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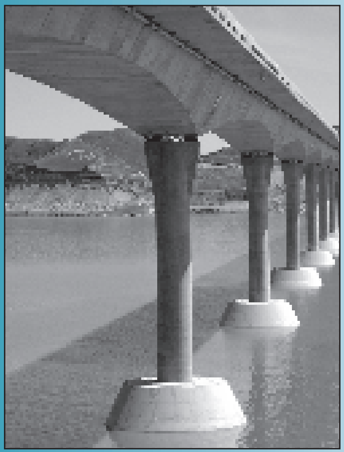

COVER: Four Bears Bridge, which opened in October 2005, is an exemplar of context-sensitive design. (Photo by Mike Kopp, North Dakota DOT)

TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

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A TRB study committee has assessed the future of traditional transportation finance, notably through the fuel tax, and has identified financing alternatives. The committee gave special attention to methods of charging fees that relate directly to the cost of providing services, such as tolls and mileage charges, and recommended immediate changes to strengthen the highway and transit finance system, as well as actions to prepare the way for more fundamental reform.

Each year Americans spend about $20 billion to replace approximately 200 million tires on their passenger cars and light trucks, and the choices affect the handling, traction, comfort, and appearance—as well as the fuel economy—of their vehicles. At the request of Congress, a study committee examined the rolling resistance characteristics of passenger tires and how changes in tire designs and materials to reduce rolling resistance can influence other tire attributes.

ALSO IN THIS ISSUE:

COMING NEXT ISSUE

The September–October *TR News* focuses on freight transportation, with feature articles and editorials by government and industry leaders, economists, and expert observers, covering policy, trends, security, and more, with special emphasis on containerization, the shipping revolution now celebrating its 50th anniversary.

Containers in the port of Charleston, South Carolina

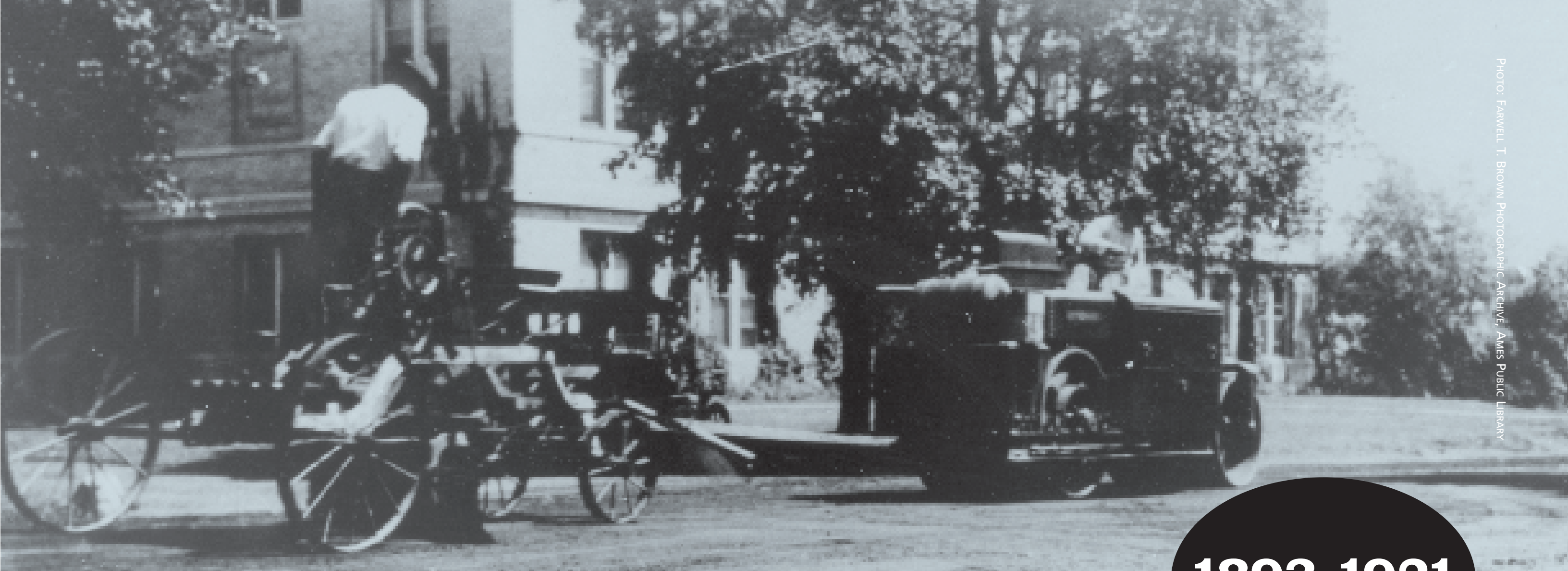

Photo: Farwell T. Brown Photographic Archive, Ames Public Library

1893–1921

The Beginning of State Highway Administrations

Engineers Take Control

BRUCE E. SEELY

The author is Professor of History and Chair, Department of Social Sciences, Michigan Technological University, Houghton.

Above, road work at Iowa State College, Ames, before 1920, under the direction of the Iowa Highway Commission, which was headquartered in the college's engineering hall until 1924.

In 2005, five states celebrated the centennials of the formation of their departments of transportation, marking decisions that helped set the pattern for the acceptance of state responsibility for the development of highways. A few states had created highway commissions earlier, but many more followed in the decade after 1905. Ten years later, Congress required each state to establish a strong highway department, with administrative authority and adequate budgets, to participate in the federal highway program and to receive the first federal-aid highway funds. By then, the pioneering highway commissions created in and before 1905 had established the basic patterns for the operation of state highway administrations.

Officials within those state organizations have worked with their counterparts in the federal government for the past century to oversee the largest public works project in history—the American highway system. The enormous popularity of the automobile was the ultimate reason for embarking on this project, but the goal of developing road-based transport systems predated the automobile, drawing on demands from bicyclists and rural reformers.

The various advocates of better roads eventually concluded that their hopes rested on the creation of administrative agencies at the state level to develop and construct improved highways. The typical structure for state highway administrations developed between 1895 and 1920, yet the story of how and why state highway departments and highway commissions came about involves politics more than technological change.

Good Roads Movement

The Good Roads Movement began in the United States in the mid-1880s, spurred by the introduction of the safety bicycle, the first inexpensive personal vehicle. Early riders venturing beyond city streets discovered that the nation's roads were terrible—dusty ruts in dry weather and impassable mud holes in the rain.

The first road census, conducted in 1904, confirmed that only 154,000 of more than 2 million miles of roads had received any kind of improvement and that paving was almost nonexistent. The League of American Wheelmen (LAW) and other

Bicyclist organizations, like the League of American Wheelmen (*above*, members of the Kentucky Division), were instrumental in the Good Roads Movement.

bicyclists spearheaded the initial push for road improvements and in 1893 persuaded Congress to create an Office of Road Inquiry within the Department of Agriculture, to disseminate information about better roads.

Joining bicyclists as early supporters of road improvements were many of the nation's railroads. Railroad officials saw roads as feeders for rail traffic and steadily pressed for better farm-to-market roads from rail stations into the countryside. Railroads underwrote the cost of good-roads trains that toured states promoting road improvements, with exhibits of road machinery, models of road construction techniques, public lectures, and demonstrations, often in a carnival-like atmosphere. Sometimes a sample road was constructed as an object lesson to show local officials and residents the advantages of better roads.

Rural Reformers

By the mid-1890s, road improvement efforts gained the support of rural reformers whose initial goal was to extend rural free delivery of the mail. In 1896, the Post Office set minimum standards for the roads used for postal delivery, creating a new incentive for developing better roads. For the first time, rural residents saw a reason to support road improvements.

