section 4(f) stipulated that the Federal Highway Administration (FHWA) and other USDOT administrations cannot approve use of these lands unless (1) no feasible and prudent alternatives exist, and the action includes all possible planning to minimize harm to the property, or (2) the use is determined to be so minor that it has a de minimis impact. Regulations directing FHWA on how to implement the provisions of Section 4(f) are available in the Code of Federal Regulations (Title 23 CFR Part 774).

Likewise, Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their activities on historic properties. Section 106 mandates a historic preservation review process. Revised regulations, Title 36 CFR 800, require Federal agencies to make a "reasonable and good faith effort" to identify historic properties and archaeological sites within the area of proposed projects. This effort could include research, consultation field investigations, and field surveys.

The National Environmental Policy Act (NEPA) of 1969 also plays a major role in governing the review and analysis of potential impacts of transportation projects on the environment. Specifically, NEPA mandates that Federal agencies consider the potential social and environmental consequences of their proposals, document the analysis of potential impacts, and make this information available to the public for comment prior to project implementation.

Section 106 Process Explained

Section 106 of the National Historic Preservation Act requires transportation agencies to evaluate all federally funded or permitted projects for potential impacts on historic properties. Through the Section 106 process, the Federal agency, in consultation with the State Historic Preservation Office (SHPO), must first determine if a specific property is eligible for listing on the National Register of Historic Places, which lists districts, sites, buildings, structures, and objects deemed worthy of preservation. For a property to be considered eligible for the National Register, the Federal agency must consult with State or tribal historic preservation officers before making a determination after examining the property's integrity and significance.

Historic preservation officers administer the National Historic Preservation Program at the State and tribal levels, review nominations to the National Register, maintain data on historic properties that have been identified but not yet nominated, and consult with Federal agencies during the Section 106 review. These individuals are designated by the Governor (or tribal leadership) of their respective State or territory (or tribe).

In the case of specific transportation projects, the Federal agencies consult with the historic preservation officer to determine whether the project has the potential to affect historic properties. Highway agencies also consult the public and other stakeholders, such as

FDOT restored Tampa Union Station using Transportation Enhancement funds provided by FHWA. The historic building remains an active train station and multimodal transportation facility accessible by Amtrak, the Hillsborough Area Regional Transit bus system, Tampa's historic streetcar system, and a future regional commuter rail network.

Mack Frost, FHWA DelMar Division

Native American tribes, when determining whether a specific project has the potential to affect historic properties. After consultation, the Federal agency may decide that the project has no potential to affect historic properties and satisfies Section 106, and the agency then may direct the project to proceed. However, if project effects are possible, or if the parties cannot agree, the Federal agency will continue to consult and will seek ways to avoid, minimize, or mitigate the adverse effects before proceeding.

"Engaging the public and incorporating the views of other interested parties throughout the process is critical for a successful Section 106 consultation," says FHWA Federal Preservation Officer MaryAnn Naber. "We define consultation as an active exchange of ideas and information between a Federal agency and other Section 106 participants to seek consensus about what properties are eligible or listed, the nature of project effects, and potential resolution of any adverse effects."

FHWA's Historic Preservation and Archeology Program, housed within the Office of Project Development and Environmental Review, provides guidance and technical assistance to Federal, State, and local government staff regarding Section 106 and the Federal laws, regulations, and policies related to historic preservation and cultural resources. In addition, the Advisory Council on Historic Preservation—established by the National Historic Preservation Act to guide Federal agencies in considering preservation during planning—created a Section 106 flowchart to help agencies integrate the Section 106 process into project planning. The flowchart is available at www.achp.gov/regsflow.html.

Section 4(f) at Work in Texas

Transportation officials involved with the Section 4(f) and Section 106 processes might find it beneficial to be aware of previous case law. Understanding how historic preservation laws have affected earlier projects can help agencies successfully meet the acts' requirements and avoid potentially costly delays.

For example, in Fort Worth, TX, residents used preservation law to reunite several historic buildings with the downtown area. When I–30 opened to traffic in 1958—8 years before Section 4(f) became law—it separated a number of significant historic buildings on the south side of Fort Worth from the rest of the downtown. In the early 1980s, the Texas Department of Transportation (TxDOT) proposed widening I–30, pushing the roadway closer to the historic buildings. A local coalition of concerned residents argued that the proposed project failed to follow the Section 4(f) requirement to protect historic places.

After the old elevated I–30 in downtown Fort Worth, TX, was moved to a new alignment, TxDOT installed wide medians, pedestrian walkways, and streetscaping, such as this sculpture, along Lancaster Avenue to help revitalize the historic district.

Val Lopez, TxDOT Fort Worth District

The U.S. Court of Appeals sided with the residents and ordered TxDOT to develop a new plan to comply with Section 4(f). The alternative plan moved the alignment south of the historic buildings along Lancaster Avenue. In 2002, the old section of I–30 was torn down, reuniting the historic buildings and Lancaster Avenue with downtown Fort Worth. The result protected the cultural and historic properties and paved the way for further downtown development.

"The relocation of I–30 has enabled us to redesign and reconstruct Lancaster Avenue in a way that respects the character of our historic buildings while attracting reinvestment to the south end of downtown," says Fernando Costa, assistant city manager for Fort Worth. "That reinvestment, including the development of a new hotel and condominium, as well as restoration and adaptive reuse of the historic Texas and Pacific passenger terminal building, shows how transportation decisions can serve as a catalyst for historic preservation and economic development."

Environmental Streamlining Tools

Managing the effects of transportation projects on cultural resources depends greatly on coordination between State DOTs, the State or tribal historic preservation officer, FHWA, and other Federal agencies. To evaluate the potential cultural and environmental effects of proposed projects, some States have developed tools to help streamline the process.

The Florida Department of Transportation (FDOT), for example, developed an online environmental screening tool used for the Efficient Transportation Decision Making process (available at https://etdmpub.fla-etat.org/est). The tool provides transportation planners, project analysts, and managers with sufficient information to plan and develop projects for future compliance with Federal and State environmental laws. The process helps FDOT improve long-range transportation planning, shorten project delivery, minimize the cost of environmental studies, and improve agency coordination.

Efficient Transportation Decision Making involves three phases: planning, programming, and project development. In the first two phases, FDOT, FHWA, and the resource agencies conduct screenings of the proposed project to determine ways to avoid, minimize, or mitigate impacts on cultural resources. After both screenings, the agencies make a class of action determination, which can be a categorical exclusion, environmental assessment, or environmental impact statement, to decide which studies are required to meet NEPA and Section 106 requirements. Once

the class of action is determined, the project is ready for a project development and environment study.

Throughout the Efficient Transportation Decision Making process, the agencies use FDOT's interactive, Web-based Environmental Screening Tool to evaluate proposed projects' impacts on their surroundings. The tool documents project changes, helps decisionmakers evaluate impacts, and facilitates communication with the public, agencies, metropolitan planning organizations, and tribes.

GIS Databases

FDOT's Environmental Screening Tool also provides GIS analysis and visualization capabilities. GIS technology makes it possible to create cultural resource data layers that can be spatially and analytically compared to and overlaid with information on a variety of environmental and transportation-related data. GIS can dramatically improve the response times for agencies when determining potential risks to cultural resources by quickly indicating the location of sensitive historic resources in relation to proposed highway improvements. Project officials can upload local property appraisal records into the GIS database layers to help identify potential historic sites. After projects are loaded into the database, project officials can run standard GIS analyses (such as soil mapping, demographics, wetlands, historic sites, and native species) to identify potential environmental effects.

"Our GIS data layers and early consultation represent integral components of our efforts to produce the best possible roads to serve the mobility and historic preservation goals of our communities and State," says Roy Jackson, environmental scientist/historian in FDOT's Central Environmental Management Office.

Other States also have developed GIS models for identifying potential risk areas where cultural resources may be affected. A cultural resource GIS database can help States streamline the Section 106 process and allow for quicker implementation of roadway improvements. GIS databases enable State DOT project managers to evaluate project alternatives to avoid potential cultural resource impacts early in the planning stages.

In September 2010, the American Association of State Highway and Transportation Officials (AASHTO) released a report that collects best practices from States' use of cultural resource GIS databases. The report, *Best Practices for Establishing and Maintaining Statewide Cultural Resources GIS Databases*, highlights effective methods for using these databases to assess the potential effects of transportation projects on historic properties.

For example, TxDOT uses a planning tool grounded in GIS to conduct archaeological evaluations in the Houston area. Developed by TxDOT geoarchaeologist Dr. James T. Abbott for the department's Houston District Office, the Houston Potential Archeological Liability Map GIS database is able to predict where transportation projects have the potential to encounter archaeological sites. The tool is available for use by the SHPO, Texas Historical Commission, and others.

"It is a great tool for planning and prospecting for prehistoric sites," says Allen Bettis, staff archaeologist in TxDOT's Environmental Affairs Division. "It is generally very accurate in its ability to predict the liability for archaeological materials at a particular location; however, there are occasions when personal experience of a location has resulted in the [Potential Archeological Liability Map] being overruled by the archaeologist. But rarely are field and site visits needed to confirm the results of the model."

The use of GIS databases enables TxDOT project managers to evaluate project alternatives for potential cultural resource impacts early in the planning stages. TxDOT's model uses geologic, soils, and geographic data; aerial photos; and geoarchaeological data from field visits to produce a predictive model to identify the likelihood of finding prehistoric archaeological sites within a study area. The department already expanded the tool for use in the Fort Worth area and other districts will follow.

Programmatic Agreements

Another method for streamlining the Section 106 review process is the development of programmatic agreements to govern how the process is carried out within a given State. A programmatic agreement is a legally binding document between the signatory parties that establishes a process, delegates certain tasks (and sometimes responsibilities), or

Shown here is FDOT's "Efficient Transportation Decision Making" Web site, which the department uses to streamline its historic preservation efforts.

Mark W. Toigo, FDOT

Mark W. Toigo, FDOT

(Above) Shown in this aerial photo is the newly rehabilitated Bridge of Lions in St. Augustine, FL. During the renovation, FDOT took steps to preserve the original architectural details of the bridge, which is listed on the National Register of Historic Places.

(Left) The bridge's iconic lion statues, including the one shown here, were cleaned, restored, and placed back in their original locations during the rehabilitation project.

describes actions that will be taken by the parties. These agreements typically reduce the number of steps and amount of time required for review and approval of projects that meet the predefined conditions. Programmatic agreements are most often used when the Federal agencies and State DOTs want to streamline the project delivery process.

For example, in 2006 the Indiana Department of Transportation (INDOT), the Indiana SHPO, Advisory Council on Historic Preservation, and FHWA adopted a programmatic agreement that defines a process to identify those historic bridges within the State that are most suitable for preservation. The agreement applies to projects that would result in the rehabilitation or replacement of historic bridges, dubbed "select bridges" in the agreement. The key provision is that "FHWA will not consider demolition to be a 'prudent' alternative for any Federal-aid project involving a select bridge, and FHWA will not participate in a project that would result in the demolition of a select bridge." The vast majority of the remaining bridges—those that did not make the "select" list—are therefore excused from further consideration under Section 106, saving time and administrative attention for future projects.

To help determine if rehabilitating a historic bridge for vehicular use is feasible and prudent, INDOT added a section to its design manual called "Treatment of Historic Bridge on Low-Volume Local Road." The new section defines types of historic bridges, treatment conditions, and economic criteria to guide the department and its partners when making decisions regarding rehabilitation.

FHWA's Naber says that programmatic agreements to address historic bridges are an effective approach, especially under FHWA's Every Day Counts Initiative, which encourages practices that shorten project delivery times. "Some bridges may be functionally obsolete but structurally sound and could be candidates for rehabilitation at a lower cost than replacement," she says. "We should consider whether there are treatments that would make rehabilitation possible before we choose to replace our dwindling inventory of historic bridges."

Resources are under development to help State DOTs prepare programmatic agreements for historic bridges and guide decisions about classifying them for rehabilitation, replacement, or demolition. For example, in conjunction with the National Cooperative Highway Research Program, FHWA is in the process of identifying case studies that highlight bridges that have been

rehabilitated rather than replaced. The final product will include best practices for States when dealing with historic bridges. In addition, AASHTO's Center for Environmental Excellence has compiled a list of sample programmatic agreements from across the country. The list is available at http://environment.transportation.org/pal_database.

Consulting With Interested Parties

Involving the public and other interested parties throughout the Section 106 process and incorporating their viewpoints are critical to projects' success. To guide public involvement in Pennsylvania, the Department of Transportation (PennDOT) entered into a Section 106 programmatic agreement with FHWA, the Advisory Council on Historic Preservation, and the SHPO. The agreement is particularly helpful in facilitating consultation with tribes with ancestral ties to Pennsylvania who may attach religious or cultural significance to properties within the Commonwealth. Pennsylvania also has individual agreements with federally recognized tribes in the State to facilitate consultation.

PennDOT, using Preservation Pennsylvania, a statewide nonprofit organization, launched a searchable database called the Project for Pennsylvania Transportation & Heritage, or ProjectPATH, to track all active PennDOT projects in the Statewide Transportation Improvement Plan. The database provides agencies and the public with up-to-date information about the Section 106 consultation process on transportation projects.

PennDOT staff enters project documents into ProjectPATH and uploads them to a server maintained by Indiana University of Pennsylvania for ease of accessibility. For each project, in consultation with PennDOT cultural resources professionals, Preservation Pennsylvania helps determine appropriate stakeholders and solicits public involvement as needed. PennDOT also developed a document titled *Cultural Resources Administrative Procedures for PennDOT Cultural Resources Professionals*, which provides guidance and consistency regarding actions taken by the department.

"PennDOT wanted to formally and broadly delegate activities to the State [by means of ProjectPATH] to better track cultural resource documents and to ensure the public had better access to them," says Deborah Suciu-Smith, an environmental protection specialist at FHWA's Pennsylvania Division Office. "PennDOT's procedure embodies the use of an innovative technology to streamline the Section 106 consultation process."

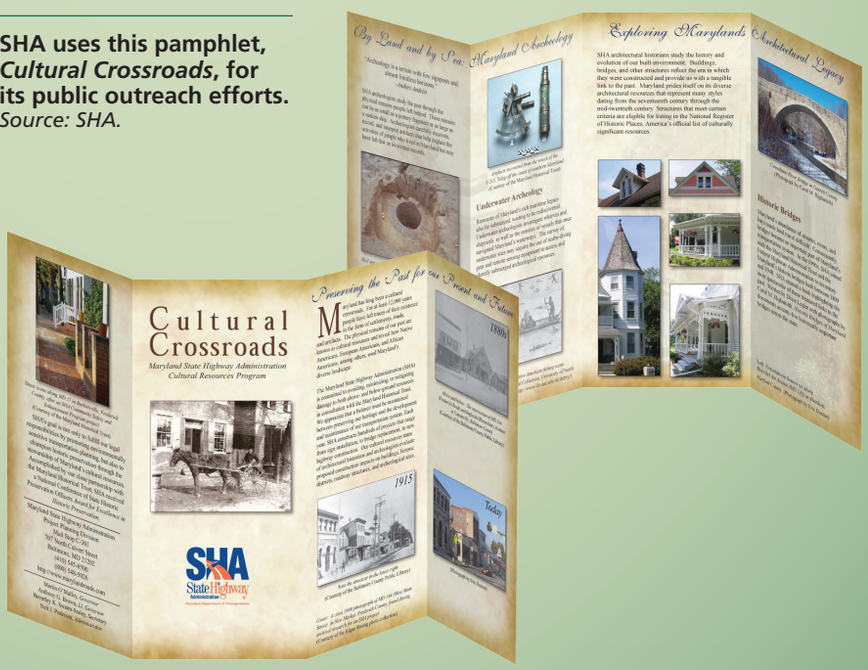
Reaching Out to the Public

Agencies can serve a vital leadership role in the stewardship of historic resources by actively seeking public involvement. To facilitate public outreach, agencies should keep technical definitions and descriptions to a minimum when presenting archaeological investigations and recommendations. In addition, agencies should reasonably consider the public and consulting parties' interest and existing knowledge levels. In particular, agencies should reach out to federally and State-recognized Native American tribes and Native Alaskan and Hawaiian organizations, as they are recognized in Federal regulations as having special expertise in assessing whether a property or site has religious and cultural significance to the tribe or organization.

Maryland, for example, has no resident federally recognized tribes. However, in concert with FHWA, the State Highway Administration (SHA) is developing a working relationship with local Native American groups who claim a tribal affiliation but are not legally recognized by the State or Federal government. "We actively consult with Maryland tribal groups and federally recognized tribes," says April Fehr, an archaeologist with SHA. "We have developed a Native American outreach program, and we plan to develop a programmatic agreement to facilitate our consultation process."

The State's outreach efforts also include the publication and dissemination of a quarterly newsletter called the "Cultural Resources Bulletin" that showcases local projects. In addition, Maryland circulates an information pamphlet, *Cultural Crossroads*, which illustrates SHA's responsibilities and underscores its commitment to preserving archaeological sites and historic buildings and bridges. SHA designed the pamphlet as an information tool for cultural resource professionals and the public to showcase Maryland's dedication to protecting cultural resources.

Public involvement is also a cornerstone of the Delaware Department of Transportation's (DelDOT) archaeology and historic preservation efforts. "Over the past 30 years, we have reached out to schools, senior centers, libraries, historical societies, and professional and civic groups," says DelDOT archaeologist



SHA uses this pamphlet, *Cultural Crossroads*, for its public outreach efforts. *Source: SHA.*

(Left) DelDOT archaeologists and consultants carefully unearth artifacts from an archaeology site near a highway project on U.S. 301. The project is currently in the planning stages. *Photo: Ian Burrow, Hunter Research.*

(Right) The artifacts shown here include pottery shards exhumed near the U.S. 301 project area. *Photo: Ilene Grossman-Bailey, Richard Grubb & Associates, Inc.*

Kevin Cunningham. "We publish archaeology and historic preservation series reports and distribute them all over the State and region. Now, all past and current materials are available on our Web site at www.archaeology.deldot.gov. We genuinely value public input and participation in all that we do and go to great lengths to properly involve all interested parties. As a result, our projects and products are more meaningful and inclusive. At DelDOT we have a saying, 'public or perish!'"

Once agencies collect public comments and feedback, they should keep those concerns in mind when determining the appropriate resolution of an adverse impact, FHWA's Naber says. Often projects require mitigation efforts to avoid or minimize the effects on historical or archaeological sites. In some cases, agencies may choose to acquire or preserve archaeological or other types of cultural sites away from the project area in return for conducting little or no mitigation on sites within the project area. This technique, known as creative mitigation or mitigation banking, may be suitable under certain sets of circumstances to avoid potential historic sites or mitigate for taking public property for other projects. Further, mitigation banking helps protect wildlife species and avoid sensitive areas such as wetlands, thereby demonstrating environmental stewardship on the part of FHWA and State DOTs.

Highway agencies also should take into account the public value of preservation; the importance of a site should be considered in balancing the need for the project.

Maintaining the Legacy

For more than 100 years, the United States Government has recognized historic preservation as critical to retaining for posterity artifacts and properties deemed valuable to the Nation's heritage. Multiple laws have outlined protocols for preservation and assigned responsibilities to Federal agencies, including USDOT, to protect those historic and archaeological resources when planning projects, in partnership with State and local government, organizations, and the public.

State agencies and FHWA continue to enhance the process required for vetting transportation projects for potential impacts on historic, cultural, and environmental impacts. The use of GIS is becoming increasingly important to reducing potential conflicts. With FHWA's heightened focus on shortening delivery time, agencies are developing new ways to balance schedule demands with efforts to protect historical sites, structures, and other properties. States that have adopted a Section 106 programmatic agreement have been able to streamline their Section 106 processes—simultaneously reducing project delivery times and minimizing conflicts.

One of the main goals of the transportation sector during the planning process is to be transparent and consistent. Section 106 consultation and community outreach are vital to achieving this required level of transparency. Even in today's economic reality of doing more with less, transportation agencies need to ensure that preservation and environmental laws and regulations are followed by the letter and in spirit to avoid, minimize, or mitigate the potential impacts of highway projects on the Nation's cultural resources.

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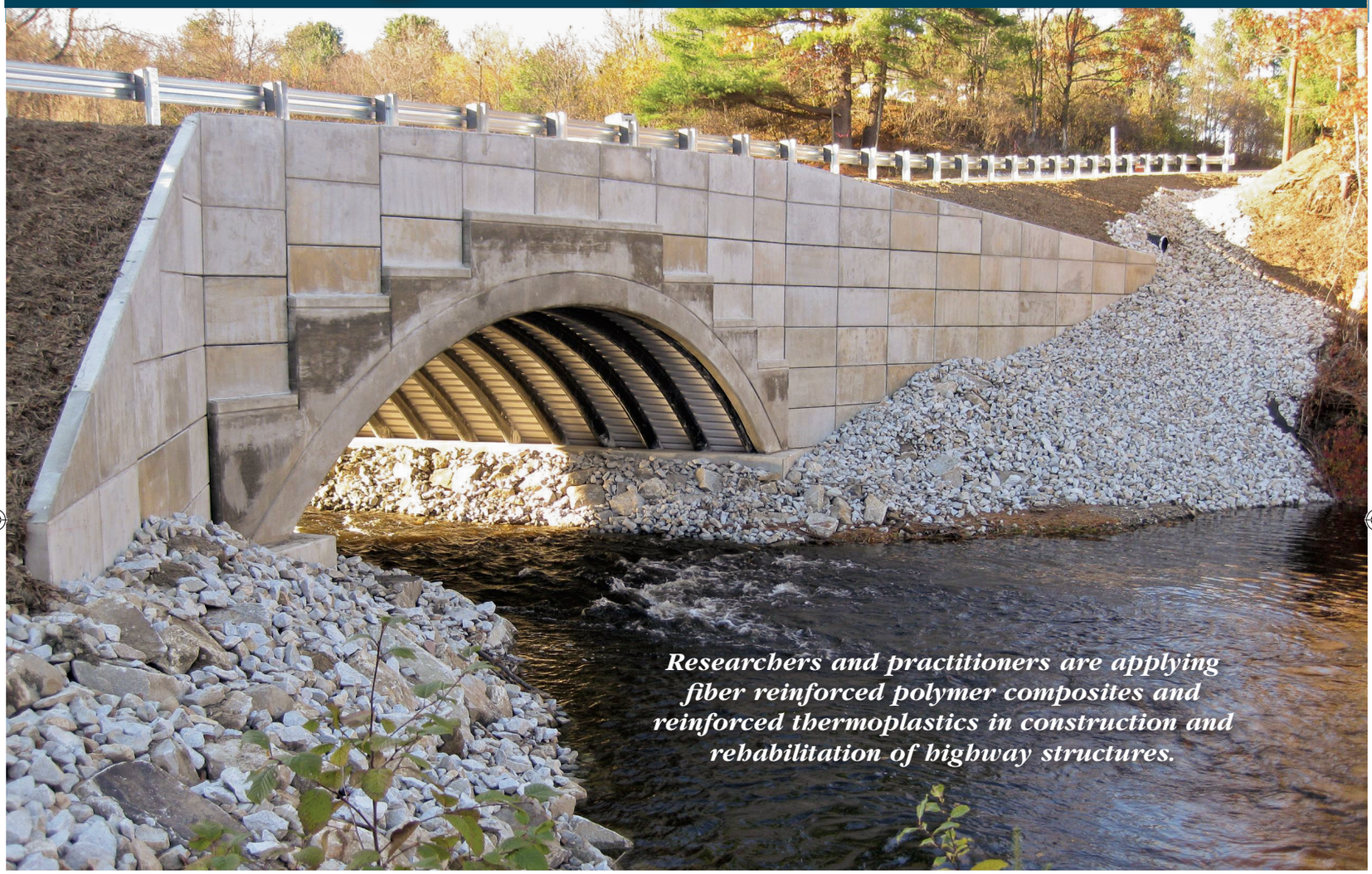
Emerging Bridge Applications

by Louis N. Triandafilou



Researchers and practitioners are applying fiber reinforced polymer composites and reinforced thermoplastics in construction and rehabilitation of highway structures.