Other reformers interested in improving rural education, increasing the participation of rural farmers in elections, and connecting rural residents to the more expansive social and economic life of towns also pressed for better roads as the easiest way to make a difference in the lives of farmers and small-town residents.

Who Should Pay?

The challenge all reformers faced was deciding who should undertake road construction and maintenance and who should pay for it. Roads had been the province of local government, reflecting the nation's reliance on railroads, as well as the fallout from the economic depression of the late 1830s.

Many state governments had invested heavily in the first railroad and canal companies, only to take heavy losses when companies defaulted during the Panic of 1837. That financial disaster caused many legislatures to pass constitutional amendments prohibiting state participation in public works projects. The road reformers of the 1890s had to overcome this legal hurdle to be able to shift part of the burden of road construction from local governments to the state.

Road improvement advocates gained support in the general climate of reform and civic improvement in the United States during the late 1890s. The most high-profile reforms involved the Pure Food and Drug Act, prohibiting the sale of tainted meat and milk; the trust-busting efforts of Theodore Roosevelt; and calls for conservation.

Management by Experts

The Good Roads Movement was part of this reforming impulse and shared many elements with other calls for change. Reformers emphasized the need for efficient management to end waste, graft, and other forms of political corruption. Road reformers and others argued that good management could be achieved most easily by shifting administrative authority from politicians to experts, and from local to central agencies. Experts could develop standards, let contracts, and create systems that would give taxpayers the most for their money.

The battle cry was to replace political influence with the scientific knowledge of technical experts. Road improvement advocates proposed placing the new state highway agencies in the hands of engineers.

Several obstacles arose. Most Americans liked having the political control of roads close to home, an outlook that stemmed from a distrust of big government—an apparently enduring attitude. But local control also involved pocketbook issues, because property taxes then provided most of the funds for road projects.

Most county road programs allowed residents to work off their road taxes with one or two days a year of physical labor on the roads that passed their property. Few wanted to pay more—or to pay cash—for better roads, especially farmers who believed that good roads primarily served wealthy urban bicyclists and automobile owners. Road advocates faced a large political challenge in developing state-level highway administrations.

First Highway Departments

The process of developing state road organizations was relatively slow and sometimes painful, but the pioneer efforts of a few states proved the value of state-level highway programs and organizations. Three key elements in state road administration

Road construction in Michigan, one of the first states with an engineer highway commissioner.

appeared at the beginning, but fine-tuning the ideas into a general model for state highway departments required more than a decade.

Key Characteristics

The first idea was state aid for road projects, implemented in New Jersey in 1891. That year, the state legislature provided $75,000 to meet one-third of the cost of county road projects.

Massachusetts worked out the second part of this financial concept, how to ensure that the state funds would be used wisely. The legislature created the first state-level highway building agency—the Massachusetts Highway Commission—in 1893 to oversee the state-aid fund. The commission could require county officials to accept the technical standards and specifications established by the state agency in return for state funds. The first standards related to bridge design, an area that required formal engineering training, but standards eventually emerged for all aspects of road building.


Massachusetts Highway Commissioner Nathaniel Shaler of Harvard pioneered the state materials testing laboratory.

The third key element was to devote state funds to the most important roads and not at the whim of county road officials. Massachusetts granted the only substantial state funding for road improvements, with the state highway commission disbursing approximately $6.75 million between 1894 and 1903.

The Massachusetts commission included another element that would not become a standard part of the state highway agency structures for nearly 30 years—a materials testing laboratory. The impetus came from Harvard engineering professor Nathaniel Shaler, a member of the first commission, who had published an early treatise on road construction and launched the first university curriculum in highway engineering. Shaler also had developed a laboratory at the Lawrence Scientific School at Harvard to test materials, and he made the facility available to the highway commission. Road builders across the state could submit materials for testing. One of Shaler's first students, Logan Waller Page, ran the laboratory from 1892 to 1900, when he moved on to head the Division of Tests, Bureau of Chemisty, in the Department of Agriculture.

Following the Leads

Similar agencies slowly appeared in other states. New Jersey appointed a commissioner of public roads to oversee the state-aid fund in 1894, but the legislature did not inaugurate a regular highway commission until 1909. A handful of other states also followed the Massachusetts example; the state road agencies authorized in Connecticut and California in 1895 evolved for several years. In 1897, LAW launched a campaign in Minnesota to overturn a constitutional restriction on state participation in internal improvements. By 1899, six states had organized highway departments or commissions.

Unlike the Massachusetts commission, most of the new road offices lacked strong administrative authority and adequate financial resources. The Connecticut Commission, for example, struggled in its first years as legislators decided how much control the agency should have. Connecticut already had a version of state aid, with the state providing the bulk of the funds for local work. Commissioners also worked on creating construction plans and on developing standards, but not until 1901 was the commission required to hire an experienced road builder. In 1908 the commissioners began to focus on trunkline highways and to consider which roads to complete and how to fill the gaps in roads between towns.

The Connecticut process, however, worked a little better than North Carolina's. That state formed a weak highway commission in 1901 that went out of business only two years later. This was not a unique occurrence.


Construction of Fall River Road, the first road to cross the Rocky Mountains in northern Colorado, September 1915.

In 1909, Colorado formed a three-person highway commission to distribute $50,000 in state aid to counties, which had to match $2 in local funds for every $1 from the state. The commission was expected to develop a state system on a shoestring budget. In 1913 the legislature changed the commission into a state highway department that derived financial support from license fees and, one year later, from a .25 mill state tax.

Similarly, New Mexico formed a highway department in 1912, when the state had only 970 registered vehicles. The commission's total budget for 1912 to 1914, however, was less than $300,000.

Strengthening the Approach

This pattern of administrative and financial weakness slowly began to change, primarily because states gave a greater role to engineers. The pattern took shape in the East Coast and in the Midwest.

Photo: Iowa DOT

Anson Marston, the first Dean of Engineering at Iowa State College, served as the state's first highway commissioner in 1904, with C. F. Curtis, the college's Dean of Agriculture. One of Marston's former students, Thomas MacDonald, worked 15 years for the commission and left to become Chief of the U.S. Bureau of Public Roads, a position he held until 1953.

In 1904 Iowa adopted the novel approach of assigning the deans of engineering and agriculture at Iowa State College to serve as the state's highway commission, with the initial charge to make a general study of the state's road problems. The commission also was asked to develop a highway plan, demonstrate construction techniques, and spread information to county officials. By 1911, the commission had three full-time and two part-time employees at the college.

The year 1905 marked significant moves toward expert control as five states formed highway organizations: Maine, Minnesota, Michigan, Washington, and New Hampshire. Michigan acted because of the relentless efforts of Horatio Earle, an impassioned road advocate and engineer who became the state's first highway commissioner. Maine appointed Paul Sargent, an Office of Public Roads engineer, as its first commissioner.

Expert Control

California revamped its highway organization in 1907, adding a state highway engineer, and two years later, the legislature passed the first bond issue for roads. The importance of expert control can be seen by comparing the experience of Washington, which had formed a weak commission in 1905. It took four years for the organization to acquire basic control over local road building activities. In 1909, state officials gained some authority over contracts, and in 1911 they were charged with developing hard-surface roads for commercial uses, but the resources were far from adequate.

Road improvements in New York also were hampered by the lack of expert control. In 1898, the state embraced the principle of state aid to local and county road programs by giving the state engineer authority to approve petitions for funds. But in the next five years, only 59 miles of new roads were built out of the 1,308 miles requested. To speed construction, the legislature approved a $50 million bond issue in 1905, the largest road fund in the country for many years. Yet not until 1909 was a state highway commission charged with overseeing this program.