Transportation agencies face ever-increasing challenges minimizing congestion and ensuring the safety of travelers and highway workers while undertaking necessary construction projects.

(Above) The Royal River Bridge in Auburn, ME, shown here, was built using rigidified FRP tube arches in summer 2010. This and other emerging FRP solutions are being evaluated in infrastructure applications around the country. *Photo: Advanced Infrastructure Technologies.*

The goal is to offer motorists high-quality, longer lasting highways and bridges while reducing the construction time and traffic congestion that cost the Nation billions of dollars each year in wasted time and fuel.

To meet these challenges, the Federal Highway Administration (FHWA) and State departments of transportation (DOTs) explore and adopt new and innovative construction technologies. For nearly 30 years, FHWA has supported research and development, technology transfer, deployment, and standardization of fiber reinforced polymer (FRP) composites as a promising solution for bridge construction and rehabilitation.

After a long history of worldwide research, use of FRP composites in seismic retrofits and bonded repairs has become almost commonplace. Also, highway agencies are applying this technology to a growing number of projects involving bridge deck panels and reinforcing bar and prestressing applications. However, despite widespread government and industry support, there has been

Advanced Infrastructure Technologies

MaineDOT, the lead agency for the three emerging technologies, installed its first FRP field application in the new Neal Bridge in Pittsfield, ME, in 2008. Here, workers are installing the composite arch tubes.

little self-sustaining, competitive deployment of this technology.

Given the current backlog of structurally deficient and functionally obsolete bridges in the United States—more than 146,000 as of December 2010 according to the National Bridge Inventory—several emerging FRP composite technologies could play an important role in future rehabilitation and replacement. Some promising emerging approaches are focused field applications of rigidified FRP tube arches, hybrid composite beams, and reinforced thermoplastics. Recent deployments in several States highlight field-testing verification of structural properties, initial assessment of potential short- and long-term benefits, implementation challenges, potential agency champions, and patent situations.

Background on FRP

FRP is a general term for polymer-matrix composites reinforced with cloth, matting, strands, or other fibers. FRP composites consist of thermoset resins, which once cured, cannot be returned to an uncured state. Reinforced thermoplastic resin composites, on the other hand, can be softened repeatedly by heating or hardened by cooling. In the softened state, workers can reshape these composites by means of molding or extrusion. FRP and reinforced thermoplastic composites have the potential to create cost-effective, durable, and long-lasting bridge structures.

With the passage of national highway legislation in the 1980s and 1990s, FHWA's early research evolved into an implementation program that has advanced the application of FRP composites in highway structures. Along with traditional programs that have been carried over from one transportation authorization bill to the next, such as the Highway Bridge Program, more recent legislation including 1998's Transportation Equity Act for the 21st Century and 2005's Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users contained new programs from which States could draw to deploy FRP technologies. A few examples are the Innovative Bridge Research and Construction Program, and its successor, the Innovative Bridge Research and Deployment Program, and the Highways for LIFE Program (an effort to advance longer-lasting highway infrastructure using innovations to accomplish the fast construction of efficient and safe highways and bridges).

In addition to providing funding, FHWA has demonstrated a leadership role in forging partnerships with State DOTs, industry, and academia in use of these emerging materials.

Rigidified FRP Tube Arches

Erecting bridges in environmentally sensitive areas presents a number of challenges, not the least of which is getting the requisite heavy machinery into the area. Seeking a low-cost, low-impact bridge solution for these types of environments, researchers with the University of Maine's Advanced Structures and Composites Center set about developing a bridge

(Right) Workers are installing the headwall on the Neal Bridge in Pittsfield, ME. *Photo: MaineDOT.*

(Far right) The completed bridge. *Photo: Advanced Infrastructure Technologies.*

Advanced Infrastructure Technologies

Workers are pouring concrete into FRP tube arches for the Royal River Bridge, constructed in Auburn, ME.

kit that could be delivered to a jobsite in the bed of a pickup truck and installed in a matter of days using only light-duty equipment. Funding from FHWA's Innovative Bridge Research and Construction Program helped support research and development of the bridge kit.

The kit consists of three main components: carbon- and glass-FRP composite tube arches, a self-consolidating concrete mix design, and corrugated fiberglass panels. Once onsite, workers inflate the 12- to 15-inch (30.5- to 38-centimeter) diameter tubes and bend them around arch forms. The crew then uses a vacuum-assisted transfer molding process to infuse the tubes with resin. The tubes, which cure in a matter of hours, function as stay-in-place forms for the self-consolidating concrete, eliminating the need for temporary formwork. They provide structural reinforcement for the concrete in the longitudinal direction, in shear, and as confinement, eliminating the need to install rebar. Over the longer term, the tubes will help protect the enclosed concrete from deterioration.

The self-consolidating concrete mix design uses high-range water reducers to achieve enhanced flowability and viscosity-modifying admixtures to achieve stability, eliminating aggregate segregation. The mix also includes set retarders (for stabilizing hydration), shrinkage reducing admixtures, and 0.375-inch (9.5-millimeter) pea stone aggregate.

The rigidified FRP tube arch technology underwent nearly 5 years of development and testing by principal investigator Habib Dagher, Ph.D., director of the University of Maine's Advanced Structures and Composites Center and professor of structural engineering. Dagher and his team subjected specimens of varied diameter and shell properties to static and fatigue tests to validate finite element modeling tools. The model predicted the nonlinear load-deflection response and capacity that resulted from laboratory four-point bending tests of concrete-filled FRP tubular beams.

They also subjected the arches to two-stage static load tests. The first test was to determine the initial tensile rupture at the crown, at a load corresponding to the ultimate strength of the arch. At the crown, the arch maintained stability along with a significant portion of its initial strength. Then the researchers investigated post-damage behavior until tensile rupture at the shoulders, signifying complete instability and failure of the arch. Actual behavior of the arch was tested to within 3 percent of the finite element modeling predictions, documenting the high degree of accuracy of the analytical tool.

Rigidified FRP Tube Arches in the Field

The first field installation occurred in 2008, when the Maine Department of Transportation (MaineDOT) replaced the 70-year-old Neal Bridge in Pittsfield. Workers installed 23 arches at 2-foot (0.6-meter) spacing to create a 34-foot (10.7-meter) span. Construction was completed in less than 2 weeks at a cost of about $581,000, which was comparable to the cost of a steel or precast concrete bridge.

In 2009, MaineDOT built a second rigidified FRP tube arch structure, the McGee Bridge, in North Anson. This 28-foot (8.5-meter)-long bridge, also constructed in less than 2 weeks, cost about $89,350, which was the lowest bid alternative submitted. MaineDOT awarded a third bridge in April 2010 and advertised another two in fall 2010, and three more are in design. All these structures are being funded through an initiative sponsored by the Maine Governor that aims to incorporate composite technologies into bridge construction and maintenance. The University of Maine is working with Advanced Infrastructure Technologies, a company headquartered in Orono, ME, to market this technology. The Massachusetts Department of Transportation expects to have a project underway later this year.

"Rigidified inflatable FRP tube arches could serve as an alternative to other proprietary [and conventional] arch bridge systems for use in a number of ordinary applications for spans of 20–100 feet [6.1–30.5 meters]," says the University of Maine's Dagher. "Advantages include speed of construction and ease of access to environmentally sensitive areas and other locations where it is not feasible to bring in heavy equipment. This type of bridge structure has…proven to be cost competitive based on alternate bidding with conventional materials. Further, it has the potential to last longer in severe exposure environments, resulting in lower life-cycle and maintenance costs."

Hybrid Composite Beam Technology

A second emerging approach for bridge construction is hybrid

John Hillman, HC Bridge Company, LLC

Hybrid composite beams are a critical component in the new Knickerbocker Bridge in Boothbay, ME. This view of the bridge under construction shows the erected beams with their wing extensions.

composite beams, which combine the properties of concrete, steel, and FRP composites together in beam fabrication. This combination results in stronger and lighter weight bridge members that can be placed using lighter and smaller pieces of construction equipment. Hybrid composite beams offer the possibility of cost-effective spans and corrosion resistance. These beams also offer a lower overall carbon footprint than concrete because they use 70–80 percent less cement. (Cement production accounts for 3.4 percent of carbon emissions worldwide.)

A hybrid composite beam is made up of a compression arch consisting of 6,000 pounds per square inch, psi (41,370 kilopascals, kPa) of self-consolidating concrete that is pumped into an internal arch-shaped conduit. The arch is composed of a polyisocyanate foam similar to roofing insulation. The modulus of elasticity of the self-consolidating concrete is 4.4 million psi (30.34 million kPa). The tension reinforcement consists of either 270,000-psi (1,862-megapascal) galvanized prestressing strand or fiberglass cloth placed in the bottom of the beam. The tension and compression reinforcement are placed within a rectangular fiberglass shell of quad-weave fabric with fibers that are oriented in four directions. This variable orientation gives the shell consistent strength and performance characteristics in all directions, simplifying the design and providing for an efficient use of composites to resist various internal stresses.

Hybrid Composite Beams in the Field

These beams underwent a 14-year research and development program led by John Hillman, who created the HC Bridge Company, LLC, to market this technology. "While working at Jean Muller International, I was exposed to the vacuum-assisted resin transfer molding process," Hillman says. "Combining some knowledge of FRP composites with my experience on a steel arch bridge and numerous posttensioned concrete bridges, I was intrigued with the idea of combining several different materials to create an optimized composite beam. At first it was sort of an academic curiosity, but it rapidly evolved into an obsession to validate the concept."

The first installation of a bridge using hybrid composite beams was on a railroad test track in Pueblo, CO, in 2007. It was a 30-foot (9.1-meter) span designed for Class 1 railroad loads of 320,000 pounds (145,150 kilograms). Researchers erected the structure at the Transportation Technology Center, operated by a subsidiary of the Association of American Railroads. The bridge was subjected to more than 2 years of heavy axle loading—approximately 237 million gross tons or 1.5 million cycles of fatigue. Laboratory and in situ measurements of live load deflections agreed well with analytical predictions, attesting to the accuracy of the predictions.

The first highway installation was on the High Road Bridge in Lockport, IL, in 2008, funded under the FHWA Innovative Bridge Research and Deployment Program. Workers delivered all six of the 57-foot (17.4-meter)-long girders to the site on one tractor-trailer, a clear efficiency benefit compared to the one girder per trailer that would have been necessary for shipping prestressed concrete box beams. Workers erected the six 42-inch (107-centimeter)-deep girders in less than 3 hours, compared to the 12 hours the contractor said it typically would take to install this number of box beams.

In a side-by-side comparison of a MaineDOT project, a 33-inch (84-centimeter)-deep by 48-inch (122-centimeter)-wide precast concrete box beam weighed about 784 pounds per linear foot (1,167 kilograms per linear meter), while the same depth and width of hybrid composite beam weighed in at 250 pounds per linear foot (372 kilograms per linear meter) with concrete placed in the arch section.

According to Jack Waxweiler, commissioner of the Lockport Township Highway Department, the project was extremely efficient. "It took approximately 90 minutes to set six beams," he says. "For traditional steel beams, this erection process would have taken a lot longer and required the use of heavier equipment. Instead, the hybrid composite beams arrived in one truck, which is much more time efficient and economical. This project finished 2 months ahead of schedule, and I credit the new beam technology for the unusually early completion of a bridge of this magnitude. I am confident that hybrid composite technology will reduce the necessary maintenance and repairs I see with other bridges. My goal is to maintain the best and

safest bridges and roads for Lockport Township residents, and I believe the hybrid composite technology helps accomplish this goal. Lockport Township residents are driving on a new state-of-the-art bridge structure."

In June 2009, the New Jersey Department of Transportation installed hybrid composite beams in its replacement of the Route 23 Peckman's Brook Bridge in Cedar Grove, NJ, also funded under the FHWA Innovative Bridge Research and Deployment Program. The 31-foot (9.5-meter) side-by-side girders each weighed only 2,200 pounds (998 kilograms), approximately one-tenth of the weight of each equivalent concrete beam. Workers used a methyl methacrylate material, which has high shear strength, to connect the beams.

MaineDOT also is constructing a hybrid composite beam project: the 8-span, 540-foot (165-meter)-long Knickerbocker Bridge in Boothbay, ME. The design for the beams is a modification of the one used for the Illinois and New Jersey structures, with wings projecting from the upper edges of each beam until they touch each other. This design provides continuous permanent formwork for the cast-in-place deck. Prototype beams have undergone more than 2 million fatigue cycles of successful load testing, failing at 60 percent beyond minimum design code requirements.

According to Nate Benoit, project manager for the MaineDOT Bridge Program, the department chose hybrid composite beams for the Knickerbocker Bridge for a number of reasons. "First, the bridge is in a saltwater environment with limited freeboard," he says, "and we wanted to take advantage of the high corrosion resistance that the hybrid composite beam shell provides. Second, the lightweight superstructure required only one crane and one barge to erect the bridge. Third, the lightweight superstructure reduced the dead load applied to the pile bents and allowed for a more economical substructure." All beams have been erected, and the project is on schedule for a June 15, 2012, completion.

Other State DOTs have plans to use the hybrid composite beams. For example, the Virginia Department of Transportation (VDOT) intends to use the technology on a bridge at Route 729 over Battle Run in Rappahannock County. VDOT is working with the Virginia Center for Transportation Innovation and Research and Virginia Tech's Cooperative Center for Bridge Engineering to research and deploy this and other FRP technologies and applications.

Reinforced Thermoplastics Technology

A third emerging technology for bridge applications is reinforced thermoplastics, which consist of 65 percent high-density polyethylenes blended with 35 percent polystyrene or polypropylene glass fibers. The resulting materials have a high resistance to corrosion, rotting, and insect infestation, making them excellent candidates for replacing deteriorated railroad ties. Reinforced thermoplastics also possess favorable durability and toughness characteristics without chemical additives.

Thermoplastics are lightweight, at 55 pounds per cubic foot, lb/ft^3 (881 kilograms per cubic meter, kg/m^3), compared to 60 lb/ft^3 (961 kg/m^3) for wood, 150 lb/ft^3 (2,403 kg/m^3) for reinforced concrete, and 490 lb/ft^3 (7,849 kg/m^3) for structural steel. Favorable engineering properties such as flexural, compressive, and shear stress make these materials a viable alternative for highway bridge applications.

In laboratory testing at Rutgers, The State University of New Jersey, Dr. Thomas Nosker also found that thermoplastics are virtually impervious to moisture, retaining their properties in humid and wet environments. Thermoplastics also are chemically resistant to most acids and salts, and resist abrasion by the salt and sand typical of marine environments. In addition, Nosker developed fire inhibitors that can be added to the formulation of reinforced thermoplastics and has requested fire resistance testing in accordance with ASTM International standards.

When deployed in bridge applications, reinforced thermoplastics represent a potentially long-lasting alternative to wood structures. According to Nosker, each year millions of tons of plastics are dumped in landfills worldwide. Diverting some of these materials to bridge applications represents an environmentally preferable solution for reusing a waste product in the context of replacing deficient low-speed, low-volume bridge structures. In addition, with the application of concrete or asphaltic concrete to the deck, reinforced thermoplastics could be an option for an even greater range of applications.

John Hillman, HC Bridge Company, LLC

This view from below the Knickerbocker Bridge shows adjacent beams with wing extensions.

Claude Napier, VDOT

The U.S. Army built this railroad bridge at Fort Eustis in Newport News, VA, using recycled structural plastic materials, also known as reinforced thermoplastics.

Reinforced Thermoplastics In the Field

Most of the initial bridge applications using reinforced thermoplastics have been on U.S. Army base installations, including at Fort Bragg, NC, Fort Eustis, VA, and Fort Leonard Wood, MO. The Army's interest in the technology was prompted by the need for corrosion-resistant, high-strength bridges with low life-cycle costs and a high return on investment. And, Army officials were aware of Nosker's work in the late 1980s on recycled plastic lumber.

The Army subjected the bridges to load testing involving jeeps and tanks. The Fort Leonard Wood structure, installed in 1998, involved a 24-foot (7.3-meter)-long by 26-foot (7.9-meter)-wide deck replacement on existing abutments. The bridge was designed for a maximum load of 25,000 pounds (11,340 kilograms), which would accommodate the base's military vehicle traffic. The structure at Fort Bragg is an all-thermoplastic bridge—pilings, pile caps, and deck—that was completed in 2009 and successfully load tested with a 70-ton (63.5-metric ton) M1 Abrams tank.

At Fort Eustis, in 2010, the Army completed two railroad bridges with most components consisting of recycled structural plastic materials. The four-span, 36.5-foot (11.1-meter) and eight-span, 84-foot (25.6-meter) structures were designed for appropriate American Railway Engineering and Maintenance-of-Way Association design loads and deflection criteria.

Aside from retaining the existing timber abutments, the Army decided to use reinforced thermoplastic materials in all remaining elements and components, including the railroad ties, curbs, girders, shear blocks, pier caps, piling, and transverse connectors. Researchers measured deflections during locomotive load testing to be approximately 0.25 inch (6.35 millimeters) on each bridge, which was within 0.03 inch (0.762 millimeter) of estimated deflections and met the railway association's criteria.

The New Jersey Department of Environmental Protection (NJDEP) funded construction of the first known reinforced thermoplastic bridge for automobiles in Wharton State Forest in 2002. The 56-foot (17-meter)-long structure was designed for standard highway bridge loadings and included reinforced thermoplastic bents and I-beams. "NJDEP already had funding available and was interested in a lightweight, low-maintenance structure," Nosker says. "It was aware of our work at Rutgers and asked us to build the bridge. It took four of us 11 days to complete the bridge, using 30,000 pounds of material. We would have needed 90,000 pounds of conventional timber to complete the job. After nearly 10 years in service, the bridge is still performing very well."

Axion International, Inc., a company based in New Providence, NJ, is producing and marketing the reinforced thermoplastic materials. Counties in Maine and Ohio are in the process of designing highway structures using reinforced thermoplastics. The North Carolina and Virginia DOTs also have expressed interest in the material. In addition, reinforced thermoplastics are finding their way into other infrastructure applications such as marinas, fenders, boardwalks, culverts, and temporary, reusable bridges.

AASHTO Implementation

The American Association of State Highway and Transportation Officials' (AASHTO) Technology Implementation Group has evaluated the two highlighted FRP technologies and reinforced thermoplastics. Specifically, AASHTO's assessments addressed the following factors: (a) adequacy of field testing, (b) potential for substantial benefits, (c) potential for widespread application, (d) necessity of technology promotion, (e) primary implementation challenges, (f) potential for champion agencies, (g) existence of patent situations, and (h) marketing level needed.

Based on these assessment factors, members of the AASHTO Subcommittee on Bridges and Structures' Technical Committee T-6 Fiber Reinforced Polymer Composites ranked the three technologies as focus areas for the near future. The committee determined a high level of desirability for advancing the rigidified FRP tube arches and hybrid composite beams, and a moderate level of desirability for the reinforced thermoplastics. MaineDOT has volunteered to be the lead State, taking on the next step in the implementation process, which will include conducting a market analysis and developing a marketing plan for technology implementation. Other State DOTs represented on the team include Massachusetts, Michigan, Missouri, and New York, along with the Maine Composites Alliance and the University of Maine.

Benefits of FRP Technologies

Based on the experiences gained from the field deployments and assessments performed by the participating agencies, these emerging bridge technologies can yield a number of benefits. First, these materials offer a reduced carbon footprint and have the potential to achieve a minimum 100-year service life using 80 percent less cement than concrete. FRPs are lightweight—on the order of 10–20 percent (based on calculated unit weights of the materials) of the weight of concrete—and are corrosion resistant. In addition, they consistently exceed the bridge design code requirements for strength specified by AASHTO's Load and Resistance Factor Design guidelines.

Finally, FRPs support FHWA's Every Day Counts initiative, which aims to identify and deploy innovations to shorten project delivery, enhance safety, and protect the environment. Toward that end, FRPs offer solutions for project delivery and congestion relief by accelerating bridge construction with prefabricated elements and systems.

Challenges With Implementation

Despite the success of completed field installations and backing from FHWA and AASHTO, these technologies continue to face impediments to widespread deployment. One challenge is the sole source nature of the emerging products, which would require the need for alternate bid designs.

Manufacturing capacity currently is limited to one supplier. Also common to each is the lack of AASHTO-approved vehicular design standards, which is where the Technology Implementation Group comes in with its evaluations. For the reinforced thermoplastics technology, the current lack of capability to attach a crash-tested bridge railing that meets AASHTO design standards limits the number of applications with vehicular traffic. Also, researchers have not yet investigated the application of a proven deck overlay material. Other challenges include the need for education in the use of these new FRP technologies and for developing procedures for load rating and conducting safety inspections of these types of bridges.

Toward Commercialization

The emergence of these technologies is one measure of the success of FHWA's Applied Highway Infrastructure Research Program on Composite Materials, which was implemented in the 1990s. That program identified two interdependent measures: field implementation and private sector involvement. Each of these three technologies has involved private sector companies with manufacturing know-how, marketing expertise, and regional or national sales organizations. Engineers who have an understanding of composite structural design have provided the engineering design. Together, with public sector leadership, these private sector innovators are pursuing the promise of an improved driving experience for the American public.

Building on this successful track record, highway agencies, industry, and academia are continuing to move forward in developing and deploying FRP composites and reinforced thermoplastic technologies in infrastructure applications. With the backing of AASHTO and recent naming of a lead State (Maine) to spearhead ongoing evaluations, researchers will continue to advance these technologies through field testing and monitoring, verification of structural properties, and assessment of short- and long-term structural performance. With all partners working together, these technologies are on track to finding greater acceptance and adoption across the country.

Louis N. Triandafilou, P.E., has been with FHWA for more than 36 years in various field office bridge engineering positions, including 12 years in the Office of Technical Services and Resource Center. Since February 2011, he has served as team leader for the Bridge and Foundation Engineering Team in the Office of Infrastructure Research and Development. Triandafilou received a B.S. in civil engineering and a B.A. in business administration from Rutgers, The State University of New Jersey. He also completed graduate structural engineering courses at Northeastern University. He holds a P.E. license in Ohio.