The New York legislation authorizing the commission also outlawed the payment of road taxes through labor and centralized control of construction and financing for state roads in Albany. But the new commission proved vulnerable to political influence and soon was bogged down with charges of graft and corruption. Officials were appointed on political criteria and the agency had no stability in leadership; political needs similarly shaped projects and con-

Photo: Farwell T. Brown Photographic Archive, Ames Public Library

The new Iowa Highway Commission building on Lincoln Way in Ames, 1924.

tracts. Because of the problems of waste and political interference, New York's road commission remained a disappointment throughout the second decade of the 1900s.

Office of Public Roads

The primary reason that states slowly began after 1905 to develop stronger, better-funded highway departments with a measure of control over local road building activities was the Office of Road Inquiry in the U.S. Department of Agriculture in Washington, D.C. Founded in 1893 in response to demands from LAW, the agency grew into the Office of Public Roads (OPR), as it was known from 1905 to 1918, when it became the Bureau of Public Roads. From the beginning, even before it administered federal funds for road construction, the office played a significant role in defining the structure and shape of state highway organizations.

The first director of the office, General Roy Stone, had been a lobbyist for LAW and authored a general state-aid road bill that state legislators could use for forming state highway agencies. Stone continued to provide this type of assistance as office director, although he was sensitive to the limits of federal authority. By 1895, he had fielded and responded to requests for legislation from Iowa, Connecticut, New York, Rhode Island, Kansas, and Michigan, where he volunteered to appear before the legislature.

Stone also drafted the bill that shaped the initial California highway department, met with the governor, and reported that the bill was "speedily adopted" by the legislature. Stone's legislative ideas resembled in basic features the state highway commission legislation from Massachusetts, which situated central authority for system development and standards in the state office and granted administrative authority to engineering experts, not to politicians. Stone's preferred model of a competent and efficient state highway agency, in other words, embodied the classic elements of progressive reform movements.

Engineer Influence

Later directors at OPR continued this pattern, especially Page, who arrived in Washington, D.C., from Massachusetts in 1900 to head the office's materials testing laboratory. In 1905, Congress mandated that the office be administered by an engineer, and Page was promoted. His main suggestion to the states was to emulate federal government policy by installing engineers as the directors of state road building. Even if the state commission was politically appointed, he maintained, engineers should control the road construction. Page also urged that state commissioners designate the road systems that were eligible for state aid, and that the state offices set specifications and standards for work by county roadbuilders.

After 1905, the federal office's efforts to assist in framing legislation for state highway agencies steadily increased. In 1907, OPR engineers lectured in support of state-aid bills in Delaware, Arkansas, and Washington, where the engineers canvassed the state from January through April before addressing the legislature. OPR distributed state-aid bills in California, Oklahoma, and Colorado in 1907, and in Kansas, Indiana, and Texas in 1909. By 1911, the office received so many requests for help that staff drafted a model bill that was distributed in at least 24 states.

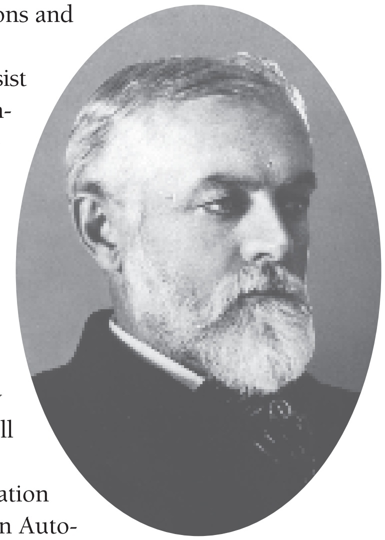

Photo: FHWA

General Roy Stone, a Civil War and Spanish-American War veteran was the first director of the federal Office of Road Inquiry, and the architect of many state-aid laws for road building. He also proposed the first parcel post, the first rural free delivery, and postal savings banks.

OPR was not the only source of information about state highway agencies. The American Automobile Association also distributed sample bills, and later the Lincoln Highway Association circulated its ideas about state highway agencies. Basic similarities are apparent in the content of the legislation advocated by these different organizations. Yet OPR had a special position in this process—its efforts after 1905 coincided with a steady upswing in the number of state highway departments.

In addition, the element of expert control became more common, as shown in the 1913 highway bill for Montana. The legislation created a highway commission under the control of three commissioners, all of them engineers: the professor of civil engineering at Montana State College, the state engineer, and an engineer appointed by the governor as chair of the commission.

Tortuous Paths

Despite its strong influence, OPR could not mandate that states form strong highway departments nor could it guarantee proper implementation. Tennessee, for example, underwent a long struggle to develop a state road-building agency. The legislature created a commission in 1907 but refused to renew its legal mandate in 1909. Not until 1913 was a bill passed allowing counties to issue bonds for road construction, and the state road department was not approved until 1915. This administrative agency, however, had no separate source of funds and was forced to work with county road officials. Only in 1923 did the state legislators agree on a reorganization plan that strengthened the department sufficiently to carry out a road program.

Kansas followed a similarly tortuous path to develop a competent state roads office. By 1909, many of the components of legislation in other states were in place, including a statewide good roads organization and assistance from OPR. A state

Histories of State Highway Departments

An Extended Bibliography

(Arranged alphabetically by state)

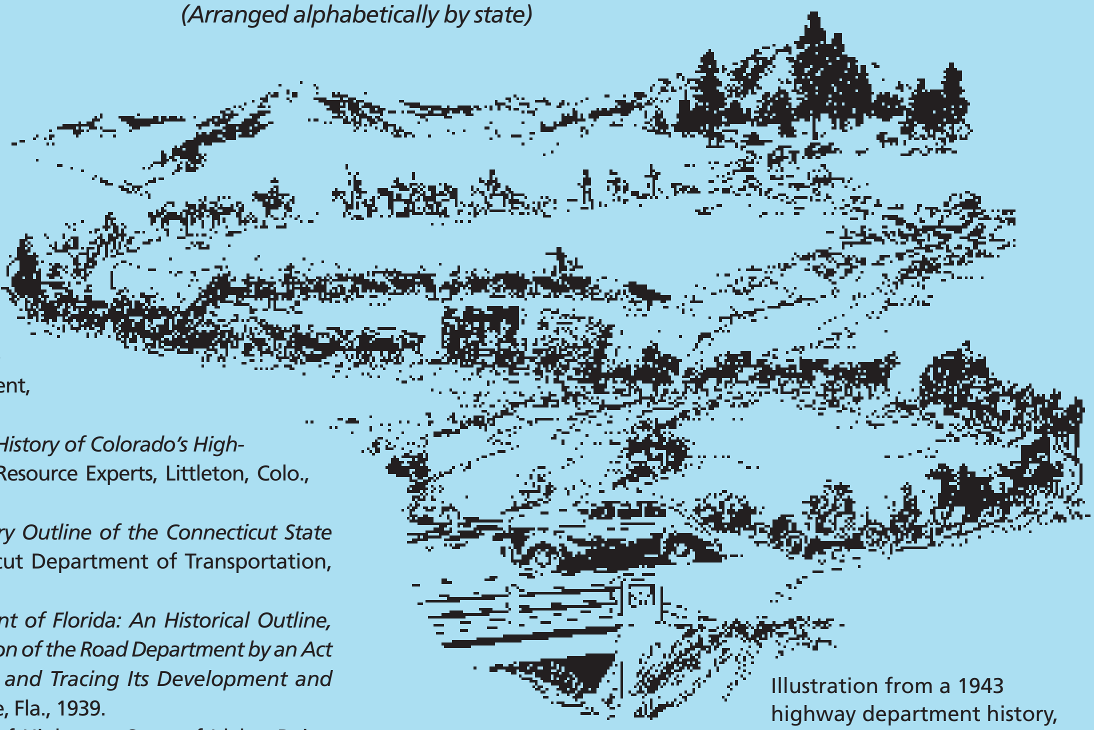

Illustration from a 1943 highway department history, showing the evolution of highway travel in Montana.