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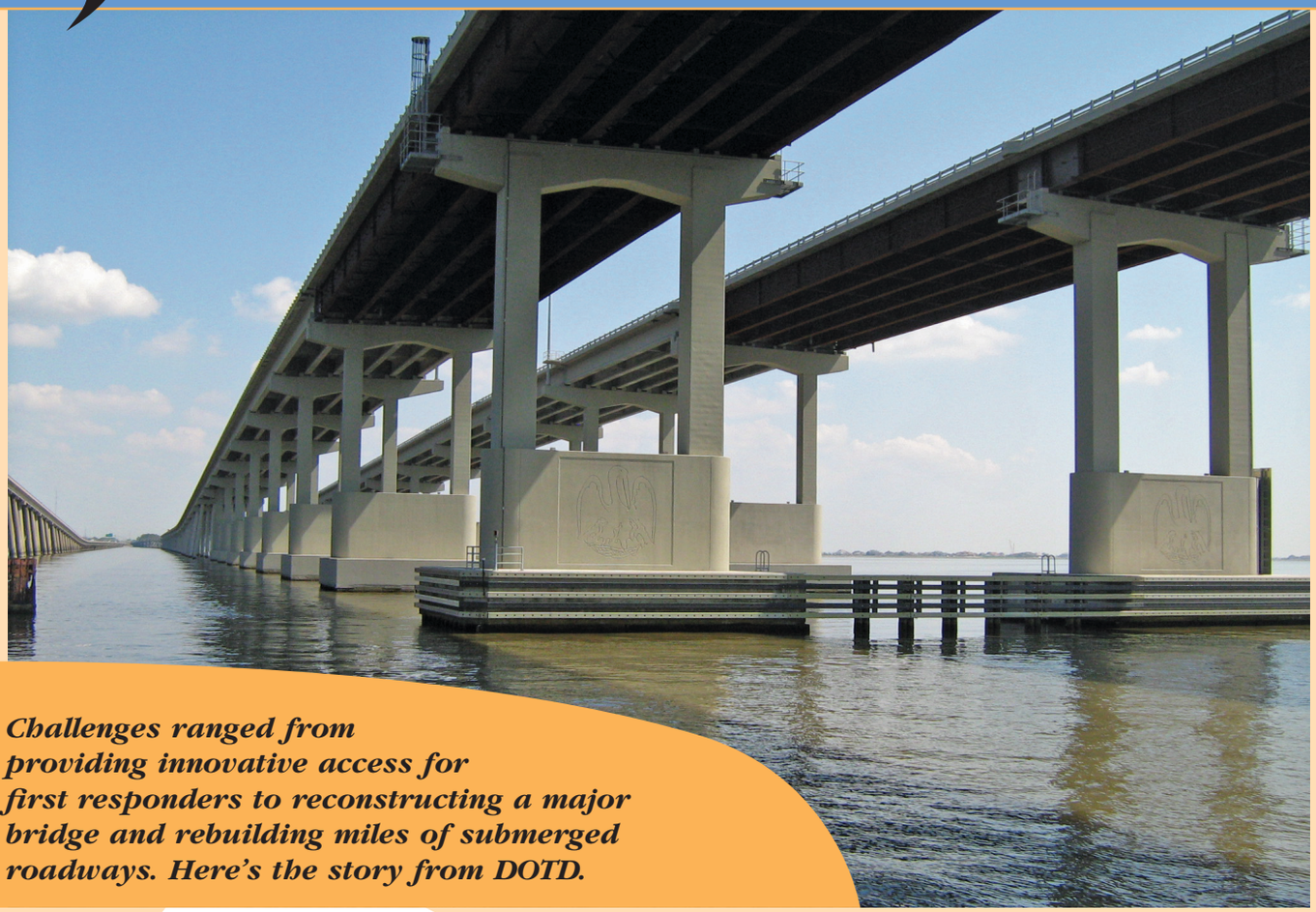
This closeup shows the Fort Eustis railroad bridge's pilings, pile caps, I-beams, and railroad ties. *Photo: Claude Napier, VDOT.*



Challenges ranged from providing innovative access for first responders to reconstructing a major bridge and rebuilding miles of submerged roadways. Here's the story from DOTD.

Louisiana's Recovery

by Lauren J. Lee and Bambi Hall

Hurricane Katrina roared ashore on August 29, 2005, bringing unprecedented destruction to Louisiana and the Gulf Coast. For days, the eyes of the world focused on New Orleans as the city battled rising floodwaters and evacuees fled. Some who remained had to be

(Above) The I–10 Twin Span Bridge, which leads east out of New Orleans across Lake Pontchartrain, is shown here after repairs of severe damage caused by Hurricane Katrina's storm surge. *Photo: Louisiana DOTD.*

(Right) During the surge, many of the bridge's concrete spans tumbled off their piers and into Lake Pontchartrain, making the bridge impassable. *Photo: Louisiana DOTD.*

plucked from rooftops by helicopters, while others sought shelter at the Louisiana Superdome. Images from the worst natural disaster in American history remain vividly etched into the national psyche.

The regional transportation infrastructure was not immune to the destruction brought by the hurricane. In the New Orleans area, roadways such as La. 23 were literally torn apart, and docking structures along the Mississippi River collapsed. Frighteningly, segments of the Interstate 10 (I–10) Twin Span Bridge were ripped apart, leaving hundreds of 65-foot (20-meter)-long concrete slabs in the water and rendering the 5.5-mile (8.9-kilometer) structure impassable.

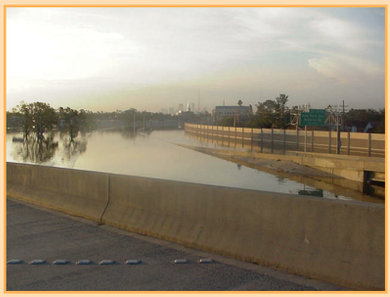
To date, more than $2.4 billion has been invested to revitalize the region's infrastructure. What follows is the story of the recovery from the perspective of the Louisiana Department of Transportation & Development (DOTD) in the context of the overall Federal response.

Humanitarian Responses

Given the immediate damage and levee breaches, DOTD's first priority was assisting with rescue and recovery operations. Ferry boats saved more than 6,000 people in St. Bernard Parish alone. In the Hammond area, DOTD employees assisted their coworkers and neighbors with food, water, equipment, and supplies. The department's prompt response also included debris removal and infrastructure repairs. In addition, DOTD initiated a call center for the public to obtain road closure information and to report roadway debris.

In the days following the storm, DOTD Secretary Sherri H. LeBas, P.E. (at the time, facilitator for the department's Change Management Program) coordinated housing accommodations for DOTD employees whose homes had been damaged or destroyed. Working with the Federal Emergency Management Agency (FEMA), LeBas secured temporary shelter at local hotels, for which DOTD was reimbursed by FEMA, and identified long-term housing in FEMA trailers placed on the department's property.

(Right) On La. 23, which runs along the Gulf Coast in Empire, LA, these boats landed across the road, tossed like toys by the powerful storm surge. *Photo: Louisiana DOTD.*



(Above) As shown in this photograph taken on August 30, 2005, Interstate 10 in New Orleans was underwater. *Photo: Louisiana DOTD.*

"We were able to secure housing for our employees so they could then effectively do their jobs in assisting the citizens of New Orleans in debris removal, roadway cleanup, damage assessment, signal repair and signage," says LeBas.

In addition to reaching out to employees in need, DOTD called on regional personnel to make the roadways passable for supply trucks and first responders. DOTD District 02 Administrator Mike Stack, P.E., was at that time the New Orleans district design and water resources engineer, and served as an engineering adviser to area levee districts. Stack was one of the first responders to the 17th Street Canal levee breach, immediately coordinating resources and personnel to begin repairs. Using his engineering knowledge and experience, and calling on public employees and the limited materials and equipment available near the breach, he had a makeshift road built to access the site.

Stack explains, "We used large stone and broken concrete found along the nearby Lake Pontchartrain shoreline as a base and placed it directly into the breach, using dump trucks and bulldozers. We then covered it with recycled asphaltic

This leaning telephone pole was one of many that complicated the post-hurricane cleanup of streets in New Orleans. *Photo: FEMA.*

FEMA

This house ended up straddling a highway in South Louisiana.

concrete from a stockpile found nearby. The recycled asphalt was fine enough to fill voids between the large stone, and the top layer created a riding surface. This method did two things. It allowed us to bring equipment and resources directly to the breaches, and while not totally stopping the flow, it did provide enough of a closure to allow pumping to resume and the draining of the city to begin."

In other humanitarian efforts, DOTD teamed with FEMA to begin LA Swift, a bus service that offered displaced New Orleans residents a free ride to and from work. Before the end of the year, DOTD also restored the famous New Orleans streetcars that were damaged by Hurricane Katrina.

I–10 Twin Span Bridge

The I–10 Twin Span Bridge, two parallel structures spanning Lake Pontchartrain between New Orleans and Slidell, was severely damaged by the violent storm surge that accompanied Katrina. Damage assessment teams from DOTD, supported by consultants, went to work as soon as the winds began to subside. What they found was startling evidence of the storm's fury.

"The rising water, combined with the battering of the waves, shifted a number of concrete spans off their piers," recalls Arthur D'Andrea, P.E., the department's assistant bridge design administrator. "The eastbound bridge was missing 38 spans with another 170 misaligned. The westbound bridge was in worse shape, with 26 spans in the lake and another 303 knocked askew. Each of these spans weighed in excess of 255 tons [231 metric tons]."

The destruction of the Twin Span Bridge, combined with damage to nearby U.S. 90, left the two-lane U.S. 11 bridge as the only eastern route into New Orleans. Knowing that the recovery of the region would require a viable transportation link, DOTD personnel went to work on a bid package for emergency repairs. Within 12 days, the department accepted a $30.9 million bid from Boh Bros. Construction Co. of New Orleans. The repair plan called for using undamaged segments from the westbound bridge to fill gaps in the eastbound structure and to open one lane of traffic in each direction. The construction team worked day and night to complete the work 17 days ahead of schedule. Later, DOTD's contractor used prefabricated steel panels to repair the westbound bridge, completing the work 9 days ahead of the 120-day contract deadline.

Excluding the high-rise section that accommodates the navigation channel, much of the 42-year-old bridge featured a vertical clearance of only 8.5 feet (2.6 meters). DOTD determined the best course of action was to replace the existing Twin

(Right) These cranes are helping reconstruct the I–10 Twin Span Bridge.

Louisiana DOTD

(Above) This makeshift road was built to access the 17th Street Canal in order to close the floodwall breach. The method, devised by DOTD's Mike Stack, proved so successful that the U.S. Army Corps of Engineers used it to close many of the breaches in the levees.

Louisiana DOTD

Louisiana DOTD

Sections of La. 23, shown here on September 12, 2005, were torn apart during Hurricane Katrina, as were other roadways in South Louisiana.

Span Bridge with a wider, taller, more robust structure that would be better able to withstand surges driven by hurricane-force winds.

The department secured approximately $803 million in funding from the Federal Highway Administration (FHWA) and broke ground for the new Twin Span Bridge only a few days before the 1-year anniversary of the storm. "Rebuilding this bridge was essential to the recovery of the New Orleans region," says FHWA Division Administrator Charles "Wes" Bolinger. "I–10 is a vital artery for this area, and its reconstruction has been a priority for everyone involved."

The original bridge accommodated two eastbound and two westbound travel lanes. The new bridge features two parallel spans, each 60 feet (18 meters) wide, and capable of supporting three 12-foot (3.7-meter) travel lanes bounded by 12-foot shoulders. The new bridge is 30 feet (9 meters) above the waters of Lake Pontchartrain and 21 feet (6 meters) higher than the former Twin Span Bridge. A high-rise section spans the navigational channel and provides 80 feet (24 meters) of vertical clearance.

Not only is the new Twin Span Bridge redesigned to withstand powerful storm surges and unexpected events, but also it is equipped with an unusual and complex monitoring system. The system includes sensors along one pier from the foundation of the bridge up to the roadway. The sensors will be able to detect when the structure has been hit along the instrumented area by anything ranging from a barge to a storm surge. This capability will enable DOTD to take immediate action to ensure safe travel for drivers, as well as extend the life of the bridge by monitoring its health over the years.

In addition, a weigh-in-motion scale will measure the weight of trucks traveling over the bridge. With this technology, DOTD will be able to monitor the impacts of each truck's weight on the structure and foundation. The comprehensive monitoring system will allow DOTD officials to identify when the bridge is overloaded, evaluate the structure's performance, respond quickly to unexpected incidents, and perform repairs as needed. This data also will assist in designing future bridge projects in Louisiana.

The first span opened to eastbound traffic in July 2009 and westbound traffic in April 2010. Eastbound and westbound drivers currently share the eastbound approaches while the westbound approaches remain under construction. Final completion is slated for mid-2012.

Louisiana DOTD

A long section of the rebuilt I–10 Twin Span Bridge is shown here, along with the high-rise section for the navigation channel.

Submerged Roads Program

The devastation from hurricanes Katrina and Rita, coupled with the subsequent failure of critical flood protection systems, led to massive flooding that lasted up to 5 weeks. Nearly two-thirds of the Federal-aid road network in Orleans and St. Bernard parishes was covered by water saturating the roadway subbases. Emergency response, debris removal, demolition, and construction in the months following the storms compounded the situation. As traffic returned to the roadways prior to their reconstruction, the damage continued to worsen.

FEMA

These workers are helping clear debris from a street.

The needs of the region's road network were so great that they had to be addressed through multiple forms of assistance. The South Louisiana Submerged Roads Program was and continues to be a critical component of that process. This extensive program to repair and restore roads provides hope to residents who are still rebuilding in the aftermath.