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highway engineer was appointed to work with the counties, which resisted the centralized control. Stymied in the legislature, supporters of good roads settled for legislation that created the position of state highway engineer to pass state funds to the counties, which would build the roads.

Federal-Aid Road Act of 1916

The final step in bringing professional state road-building agencies into all the states started with the passage of the Federal-Aid Road Act of 1916, which authorized the first federal funds for road construction. Pressed by Page and other state highway engineers, Congress accepted the concept of federal aid to the states with construction costs divided evenly.

But Congress also required the states to have in place highway departments that met OPR approval. This gave federal engineers a club with which they could force the states to create engineer-controlled highway agencies. Nearly every state had to make changes after 1916, as federal engineers set out to ensure that state engineers had sufficient authority and funding to carry out the tasks of developing the roads of greatest national significance.

Only California had to make no changes, and for some states, such as Michigan, the adjustments were minor. But 15 states, such as South Carolina, lacked a highway commission and had to establish an agency to qualify for federal-aid funds.

Three states passed constitutional amendments to allow state funding of internal improvements, 18 others had to strengthen or reorganize, and 15 had to make less extensive changes. OPR directly assisted 23 states in bringing their highway departments to minimum standards, often by drafting appropriate legislation. In Texas, Missouri, Indiana, and South Carolina, OPR assigned engineers to organize the new departments.

Even with this mandate, the task of forming competent and professionally managed state highway departments was not simple. Good roads supporters in Kansas, for example, hoped that the 1916 federal-aid bill would settle the debate between supporters of strong state authority and those who advocated local control of road work. The 1917 legislation designed to bring the state into conformity with OPR guidelines, however, required the new state highway commission to pass federal-aid funds directly to county road commissioners, who would provide the matching funds.

At least three times during the 1920s, a U.S. Senator had to add special language to the federal-aid highway bill granting Kansas more time to create an appropriately strong highway agency. Without these exemptions, the state would have lost its share of federal-aid funds. Not until 1929 was county control over roads dissolved and control given to the Kansas Highway Commission.

The historians of the Kansas Highway Department suggest that the state's resistance was the "last assault for a lost cause"—namely, the protection of citizen control of road construction. But few other states and citizen groups were willing to wage such a battle.

Many states in the South and the intermountain West were much less capable in terms of engineering and administration than those with longer histories, especially those on the coasts or in the industrial states of the Midwest. Arkansas, for example, nearly lost federal-aid funding in the mid-1920s because of excessive political interference in the affairs of the highway department.

But in general, professional state highway organizations directed by engineers and focused on efficient use of taxpayer resources for state road networks already had become the norm by the second decade of the 20th century. The Federal-Aid Highway bill provided the legislative muscle that moved the last holdouts into line. OPR's program of helping to create strong highway departments by working with the states before 1916 made possible the acceptance in Congress of the idea that America's highways could be built in a process consistent with federalism. The critical prerequisite was a strong highway department, which remains a cornerstone of American highway policy today.

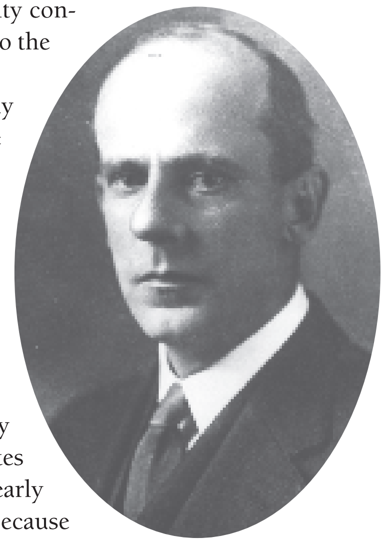

PHOTO: FHWA

Logan Waller Page applied his experience with the pioneering Massachusetts Highway Commission materials testing laboratory to assignments at the federal level, becoming director of the Office of Public Roads in 1905. He championed engineer control of state road building and was one of the founders of the American Association of State Highway Officials.

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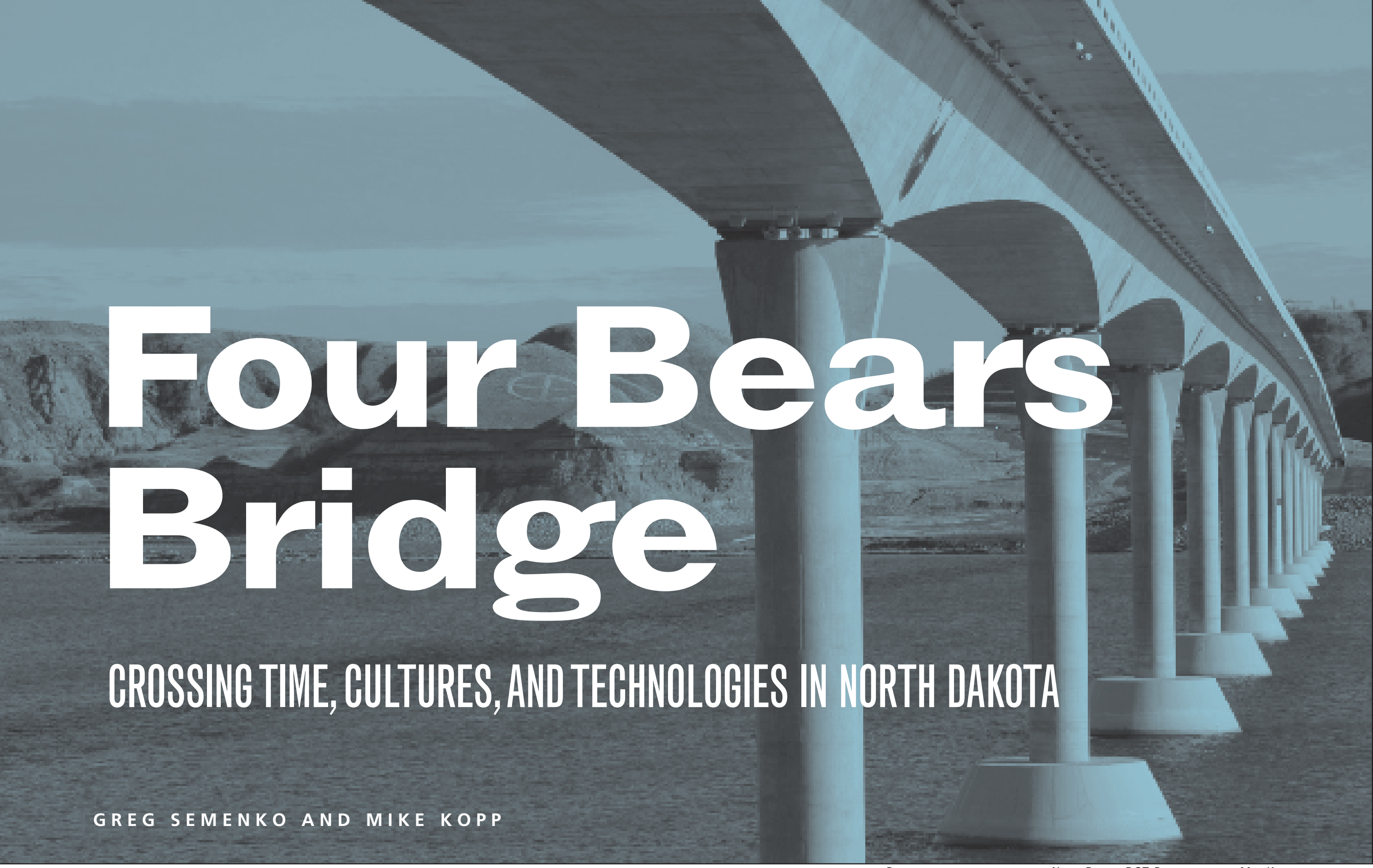


Four Bears Bridge

CROSSING TIME, CULTURES, AND TECHNOLOGIES IN NORTH DAKOTA

GREG SEMENKO AND MIKE KOPP

PHOTOS IN THIS ARTICLE COURTESY OF NORTH DAKOTA DOT. RECENT PHOTOS BY MIKE KOPP.