"The devastation of Hurricane Katrina left many roadways in the New Orleans region impassable with huge volumes of debris requiring disposal," says FHWA Project Delivery Team Leader Carl Highsmith. "Some debris haul routes required restoration, as these routes were further damaged due to being submerged and carrying heavy debris-laden trucks."

Sponsored jointly by FHWA's Louisiana Division, DOTD, and the New Orleans Regional Planning Commission (RPC), the Submerged Roads Program repairs may be funded under FHWA's Emergency Relief Program. Between July 2007 and the end of 2010, construction was completed on 12 roadway segments and underway on another 24, with completion of the final 20 segments anticipated by December 2011. More than $118 million currently is invested in the program.

Determining which roads were in need of funding was a collaborative effort by DOTD, FHWA, RPC, and local governments. The agencies identified street segments based on factors such as the extent of damage (determined through FHWA damage inspection reports), use and importance of the roadway, and public interest and concerns.

In addition to receiving support from dedicated funding for emergency relief, the Submerged Roads Program teamed with local government agencies to cover ineligible cost items under the Federal Emergency Relief Program. Nonemergency funding so far has included more than $3 million from the RPC and local government matching funds. This additional funding helped improve the quality of life for area residents by enhancing projects while still avoiding costly delays. For example, in collaboration with FHWA, DOTD, and RPC, the New Orleans Department of Public Works installed enhancements such as curbs and landscaping. In addition, $10 million in American

Louisiana DOTD

New Orleans' historic, tree-lined St. Charles Avenue is one of the roads repaired through the South Louisiana Submerged Roads Program. Here, only part of the pavement sign remained after the hurricanes.

Louisiana DOTD

This roadside sign provides motorists with contact information for the South Louisiana Submerged Roads Program, a comprehensive federally funded effort to restore roads that were damaged as a result of hurricanes Katrina and Rita.

Causeway Boulevard Interchange Project

The Causeway Boulevard Interchange Project will ease congestion and improve safety at this heavily traveled interchange, used by approximately 178,000 drivers each day. The Louisiana DOTD is executing the project in two phases. Phase I will build new ramps from northbound Causeway to westbound I–10, from westbound I–10 to northbound Causeway, from westbound I–10 to Veterans Boulevard, and from northbound Causeway to Veterans Boulevard. Work on the $35.6 million (Phase I) project began in April 2009 and is substantially complete.

Phase II is a mirror-image project of the first phase and will provide elevated eastbound and westbound ramps for southbound Causeway Boulevard drivers who are approaching I–10. This construction will eliminate the friction with ground-level traffic coming from Veterans Boulevard. At ground-level, the project will provide separate ramps for drivers approaching I–10 from Veterans. Work on the $51 million project, funded with Federal dollars, began in November 2009 and is expected to be completed in summer 2012.

Recovery and Reinvestment Act (ARRA) of 2009 funding combined with Submerged Roads funds to support construction of bicycle paths throughout Orleans Parish.

"Not only is the Submerged Roads Program restoring roadways to their previous condition," says Highsmith, "with the addition of American Recovery and Reinvestment Act funding, it is also providing funding for enhancements. Also, the repairs to the roads and infrastructure are helping to fuel recovery and investment in residences and businesses in the city."

The program is repairing or replacing more than 80,280 linear feet (24,469 meters) of sidewalks and planting more than 1,125 trees along Submerged Roads corridors to help reestablish the tree canopy. The program also is adding 72,026 linear feet (21,953 meters) of shared-use lanes and 51,016 linear feet (15,550 meters) of dedicated-use bike lanes to the preexisting system. DOTD Secretary LeBas says the addition of these enhancements is one of the hallmarks of the Submerged Roads Program. Those enhancements would not have been possible without close coordination that reaped "the highest return on investment for the public," she says. "Improvements add to the quality of life for residents, area business owners, and visitors alike. Our commitment is not just to rebuild New Orleans, but to rebuild it better by adding a complete streets approach. We want roadways that support the local economy and community and provide an enhanced environment for pedestrians, cyclists, and disabled citizens."

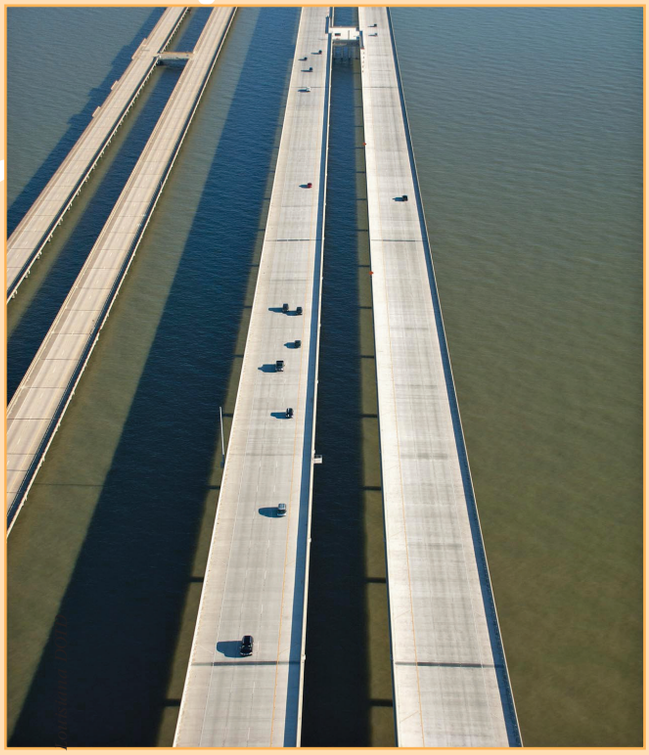
Through careful coordination, DOTD incorporated an additional $5 million from the RPC and $15 million from the Louisiana Recovery Authority into the program so the Sewerage and Water Board of New Orleans could repair or replace broken water lines in advance of street work. This effort streamlines the process and lessens the inconvenience to neighborhoods, local businesses, and motorists.

Last Word

South Louisiana's infrastructure suffered extensive damage due to hurricanes Katrina and Rita and the flooding that resulted. Having made considerable progress to date, Louisiana continues to rebuild and repair its road networks, with assistance from the Federal Government. An estimated $175 million to $200 million is scheduled to be let to construction in the New Orleans region during the remainder of 2011 and 2012.

Signs of South Louisiana's recovery and rebuilding in the years following the devastating storms are evident as well in newer infrastructure projects, such as the Causeway Boulevard Interchange Project in Jefferson Parish, intended to relieve traffic congestion. (See "Causeway Boulevard Interchange Project" on this page.) "This type of project is indicative of the region's continued growth in the years after the storms," says LeBas, "as well as the area's thriving spirit."

The Louisiana Governor's Office of Homeland Security and Emergency Preparedness provides valuable information on hurricane evacuation and emergency preparedness at http://gohsep.la.gov and encourages individuals and families to visit the site and establish a game plan.



An aerial view of the new I–10 Twin Span Bridge, taken December 2, 2010.

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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 Fatality Rate Drops to Lowest Level Since 1949

Early projections by the National Highway Traffic Safety Administration (NHTSA) indicate that U.S. traffic fatalities in 2010 fell to the lowest level since recordkeeping began. The decrease in fatalities occurred despite an estimated increase of 20.5 billion vehicle miles traveled (VMT) nationwide in 2010.

The number of traffic fatalities fell 3 percent between 2009 and 2010, from 33,808 to 32,788. Since 2005, fatalities have dropped 25 percent, from a total of 43,510 fatalities in 2005. The same estimates also project that the fatality rate will be the lowest recorded since 1949, with 1.09 fatalities per 100 million vehicle miles traveled, down from the 1.13 fatality rate for 2009. Regionally, the greatest drop in fatalities occurred in the Pacific Northwest States of Alaska, Idaho, Montana, Oregon, and Washington, with a 12 percent drop. Arizona, California, and Hawaii had the next steepest decline, nearly 11 percent.

USDOT has taken a comprehensive approach to reducing roadway fatalities by promoting strong traffic safety laws while stepping up high-visibility enforcement. The Department also has worked to make roadways safer through vehicle safety programs and public awareness campaigns such as "Over the Limit. Under Arrest." to curb drunk driving and "Click It or Ticket" to increase seatbelt use.

USDOT officials, while pleased with the reduction in fatalities, are steadfast in their commitment to making U.S. roads as safe as possible. Officials say they will continue to promote initiatives to remind drivers to put safety first, including increasing seatbelt use and putting an end to drunk and distracted driving.

USDOT Funds Innovative Technologies To Reduce Congestion

In March 2011, USDOT awarded more than $9.5 million for 15 projects in 13 States and Puerto Rico that employ innovative construction technologies. The awards support projects that will improve safety, reduce congestion, and create high-quality, long-lasting highways and bridges.

Administered through the Federal Highway Administration's (FHWA) Highways for LIFE program, the money is intended to encourage use of proven technologies and practices that are not yet widely deployed within the particular State. The projects will use innovations such as prefabricated bridge elements, precast concrete pavement slabs, road safety audits (RSAs), and shoulder paving techniques proven to reduce crashes.

USDOT awarded the grants to projects focused in three areas: those that facilitate faster construction, those that assure longer life of pavements and structures, and those that cause less traffic disruption. For example, one project will replace a bridge deck with a prefabricated deck, greatly reducing construction time by eliminating lengthy steps required in traditional methods. Another project, involving reconstruction of an interchange, will use performance contracting and a two-step, best value design-build procurement process expected to cut construction time in half.

Technical News

Device Helps Predict Cold-Weather Cracking in Asphalt Binder

Cold temperatures can cause asphalt pavements without the proper binder to crack, leading to premature roadway deterioration and costly repairs. The results of a recent FHWA Highways for LIFE Technology Partnerships grant project confirmed the accuracy and usability of the Asphalt Binder Cracking Device to help pinpoint the temperature at which asphalt binder will crack.

The project evaluated the Asphalt Binder Cracking Device as a means to determine the susceptibility of various binders to thermal cracking using a three-study, interlaboratory approach. Led by the Ohio-based company that developed the device, 23 public and private laboratories conducted the tests. In the first study, the laboratories evaluated the performance of the Asphalt Binder Cracking Device. The second study involved comparing use of the device with Bending Beam Rheometer testing, another method for measuring low-temperature properties of asphalt binders. Lastly, a third study modified the Asphalt Binder Cracking Device testing procedure to improve its precision.

The results indicated that the precision estimates of the Asphalt Binder Cracking Device cracking temperature

EZ Asphalt Technology, LLC

The Asphalt Binder Cracking Device system includes a computer (left) to collect data and to control the environmental chamber (right).

EZ Asphalt Technology LLC

Inside the environmental chamber, asphalt binder is poured around metal rings inside silicone molds, and then cooled at a controlled rate until the binder samples crack.

MoDOT

These workers are using an under-bridge inspection unit to perform a biennial indepth inspection on a bridge in Columbia, MO.

and those of the Bending Beam Rheometer critical temperature were comparable. The American Association of State Highway and Transportation Officials has voted to adopt the Asphalt Binder Cracking Device test method as a provisional standard, the first step toward final adoption as a standard. The test procedure will be included in a 2011 edition of AASHTO specifications.

For more information, visit www.fhwa.dot.gov/hfl/partnerships/asphalt.cfm.

Public Information and Information Exchange

FHWA Launches New Bridge Safety Initiative

On March 21, 2011, FHWA announced an initiative to enhance oversight of how bridge owners are performing their bridge inspections and maintenance. The initiative uses 23 key inspection program areas derived from the National Bridge Inspection Standards that will help FHWA identify improvement opportunities in each State and provide for more consistency in oversight nationwide.

Prior to the initiative's launch, FHWA conducted a largely unstructured annual review with written summary reports of States' bridge inspection programs based on the outcome of assessments of key inspection areas. Under the new system, FHWA uses a data-driven, risk-based assessment of specific inspection areas, such as bridge load limits, qualifications of inspection personnel, and inspection frequency. The assessments are based on defined criteria for each of the 23 program areas. FHWA records the results of the oversight process in a database for documentation and reporting purposes. Because the new system is based on more objective data, it provides for more consistency in the inspection program and more targeted approaches to identifying problem areas.