Semenko is Highway Materials Coordinator and Kopp is Multimedia Developer, North Dakota Department of Transportation, Bismarck.

Four Bears Bridge was built in 1934 across the Missouri River at Elbowoods in northwest North Dakota. The name stayed with the bridge when it was moved upriver because of the flooding after the construction of the Garrison Dam. The name transferred again to a new concrete segmental bridge completed in September 2005.

Each Four Bears Bridge has had a significant service life, symbolic to the people and vital to the economy of the area. All the bridges were on the Fort Berthold Indian Reservation, home of the Mandan, Hidatsa, and Arikara tribes, collectively known as the Three Affiliated Tribes.

Four Bears of the Mandan, one of the two chiefs for whom the successive bridges have been named.

Enlisting Support

Harold Case, a Congregational missionary working on the reservation, started the push for the first bridge in 1925. He formed the Elbowoods Bridge Association to unify support for his plan. The Association included area communities such as Minot, Killdeer, Mott, Dickinson, Stanley, Plaza, Ryder, Williston, Sanish, Elbowoods, Van Hook, and Shell Village. Some of the towns later were inundated when Garrison Dam created Lake Sakakawea.

With help from the Association, the North Dakota Highway Commission Chief Engineer, A. D. McKinnon, gave his support to the proposal in 1925. The bridge became a political issue in the congressional campaign of 1926. Transportation, economics, and tourism were the arguments for the bridge. Spanning the Missouri River, the bridge would open a route to move agricultural goods to markets, connect the Indian cultures on both sides of the river, and provide a way for tourists to the planned Theodore Roosevelt National Park.

Crowds and lines of automobile traffic witnessed the ribbon-cutting that opened the first Four Bears Bridge in 1934.

Naming the Bridge

The Elbowoods bridge construction began in 1932 and was completed in 1934. The ribbon-cutting was June 16, 1934, and the celebration lasted four days. Case wrote that "an estimated attendance of 25,000 from Canada to the Blackhills lent a hand" (*1*). Celebrants roasted a beef cow each day and were entertained with a rodeo, powwow, dances, and political speeches. At the dedication, the bridge was officially named Four Bears in memory of two Chief Four Bears, one Mandan and one Hidatsa.

The Mandan Chief Four Bears earned his name as a youth in a battle with the Sioux, when it was said that he fought with the strength of four bears. His exploits against the Assiniboin tribe and the Sioux nation were legendary, and he was admired by his people. He died in the smallpox epidemic of 1837. He had been a friend of white people, but when he contracted the disease, he cursed the whites for killing him and his family.

Because the Mandan tribe lived on the south side of the river, the south end of the bridge was dedicated to the Mandan Chief Four Bears. A two-story monument near the entrance of the bridge was dedicated to the Mandan chief.

The Hidatsa lived on the north side of the river, and the north end of the bridge was dedicated to their Chief Four Bears, who was recognized as a diplomat and was instrumental in the signing of the Fort Laramie Treaty of 1851. The treaty included transportation access through the reservation. The Chief was killed by the Sioux in the fall of 1861, while he was bathing in the river.

Opening Access

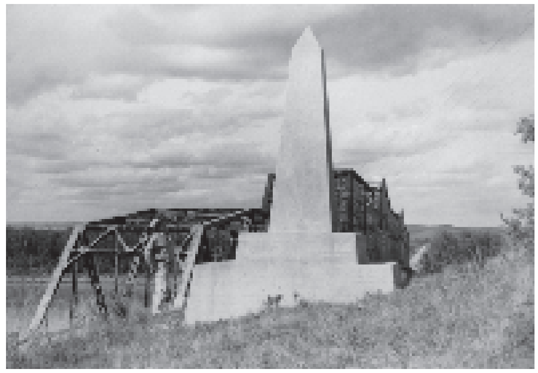
The opening of the bridge made North Dakota State Highway 8 a major route and put Elbowoods on the map. The bridge opened trade access for towns to the north such as Sanish, Parshall, and Elbowoods to cities in the south, such as Beulah and Bismarck, the state capital.

The bridge also created the opportunity for local business growth. The first convenience stores in the area sprang up between Parshall and Twin Buttes, selling tobacco, soda, and ice cream.

The bridge, however, contributed to the end of the ferryboat business that had transported people and goods across the river. When the bridge was dismantled in 1953 and 1954, the ferryboat business resumed for 18 months, keeping Highway 8 marginally functional.

Waters Rise

In 1947 construction began on the Garrison Dam, one of the largest rolled earth-fill dams in the world, 2.5 miles long and 210 feet high. The dam created one of the largest man-made lakes in the world—Lake Sakakawea's waters would have covered the Four Bears Bridge.



The monument to Mandan Chief Four Bears at the site of the first bridge is now covered by lake waters, with only the pinnacle visible above the surface at low water levels.

The federal government therefore decided to move the Four Bears Bridge before the dam was completed. In 1951 work began on the substructure for the second Four Bears Bridge on Highway 23, spanning the Missouri River to connect Mountrail and McKenzie Counties. The bridge would replace the nearby Verendrye Bridge at Sanish. New Town was established one year later so that people in the soon-to-be-flooded communities would have a new home with the modern conveniences of sanitation and water.

The rising lake water also flooded fertile farmlands, heavily wooded areas, cemeteries, sacred grounds, and a nationally renowned rodeo. The Sanish Rodeo was one of the largest and most popular in this part of the United States, attracting as many as 15,000 people, including Hollywood cowboys such as Gene Autry. The last Sanish Rodeo was held in 1953, a few hundred yards from the piers of the original Four Bears Bridge. A few months later, the rodeo grounds were under water.

Moving the Bridge

In 1953, while work was under way on the substructure at the new location, workers began dismantling the main truss section of Four Bears Bridge at Elbowoods. The components were trucked 50

The ferryboats that went out of business after the opening of the bridge returned when the bridge had to be dismantled and relocated in 1953.

Truss of the second Four Bears Bridge, spanning ice floes on the lake.

miles to the new location and stored for reassembly. After removal of the bridge and the flooding of the valley, all that was left was a dirt road for Highway 8.

Work on the superstructure of the second Four Bears Bridge at New Town began in 1954. Because the original truss section was only 1,425 feet long, 2,850 feet of deck truss and a deck girder span at each end had to be added for a total length of 4,483 feet.

The second Four Bears Bridge was completed in 1955. The grand opening took place October 1–3, 1955. Like the original bridge dedication 21 years earlier, this celebration included beef feasts, rodeos, powwows, dances, and speeches.

The second Four Bears Bridge connected the east–west North Dakota State Highway 23 and once again joined the two sides of the Fort Berthold Indian Reservation. Soon after the opening, however, the bridge's functional deficiencies became apparent.

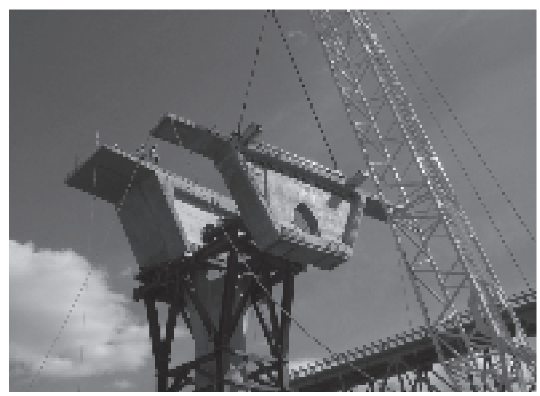
Workers position the final segment of the new Four Bears Bridge.

The 1934 bridge had two 10-foot driving lanes. In 1955, vehicles were longer, wider, taller, and heavier—it was a tight fit to get across the bridge. Traffic often stopped so that large loads could take up both lanes to cross the bridge. In addition, the height restrictions of 13 feet and 3 inches restricted the movement of goods and equipment.

The North Dakota Department of Transportation (DOT) researched alternative solutions to widening the structure in 1993. A replacement structure was the preferred solution. In 2001, North Dakota DOT and the Federal Highway Administration (FHWA) decided to remove the second Four Bears Bridge and replace it with a wider bridge, 100 feet to the north. The Three Affiliated Tribes, North Dakota DOT, and FHWA worked together to secure federal funds for the project.

New Bridge Construction

Plans for the new bridge called for two 12-foot driving lanes, two 8-foot shoulders, and a 10-foot pedestrian walkway. The bridge would be 4,500 feet long with no overhead height restrictions. After competitive bidding, the successful contractor chose to build a concrete segmental bridge with driven pipe pile as the foundation.



The west segment of Pier 2 of the new bridge is lifted into position (*above*). Cantilever segments arrive via barge (*below*).

Work began in 2003 with the installation of the foundations and the precast yard production. The cofferdam for the foundations had the shape of a truncated cone to deflect ice floes from the lake. The sloped sides allow the ice to ride up the face and then fail in bending.

Sections of pipe pile 80 feet long were trucked to the site, welded into lengths of 120 to 175 feet, and then driven through 20 to 50 feet of water to bearing in the Fort Union shale, approximately 50 to 90 feet deep in the riverbed. A hydraulic hammer drove the piling into position; a vegetable oil–based fluid was used in the hydraulic hammer, to minimize the environmental consequences of a spill into the water.

While the pile driving and pier construction were under way on the water, about one-half mile away, a casting yard overlooking the bridge site was producing pier segments. Each pier segment when complete would be moved to the casting beds for the typical segments, to ensure that the casts matched. Each span consisted of 16 typical segments on the west, 2 pier segments, and 16 typical segments on the east.

Epoxy-coated posttension bars and posttension strands connected the segments. Epoxy glue was used on the match cast faces of the segments, and six posttension bars connected the segments to the previous segments. Steel strand then tensioned the span together when two pairs of segments were hung. When the closure joint was cast, the internal tendons were stressed.

On September 1, 2005, traffic was switched from the old Four Bears Bridge to the new Four Bears Bridge. Before the shift, spiritual elders from the Hidatsa Water Buster Clan blessed the bridge and prayed for the people and animals that would cross the river on the new bridge. Shortly after the prayer ceremony and the traffic switch, the benefits of the wider design were evident, when a custom combine crew crossed the bridge without having to stop oncoming traffic.

The grand opening took place October 1–3, 2005, after completion of the context-sensitive elements. The ceremony marked 50 years since the grand opening of the second Four Bears Bridge and 71 years since the dedication of the first Four Bears Bridge at Elbowoods.

Design for Context

The context-sensitive design drew considerable attention at the grand opening but had been a major consideration from the planning stages for the bridge. Members of the Three Affiliated Tribes, McKenzie County, Mountrail County, the City of New Town, FHWA, North Dakota DOT, and the design team of Kadrmas Lee and Jackson, Figg Engineering Group, and Lichtenstein Consulting Engineers participated in a design charette. The goal of the design charette was to select preferences for bridge elements, such as pier shape, railing, lighting, pier columns, and a linear library—a walking area or plaza that tells the history of the three bridges and the story of the Three Affiliated Tribes emblems that are on display.

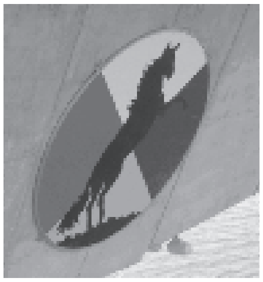
The most visible design elements are on the exterior of the piers and on the pedestrian walkway. Each pier has a mounted medallion of a medicine wheel with a different color in each quadrant and an animal significant to the tribes in the center. The 14 animal shapes are also located on the pedestrian rail on the north side of the bridge.

Each tribe was given 4 piers to display a significant tribal element as a monument. The last two piers were dedicated to the Three Affiliated Tribes to express tribal unity.

At an opening day ceremony, October 2005, mourners pause at Pier 9 to place a wreath in memory of Levi Grant, the only construction worker killed on the project. The pier is dedicated to Hidatsa Chief Crow Flies High, one of Grant's ancestors.

The truncated cone-shaped foundations of the new bridge are designed to deflect ice floes.

The second bridge is demolished after the opening of the new bridge.



Symbolic medallions above the piers, with spotlights below.

A walk along the 4,500-foot sidewalk is a history lesson in the cultures of the tribes. In addition, each tribe has its own colored geometric pattern imprinted in the concrete sidewalk in front of the monuments.

The new structure has street lights on top of the bridge and aesthetic lighting underneath. Lights are aimed at the medallions on the sides of the bridge and on the soffit and pier columns of the structure.

Dismantling the Old Bridge

As soon as traffic moved to the new structure, workers began removing the old bridge. The contractor first hammered the concrete deck out so that the pieces fell into a barge below. Then the steel trusses were cut, with explosives finishing the cuts, dropping the steel into the water. A couple of sections were dropped into the water at a time and were retrieved piece by piece. The pier columns were removed to an elevation of 1,790 feet, about 24 feet below the current water level of 1,814 feet above sea level.

All of the materials from the bridge are being recycled. The concrete deck will become salvage aggregate, the steel will be recycled into rebar, and the pier columns will become a fish habitat on the lake bottom.

Removal of the old bridge concluded the history of a 71-year-old steel structure. Much of what it took to build the structure was repeated in replacing it. The innovative construction methods and ideas employed in the construction and moving of the steel bridge were new to the state in the 1950s, just as the construction of a concrete segmental bridge was new to the state in the 2000s. The continuing name of Four Bears Bridge resonates with the culture and history of all three bridges.

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View of Four Bears Bridge looking southeast. The remnant of the roadway for the second bridge is visible in the foreground.

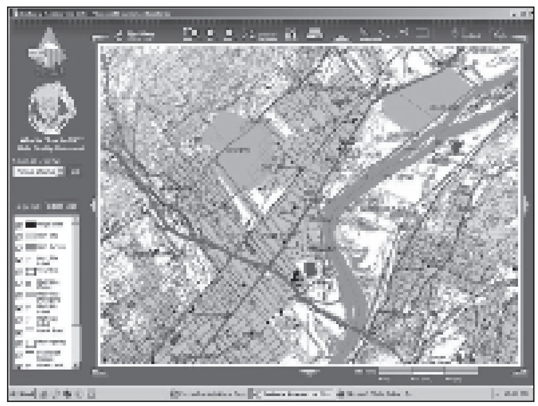
PRESERVING Pennsylvania's Past

Web Tool Locates History near Transportation Project Sites

IRA BECKERMAN AND DOUGLAS T. ARGALL

Beckerman is Cultural Resource Section Chief, Bureau of Design, Pennsylvania Department of Transportation, Harrisburg, and Argall is Project Manager, GeoDecisions, Camp Hill, Pennsylvania.