Other steps FHWA has taken to improve bridge safety include double-checking data submitted by States; conducting workshops on bridge inspection, management, and preservation; developing bridge inspection training programs; and creating working groups for States, industry, and academia to share best practices. All these efforts support FHWA's goal of improving the safety of the Nation's bridges.

For more information, contact Thomas D. Everett at thomas.everett@dot.gov.

South Florida Event Encourages Students To Consider Transportation Jobs

The Florida Department of Transportation (FDOT) recently held its 9th annual South Florida Construction Career Days event in Davie, FL, to introduce students to jobs and educational opportunities in the construction industry. The event also seeks to improve the representation of women and minorities in construction and engineering jobs. Partnering with FHWA and more than 70 local contractors, consulting firms, and organizations, FDOT and Florida's Turnpike Enterprise hosted about 1,700 students representing 54 local secondary schools and technical programs.

During the event, students participated in various job-related activities, labs, and discussions. Participants had the opportunity to operate construction equipment such as a backhoe, bucket truck, concrete drum, front-end loader, and crane. In addition, students could try out Florida Highway Patrol safety simulators and inspect tow trucks and emergency vehicles. Students received instruction on work zone safety, structures and bridge design, concrete testing, site development, signalization, and filming public service announcements. Several institutes of higher learning were onsite to advise students on 4-year courses of study and job-specific curricula. Local businesses sponsored mock interviews and showed students how to write cover letters and résumés.

Hendry County Commissioner Karson Turner, who attended the event and observed students from his county participating in a variety of activities, says, "It's

A student affixes a road sign to a sign post in the FDOT Maintenance Road Rules lab during South Florida Construction Career Days.

really important for kids to be exposed to events like this and to know that construction is a heck of a place to be right now."

For more information, contact Carey Shepherd at 850-553-2206 or carey.shepherd@dot.gov.

FDOT

Highway Traffic Reaches Highest Level Since 2007

FHWA's *Traffic Volume Trends* report shows that U.S. motorists drove 3 trillion miles in 2010, the most VMT since 2007 and the third highest ever recorded. The increase means more wear and tear on the highway system and underscores FHWA's focus on repairing and enhancing the Nation's roads and bridges. The increase also comes at a time when U.S. traffic fatalities have dropped to the lowest level in recorded history.

According to the December 2010 report, drivers in the United States drove 20.5 billion more miles in 2010 than in the previous year. In December alone, travel increased by 0.6 percent, or 1.4 billion VMT, compared to December 2009. Regionally, the South Gulf area, a bloc of eight States ranging from Texas to Kentucky, experienced the greatest increase in December 2010 with 46.6 billion VMT, an increase of 624 million miles traveled compared to the previous December.

Traffic Volume Trends is a monthly report based on hourly traffic count data reported by the States. FHWA releases the reports at www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm. Transportation officials use the data to make decisions about infrastructure investments.

Competition Generates New Wildlife Crossing Solutions

Collisions between wildlife and vehicles have increased by 50 percent in the past 15 years, costing the United States $8 billion annually. The ARC International Wildlife Crossing Infrastructure Design Competition recently took on the challenge of finding innovative solutions for safer wildlife crossings. Participants designed engineering and architectural solutions with the goals of ensuring the safety and mobility of motorists, while creating safer crossings for wildlife.

To provide singular site conditions for the designs, the competition asked competitors to propose design concepts specifically for a wildlife crossing at West Vail Pass on I-70 in Colorado, about 90 miles (145 kilometers) west of Denver. Selected from 25 potential candidates in 16 States, the location is on a critical transportation corridor and the only east-west interstate in Colorado. At the same time, the interstate can be a barrier to the movement of wildlife in the Rocky Mountain region. Designers had to account for many challenges, including snow and severe weather, high elevation and steep grades, a six-lane roadway, a bicycle path, high traffic volumes, and multiple species of wildlife.

The competition jury announced the winner at the Transportation Research Board's 90th Annual Meeting in January 2011. The winning design, developed by HNTB with Michael Van Valkenburgh Associates, Inc., of New York, features a concrete bridge that is 328 feet (100 meters) wide and spans 176 feet (53.6 meters) over the highway. The design calls for the bridge to be planted with a variety of vegetation types including a pine tree forest and meadow grasses to attract different species. The modular precast concrete design allows for partial construction offsite, shortening construction time and

The winning design in the ARC International Wildlife Crossing Infrastructure Design Competition features a precast concrete bridge that crosses the highway and is planted with vegetation, as shown in this rendering. *Photo: HNTB Corporation and Michael Van Valkenburgh Associates, Inc.*

minimizing disruption to the traffic flow. There are no commitments currently to construct the structure.

For more information on the competition and all design finalists, visit www.arc-competition.com.

PBIC Launches Web Site for Bike Commuters

In March 2011, the Pedestrian and Bicycle Information Center (PBIC) launched a new Web site containing resources and guidance on commuting by bicycle and organizing Bike to Work events. The "Bike to Work" site at www.biketoworkinfo.org provides resources for beginner bicycle commuters, advanced bicycle commuters, and other stakeholders who want to promote bicycle commuting. Resources include tips for riders, downloads for event organizers, facts for the news media, and information for employers and sponsors.

The home page includes a "Programs in Motion" section, which shares success stories from Bike to Work programs around the country. Visitors also can submit their own success stories using this section of the Web site. Also from the home page, event planners can select their event dates and create planning calendars. One of the main features of the site is the discussion forums, which enable bike commuters to network with one another by posting questions and responding to other posts. Forum discussions cover topics such as tips for planning Bike to Work events, commuting strategies, pointers, and resources. In addition, the site hosts an image library where site visitors can browse and submit images related to bicycling.

This site is funded by FHWA and maintained by the PBIC, which is housed within the University of North Carolina Highway Safety Research Center.

PBIC

Mexico to Host 24th World Road Congress

On September 26–30, 2011, Mexico City will host the 24th World Road Congress. Organized by the World Road Association (PIARC), the conference offers transportation professionals an opportunity to learn about the latest state-of-the-art technologies in the road infrastructure sector. For the first time in nearly two decades, the international event will take place in North America.

"The World Road Congress is a must-attend event for transportation professionals and practitioners," says FHWA Executive Director Jeffrey Paniati, who is also the United States' first delegate to PIARC and coordinator for PIARC's strategic theme Safety of the Road System. "The event provides an excellent venue to discuss technological advances and best practices showcasing innovation, progress, and new directions in all areas of road transportation—from road safety and administration to infrastructure, sustainability, and maintenance."

Past events have attracted more than 5,000 delegates from government agencies, corporate institutions, and international associations.

For more information, visit www.aipcrmexico2011.org.

PIARC

Internet Watch

by Alicia Sindlinger

Volpe Center Library Celebrates 40 Years With Facelift

The Volpe Center Technical Library and Information Center supports staff at the John A. Volpe National Transportation Systems Center and others engaged in transportation research. Over the past four decades, the library has helped transportation professionals address major national and international issues related to safety, security, environment, mobility, and economic growth and trade. In 2010, to celebrate 40 years supporting the transportation industry, the library received major enhancements—onsite and online.

At a celebration in October 2010, the library officially opened its doors at its new location in the main building on the Volpe Center campus in Cambridge, MA. The new location is more convenient for most users than the previous facility in another building, and the space is more accommodating for group gatherings. In addition to the physical space, the library launched an updated Web site. The new site, available at www.volpe.dot.gov/library, also aims to make library resources more accessible.

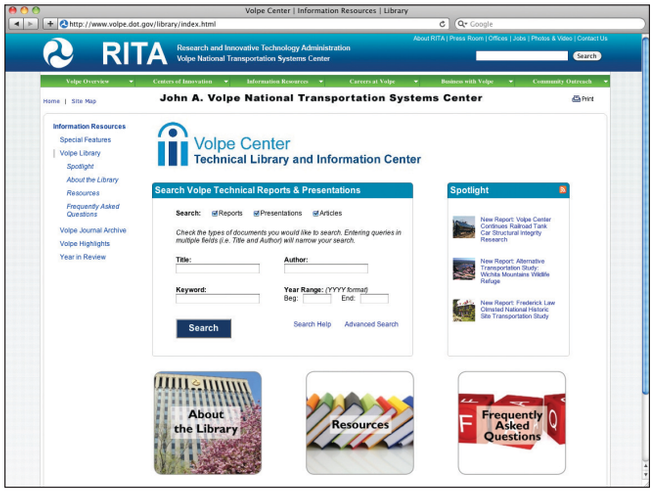
"Our goal with the new and improved library—both the new space and new Web site—is to have more people use the facility and resources," says Volpe Center librarian Susan Dresley, who has worked at the library since 1980. "We're now better positioned to serve as a knowledge-sharing hub for transportation professionals."

Using the Library

The Volpe Center library has an extensive collection of more than 27,000 books and technical reports, 180 professional and general interest journals, and 250,000 microfiche titles. The collection covers all aspects of transportation, as well as computer science, economics, engineering, environment, management, psychology, public policy, and statistics. Also included in the collection are reports and publications by other transportation agencies and associations, such as the Federal Aviation Administration, Federal Highway Administration, National Highway Traffic Safety Administration, and Transportation Research Board.

The library is staffed by a professional information specialist skilled in data storage, retrieval techniques, and research methods. The specialist can help to identify documents, conduct literature searches, locate materials on interlibrary loan, and keep track of transportation-related Web sites and publications available on the Internet. The librarian also provides additional services, such as project-specific support, to Volpe Center staff.

To further support knowledge-sharing efforts, Volpe Center recently established a partnership with the Research and Innovative Technology Administration's National Transportation Library (NTL). The partnership will make the Volpe Center's catalog holdings available through the library's catalog and full-text versions of Volpe Center's publications accessible at http://ntl.bts.gov.



Improving Web Site Functionality

The library's online presence is essential for providing transportation researchers across the country with access to the library's resources. The Web site serves as a starting point for research and self-serve access to materials. The primary goal of the updated site design was to make all Volpe Center publications easily accessible to the research community. Accordingly, the new home page prominently displays a publication search box with which users can search by author, keyword, title, and date range.

The database search is the site's most used function. However, before the update, some of the content in the database, particularly for older Volpe Center reports, was sparse and lacked URLs, keywords, and abstracts. Library staff worked to enhance the database by adding keywords and abstracts. The library is planning additional enhancements to digitize older reports and make them available online. Currently there are more than 4,200 records in the database.

In addition to the database search, visitors to the site will notice several other new features and functions on the home page. A spotlight feature box displays new or recently added publications. The spotlight, which is connected to a popular Really Simple Syndication (RSS) feed, is updated approximately every 10 days. New navigational links also appear in three graphics below the search and spotlight boxes. The links provide access to the site's other key areas: "About the Library," "Resources," and "Frequently Asked Questions."

"The site enhancements—visually and functionally—help to facilitate the information-gathering process," says Dresley. "Researchers and others looking for transportation resources now have a much improved tool at their fingertips."

For more information, contact Susan Dresley at 617-494-2117 or susan.dresley@dot.gov.

Alicia Sindlinger is a contributing editor for PUBLIC ROADS.

Training Update

NATIONAL HIGHWAY INSTITUTE

by Alicia Sindlinger

Understanding the Value of Value Engineering

For more than four decades, value engineering has been part of the concept development and design phases of Federal-aid transportation projects. Although the value engineering process itself essentially has remained the same during this time, its importance has never been more significant than it is today, according to Jeffrey Zaharewicz, former value engineering program manager in the Federal Highway Administration's (FHWA) Office of Program Administration. With FHWA's focus on enhancing safety, shortening project delivery time, deploying technology and innovation, and protecting the environment, value engineering is more relevant than ever before. At its core, value engineering aims to reduce costs while improving project quality and function.

To help transportation professionals put value engineering into practice, the National Highway Institute (NHI) recently updated its Value Engineering Workshop (FHWA-NHI-134005), a 3-day course in which participants learn how to serve as members of a value engineering team and conduct the related analyses. Host organizations also have the option to request longer versions of the course (4 or 5 days), depending on their needs.