For transportation planners, considering the impact a project may have on culturally sensitive sites is critical not only for the success of a project but for preserving historic and cultural resources. The Pennsylvania Department of Transportation (PennDOT), the Pennsylvania Historical and Museum Commission (PHMC), and GeoDecisions—a consulting firm specializing in geospatial solutions—therefore created a web-based application, the Cultural Resources Geographic Information System (CRGIS). With this innovative technology, PennDOT officials working from their desktop computers can explore quickly



CRGIS map of the Forty Fort vicinity with all historic resources shown on a U.S. Geological Survey topographic base (*above*). Map views can be manipulated to zoom, scan, measure distances and areas, and turn on and off individual layers such as road networks, Pennsylvania DOT projects, waterways, and municipal boundaries.

The 1806 Meeting House at Forty Fort, Pennsylvania, a Georgian-style building inventoried by the Pennsylvania Historical and Museum Commission and recorded in CRGIS under key number 086545.

and efficiently the effects of future road projects on historic properties.

CRGIS is a web-based application that contains detailed information on tens of thousands of archaeological sites, historic districts, old bridges, historic farmsteads, and other historic properties in the museum commission files. Through CRGIS, PennDOT officials have saved time, money, and historic resources.

The system evolved from the need to share information among state transportation and historic preservation agencies. PHMC and PennDOT partnered to develop a framework for the CRGIS system. In the initial development stages, maps, tables, and other data were converted from paper records to an electronic format. Rudimentary databases and spreadsheets also were converted to more sophisticated and modern databases.

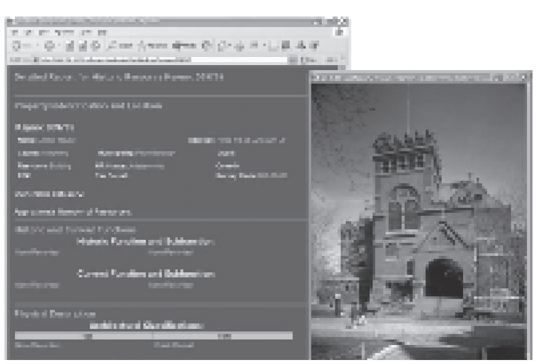
CRGIS also receives financial support from the Federal Highway Administration, the Baltimore District of the U.S. Army Corp of Engineers, and PHMC. From conception to implementation, the entire project has cost $3.5 million.

Locating History

When initiating a project, PennDOT project managers, personnel, and contractors are required first to research the geographic surroundings of the proposed site to address and diagnose issues related to cultural resources. In accordance with the National Historic Preservation Act and the State History Code, PennDOT policy requires consideration of the impact a project may have on historically significant properties. CRGIS not only assists in compliance with the laws and regulations but also serves as a tool to avoid delays, budget overruns, or spirited public resistance to a project.

PennDOT project managers must consider the following questions:

- What historic resources or properties are in the project area?
- If a specific historic resource is already known, is it located near the project area?
- If a resource is located in the project area, is it significant? Can it be compared with others like it?



Intuitive web portal interface shows CRGIS data for Dreble House in Plum Borough, including photo image.

To answer these questions in the days before CRGIS, all interested parties had to compete for appointments with PHMC's Bureau for Historic Preservation (BHP) in Harrisburg. BHP houses a paper filing system storing cultural resource information for an estimated 20,000 archaeological sites, 2,500 historic districts, and more than 120,000 historic properties.

A search for a single project typically could require at least a half-day, including travel time. Sometimes a researcher could end up empty-handed—for example, with no resources found in a project area.

The physical files often were the only copy available, and many files had become damaged by frequent handling and transfers. Moreover, with only one copy of some records, a file could be in use by someone else, could be misfiled, or could have been lost. The realization that the physical information was at risk provided the impetus for moving to CRGIS.

Research Efficiency

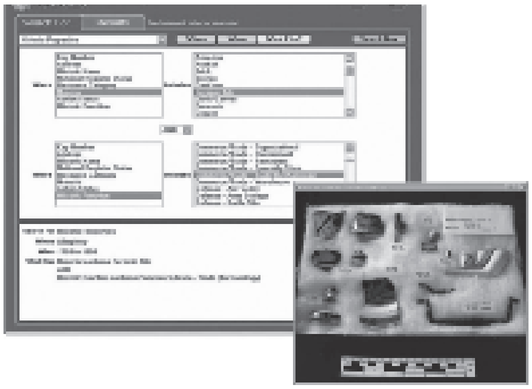
In 2000, PennDOT's Environmental Quality Assurance Division took action to reduce the time spent in gathering data and to improve the efficiency of the research. CRGIS eliminated barriers to accessing Pennsylvania's past and brought information on historic farmhouses, archaeological sites, and other documents to a user's desktop within minutes.

The application stores data about buildings, roads, and objects in the layered format of geographic information systems (GIS). The technology allows CRGIS to map the location of a single, significant historic building and to update the information as needed.

Altogether, CRGIS provides analytical, mapping, and reporting tools for users to locate cultural resources within a planned project area. The package provides

- Customized reporting and printing,
- Easy-to-use query tools for locating sites,
- A mapping interface for viewing data,
- Spatial analysis tools to determine the presence of cultural resources,
- Links to photos of historic structures, and
- Abstracts describing archaeological sites.

For example, PennDOT used CRGIS to identify a prehistoric quartz quarry near a proposed project area in Bucks County. According to the information



CRGIS search for historic properties in Allegheny that were used for commerce and trade between 1795 and 1805 and with materials that contain ceramic tile yields a photograph of sample archaeological finds.

in the system, the quartz distribution of this site was not significantly different from that of other sites in the state; therefore, additional archaeological testing would not be necessary. The data helped in balancing the scope of the project with cultural preservation, ensuring that nothing of historical significance would be harmed.

The CRGIS tool also saved time for a development in Franklin County. From the information in CRGIS, PennDOT officials determined that the cultural resources identified did not warrant additional BHP review of the project. With a desktop computer, the project manager was able to evaluate the site and to move forward quickly with the plans.

Officials rely on CRGIS in this capacity daily. PennDOT estimates that the website saves the state hundreds of thousands of dollars a year in travel costs and in BHP resource time for research in the state's archives.

Streamlining Work

CRGIS provides users with a more efficient and visual method of researching cultural resource information and improves accessibility to these resources. The package saves time and money in the early stages of project development, especially in consulting fees, by identifying the cultural resources in the vicinity before a road improvement or bridge replacement project begins.

CRGIS also helps reduce redundant work. The availability of information—such as archaeological reports from previous surveys—eliminates the need to reproduce the same survey for a future project. A survey layer indicates that an area already has been evaluated for archaeological sites.

Moving from paper files to CRGIS has improved information sharing among the organizations and agencies in Pennsylvania that work with cultural resources. Instead of traveling to a single location, researchers can obtain accurate information about Pennsylvania's cultural resources online. The system's GIS mapping capabilities have helped detect errors in the paper files, such as in the location of a stream. The technology solution also protects and preserves the original paper files.

Adding Functions

CRGIS continues to grow with new features and functions. In 2005, PHMC and PennDOT worked with GeoDecisions to provide deployment on the Internet, allowing the public and business partners access to information about above-ground resources in their community and about general archaeological data without specific locations.