"Within the project development process, value engineering is a way for transportation professionals to review project details in a collaborative setting and really assess plans to ensure cost-effective and high-quality work," Zaharewicz says. "NHI's training will prepare participants to be effective members of future value engineering analysis teams."

Getting the Most Out of Transportation Projects

Value engineering is a systematic process for reviewing and analyzing a transportation project during the concept and design phases. After a project is selected for analysis, the value engineering process involves six phases: (1) investigate and analyze the design of an existing project, (2) analyze project functions and costs, (3) creatively speculate on alternative ways to perform the various functions, (4) evaluate the best and/or least life-cycle cost alternatives, (5) develop acceptable alternatives into fully supported recommendations, and (6) present the recommendations to management.

Value engineering analysis teams are made up of multidisciplinary professionals who are not directly involved in developing the project they are reviewing. State agencies can use in-house staff or gather team members from engineering firms or FHWA division offices. Team members' areas of expertise depend on the scope of the project being analyzed.

According to FHWA's *Fiscal Year 2009 Value Engineering Accomplishment Report*, more than 420 value engineering analyses were performed in 2009. From these analyses, teams proposed more than 3,290 recommendations. The analyses and approved recommendations resulted in more than $1.7 billion in savings on transportation projects nationwide.

Participants brainstorm project alternatives during a session of the Value Engineering Workshop in Colorado.

Updating the Training Course

Traditionally, the Value Engineering Workshop was a 5-day course, requiring a major time commitment for participants. To address State agencies' requests for more flexibility, NHI and a group of subject matter experts recently redesigned the course to offer various session lengths.

States now can choose from 3-day, 4-day (FHWA-NHI-134005B), and 5-day (FHWA-NHI-134005C) formats. Participants are exposed to the same content and activities in each version, but the longer versions have more time for in-class exercises. Organizations interested in hosting a session should consult with the instructor or the FHWA technical contact to determine the appropriate course length.

The update includes a Web-based training prerequisite, Introduction to Value Engineering (FHWA-NHI-134005A), which covers basic value engineering concepts before participants attend the in-person workshop. "The Web-based training establishes a baseline understanding of value engineering . . . prior to attending the instructor-led portion of the class. The change in the course design enabled NHI to focus classroom time on interactive workshop activities, and also offer a shorter version of the course for State highway agencies requesting that option," says Marty Ross, NHI training program manager. The Web-based training, available on the NHI Web site, also may be taken as standalone training.

During the classroom training, participants work in teams to complete exercises that follow the phases of value engineering. Each team works on a real-world project selected by the host agency and executes the activities done during each of the phases. In the final phase, the teams present their recommendations to fellow participants and, when possible, to host agency project leaders and decisionmakers.

For full course descriptions, visit www.nhi.fhwa.dot.gov.

Alicia Sindlinger is a contributing editor for PUBLIC ROADS.

Communication Product Updates

Compiled by Zachary Ellis of FHWA's Office of Corporate Research, Technology, and Innovation Management

Below are brief descriptions of communications 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 FHWA's Research and Technology (R&T) Product Distribution Center (PDC).

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:

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For more information on R&T communications products available from FHWA, visit FHWA's Web site at www.fhwa.dot.gov, the FHWA Research Library at www.fhwa.dot.gov/research/library (or email fhwalibrary@dot.gov), or the National Transportation Library at ntl.bts.gov (or email library@dot.gov).

Finite Element Analysis of UHPC: Structural Performance of an AASHTO Type II Girder And a 2nd-Generation Pi-Girder (TechBrief) Publication No. FHWA-HRT-10-079

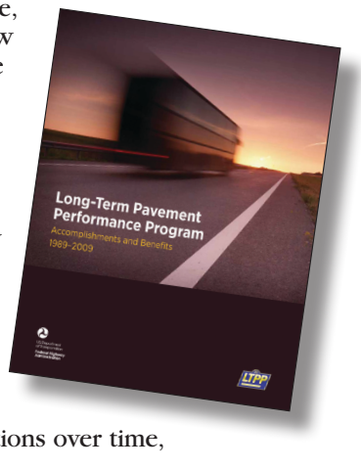
UHPC is an advanced cementitious composite material that exhibits exceptional durability, increased strength, and long-term stability. FHWA conducted a research program aimed at developing general modeling concepts within a commercially available software package to facilitate the development of UHPC structural systems including bridges. This TechBrief highlights the research techniques and the results of the program.

The research focused on calibrating the proposed finite element models to a series of completed full-scale structural tests on existing UHPC structural components, including a prestressed UHPC American Association of State Highway and Transportation Officials (AASHTO) Type II girder and prestressed UHPC second-generation pi-girder. Researchers found the proposed modeling techniques to be effective.

The document is available at www.fhwa.dot.gov/publications/research/infrastructure/structures/10079/index.cfm. Printed copies are available from the PDC.

Long-Term Pavement Performance Program: Accomplishments and Benefits 1989–2009 Publication No. FHWA-HRT-10-071

The need for information on how pavements perform over time became a critical issue for highway agencies in the early 1980s, when roads built two or three decades earlier started to show clear signs of deterioration. The Long-Term Pavement Performance (LTPP) program started in 1987 as part of the Strategic Highway Research Program (SHRP), and continued under FHWA when the SHRP ended in 1992. This report highlights what researchers have learned to date, discusses innovations and new products generated under the program, outlines LTPP's critical role in pavement design, and points to the future of the LTPP program.



Since 1989, the LTPP program has monitored nearly 2,500 pavement test sections throughout the United States and Canada. Approximately 950 test sections are still being monitored today. By collecting and analyzing data from these pavement test sections over time, researchers are gaining insights on how and why pavements perform as they do—learning how to build better, longer lasting, and more cost-effective pavements.

The LTPP program has generated a wide range of benefits across the spectrum of pavement engineering and performance. The benefits and products from the LTPP program fit into three categories: the LTPP database, advances in pavement performance measurement, and contributions to pavement design and management. The LTPP database is the single largest benefit from the program, providing reliable pavement performance data for thousands of requestors throughout the academic community and the public and private sectors. The database is the foundation for fundamental and applied research, and the nucleus for advancements in pavement design and management processes.

The document is available at www.fhwa.dot.gov /publications/research/infrastructure/pavements /ltpp/10071/index.cfm. A summary of the full report (FHWA-HRT-10-072) is available at www.fhwa.dot.gov /publications/research/infrastructure/pavements /ltpp/10072/index.cfm. Printed copies of both publications are available from the LTPP Customer Support Service Center at 202–493–3035 or ltppinfo@dot.gov.

LTPP Computed Parameter: Dynamic Modulus (TechBrief)
Publication No. FHWA-HRT-11-018

The dynamic modulus, |E*|, is a fundamental property of asphalt concrete mixtures that defines strain response characteristics as a function of loading rate and temperature. The primary objective of this project, completed under FHWA's LTPP program, was to develop estimates of the dynamic modulus of hot-mix asphalt layers on LTPP test sections following the models used in the *Mechanistic-Empirical Pavement Design Guide*. This TechBrief provides a technical summary of the project including an introduction and explanations of the objective and application.

The significance of |E*| is threefold. First, it is one of the primary material property inputs in the *Mechanistic-Empirical Pavement Design Guide* and software developed by the National Cooperative Highway Research Program. Second, |E*| is one of the primary properties measured in the asphalt mixture performance test protocol that complements volumetric mix design with mechanical properties. Third, |E*| is one of the fundamental linear viscoelastic material properties that pavement designers can use in advanced pavement response models based on viscoelasticity.

Given the significance of |E*|, populating the LTPP database provides a valuable data source for the pavement community. Supplementing the full suite of material properties, performance history, and traffic and climate data with |E*| estimates is advantageous in conducting *Mechanistic-Empirical Pavement Design Guide* calibration, validation, and implementation. As a result of this study, more than 1,000 layers in the LTPP database now have |E*| estimate information available.

The document is available at www.fhwa.dot.gov /publications/research/infrastructure/pavements /ltpp/11018/index.cfm. Printed copies are available from the PDC.

LTPP Pavement Performance Forecast (Product Brief)
Publication No. FHWA-HRT-10-080

Developed as part of the Transportation Pooled Fund study "Effect of Multiple Freeze Cycles and Deep Frost Penetration on Pavement Performance," TPF-5(013), the LTPP Performance Forecast produces freeze and thaw performance predictions for both rigid and flexible pavements. This Product Brief introduces the product, discusses its application and use, and provides an example.

State, county, and local highway agencies can use the LTPP Performance Forecast to estimate performance trends for pavement sections of interest in specific user-defined environmental settings. Using the LTPP Performance Forecast, researchers can compute roughness, structural cracking, environmental cracking, rutting, and faulting predictions as a function of pavement age. The forecasts are based on user-defined inputs such as traffic, structural, environmental, and subgrade conditions.

Because the study's main objective was to quantify the impacts of frost on pavement performance, the model covers both frost and nonfrost regions and is applicable to a range of climates. The online component is available at www.ltpp-products.com.

The brief is available at www.fhwa.dot.gov /publications/research/infrastructure/pavements /ltpp/10080/index.cfm. Printed copies are available from the PDC.

Reporting Changes of Address

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

Free copies are distributed to offices of the Federal Highway Administration, State highway agencies, technology transfer centers, and selected leaders who have responsibility for highway-related issues. Most of these copies are mailed to offices for their internal distribution or to people by position title rather than by name. If any office or individual subscriber in this category has a change of address, please send the complete previous mailing address and the complete new address to our distribution manager, Paula Magoulas, via email (paula.magoulas@dot.gov), telephone (202–493–3398), or mail (Paula Magoulas, PUBLIC ROADS Distribution Manager (HRTM), Federal Highway Administration, 6300 Georgetown Pike, McLean, VA, 22101-2296).

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Conferences/Special Events Calendar

Date	Conference	Sponsors	Location	Contact
September 20–23, 2011	35th International Symposium on Bridge and Structural Engineering	Organized by International Association for Bridge and Structural Engineering and International Association for Shell and Spatial Structures	London, United Kingdom	Symposium Secretariat + 44 (0) 207 973 4617 r.gardner@hgluk.com www.iabse-iass-2011.com
September 26–30, 2011	XXIV World Road Congress	World Road Association and Secretariat of Communications and Transport of Mexico	Mexico City, Mexico	Rodolfo Felix + 52 (55) 51 71 60 50 rfelix@aipcrmexico2011.org www.aipcrmexico2011.org
October 13–17, 2011	AASHTO Annual Meeting	American Association of State Highway and Transportation Officials (AASHTO)	Detroit, MI	Monica Russell 202-624-3696 mrussell@aashto.org www.michigan.gov/aashto
October 16–19, 2011	Rail~Volution 2011	See conference Web site for a list of sponsors.	Washington, DC	Adam Cummings 503-823-6870 info@railvolution.com www.railvolution.com
October 16–20, 2011	World Congress on Intelligent Transport Systems	Intelligent Transportation Society of America	Orlando, FL	Nicole Oliphant 202-721-4215 noliphant@itsa.org www.itsworldcongress.org
October 25–28, 2011	AMPO Annual Conference	Association of Metropolitan Planning Organizations (AMPO) and North Central Texas Council of Governments	Dallas, TX	Maria Staunton 202-296-7051 x4 mstaunton@ampo.org www.ampo.org
October 27–28, 2011	5th Asphalt Shingle Recycling Forum	Presented by Construction Materials Recycling Association	Dallas, TX	Shawna Bohan 303-779-7910 shawna@shinglerecycling.org www.shinglerecycling.org
November 2–3, 2011	Improving Transportation Safety Programs Through University-Agency Partnerships	Transportation Research Board (TRB)	Washington, DC	Tom Palmerlee 202-334-2966 tpalmerlee@nas.edu Matthew Miller 202-334-2966 mamiller@nas.edu www.TRB.org
November 15–19, 2011	8th International Conference on Managing Pavement Assets	Pontificia Universidad Católica de Chile and TRB	Santiago, Chile	Alondra Chamorro (56-2) 3544244 techicmpa2011@ing.puc.cl www.icmpa2011.cl

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