Through the Internet, state historic preservation officers, cultural resource professionals, local municipalities, tourism officials, cultural tourists, and department of education personnel have access to the valuable historical information and can contribute to the process of preserving, maintaining, and fostering awareness of archaeological and historical resources. Sensitive information about archaeological sites, however, remains password-protected for qualified professionals—such as PennDOT consultants and cultural resource managers—to prevent looting or vandalism.

Any user, however, can provide feedback or can report errors directly to PHMC through CRGIS' electronic feedback form. Through feedback and other enhancements, the application continues to evolve with relevant and up-to-date information about Pennsylvania's valuable cultural resources. The current version of CRGIS can be viewed at http://crgis.state.pa.us.

Bob Winters, Pennsylvania Historical and Museum Commission, guides a school group through a reconstructed Indian village on the City Island archaeological site in Harrisburg. Via the Internet, CRGIS offers the public information about local historic resources.

POINT OF VIEW

Eliminating the Annual Highway Safety Tragedy

SAMUEL C. TIGNOR

The author is Adjunct Professor, Virginia Polytechnic and State University, Falls Church, Virginia. He is a member of the National Cooperative Highway Research Program Project Panel on Human Factors Guidelines for Road Systems: Phase 2 and cochair of the Human Factors Road Design Guide Subcommittee of the TRB Vehicle User Characteristics Committee.

Highway safety has been a problem for nearly 100 years, yet there have been few attempts to bring national attention to it. Herbert Hoover, as Secretary of Commerce, convened the first national conference on highway safety in 1924 and a second one in 1926 (*1, 2*). In response to this early work, the initial editions of the *Manual on Uniform Traffic Control Devices for Streets and Highways*, the Uniform Vehicle Code, and the American Association of State Highway and Transportation Officials' geometric design standards were published (*3*).

The last national, high-profile conferences on highway safety were supported by President Harry S. Truman in 1946, 1947, and 1949, and by President Dwight D. Eisenhower in 1954 (*4*). Since then, national emphasis on highway safety has been limited, except for hearings by the Special Subcommittees on the Federal-Aid Highway Program of the Committee on Public Works, held in 1968 and 1971 under the leadership of John A. Blatnik of Minnesota and Jim Wright of Texas (*5, 6*).

The new highway bill—the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users—has increased funding for highway safety but will never solve the country's highway safety problem. The federal approach of throwing large sums of money at a problem and hoping it will go away will not work. Solving the U.S. highway safety problem is a task for everyone—local, state, and federal departments of transportation (DOTs); legislative groups at all levels; national, state, and local safety organizations; insurance companies; citizen groups; utility companies; road contractors; and road users.

Gaining Commitment

The primary safety problem in the United States is the lack of commitment to solve the problem. In the past, our approach has been piecemeal and uncoordinated. It still is. We have no national spokespersons or groups in this nation leading the charge for eliminating the 42,000 annual highway fatalities (*7*). The national cost of highway fatalities exceeds $230 billion per year. With such a large annual loss, in both human and financial terms, it is imperative that the nation address the problem in its totality.

In 1968, Blatnik said, "Everyone in the department should be thinking continuously in terms of highway safety in its broadest spectrum—thinking about eliminating hazards in future construction, thinking about correcting present hazards, thinking about the adequacy of highway patrols, communicating with the driver, innovations like applying the wide field of modern electronics to the road. The 'thinking' must be followed with seeing the thought into deed, and seeing to it with all the tenacity of a bulldog. . . ." He also emphasized that "highway safety needs a continuing sensitivity to the ordinary road needs of the motorist" (*6*).

In a 2005 editorial in *TR News*, Brian O'Neill of the Insurance Institute for Highway Safety indicated concern for four areas: highway speeding, use of seat belts, blood alcohol content, and motorcycle helmet laws (*8*). Each of these areas is important, but each presents a limited and unnecessarily restricted view of highway safety issues. O'Neill's article focused more on past actions than on new visionary solutions to the problem. Passing the blame to the states because the federal government cannot coerce uniform state laws through federal legislation does not improve safety or establish a way to a solution.

State DOTs and local agencies instead must be more proactive in addressing highway safety problems and implementing proven safety infrastructure countermeasures. State DOTs and local agencies need to

- Sensitize field staff and managers to find, report, and eliminate safety problems;
- Increase public awareness of safety by publishing the portion and the amount of improvement project funds that are spent on safety enhancements;
- Demonstrate that many safety solutions are simple and inexpensive; and

◆ Require highway safety impact studies for all highway projects.

Ways must be found to enlist help from citizens and private organizations in maintaining highway safety. Allowing unsafe highway conditions to be created either through initial poor design or through lack of proper maintenance must become politically incorrect. My own community includes such examples as intersection stop signs hidden by brush; traffic signals obscured by telephone cable boxes; trees and utility poles within 1 foot of edge lines; steel posts protecting fire hydrants within shoulders; and dangerous ruts at road edges, risking loss of vehicle control, crashes, and deaths.

In a *TR News* editorial earlier this year, traffic safety expert Leonard Evans of Science Serving Society correctly observed that the highway safety emphasis in the United States has been weighted too heavily to surviving a crash at the expense of preventing crashes (*9*). Both O'Neill and Evans acknowledged progress in highway safety, but neither noted that 25 percent of highway crashes relate to interaction problems between users and highway features. Eliminating these problems alone can reduce fatalities by more than 10,000 annually. The systematic use of engineering oversight, safety audits, and human factors analyses can identify many problems and lead to simple and inexpensive corrections.

Promoting Awareness

At the federal level, the U.S. DOT, the Federal Highway Administration, the National Highway Traffic Safety Administration, and others need to become corporate advocates, serving as catalysts to solve highway safety problems. They need to promote public awareness of highway safety issues as effectively as other groups have promoted congestion and environmental issues. They need to work together and to work with Congress—they need to find legislative proponents like Blatnik and Wright, who continually and vocally demonstrated their dedication by discovering, publicizing, and attacking safety problems.

Raising public awareness of highway safety requires a broad-spectrum approach to societal change. The goals of societal change and of cultivating intolerance for inadequate highway safety measures are well beyond the scope of driver education programs, but working toward these goals would constitute a giant step forward in reducing highway carnage.

The media, private interest groups, and insurance companies should work together to enhance public awareness of highway safety. In particular, automobile, medical, and life insurance companies should work with organizations like Mothers Against Drunk Driving, the Ruritans and other community service groups, the National Safety Council, the Bicycle Federation of America, academia, governors' highway safety representatives, bus and trucking firms, and others to develop and deliver effective highway safety messages. They should work cooperatively with government and use the vast statistical database to identify where and how crashes occur. They should work with the media to educate drivers continuously about road, traffic, and driving hazards. The media should increase their involvement in highway safety to what it was in the 1920s, when more than 200 newspapers devoted daily coverage to the subject (*1*).

Improving U. S. highway safety is a continuing challenge. It is misleading to interpret the decrease in fatality and injury rates per vehicle-mile as indicative of our doing a good job on highway safety. The 42,000 deaths per year are not acceptable, nor are the half-million fatalities and 35 million injuries per decade. To eliminate this annual highway safety tragedy, our nation must confront the problem and must have the collective will to solve it. As Evans suggested in the final sentence of his article, new thinking on highway safety in the United States is necessary (*9*). Although some progress has been made, we must move beyond the current stagnation and narrowness of focus to a renewed concern for life-saving, injury-free solutions.

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POINT OF VIEW presents opinions of contributing authors on transportation issues. The views expressed are not necessarily those of TRB or TR News. *Readers are encouraged to comment in a letter to the editor on the issues and opinions presented.*

NEW TRB SPECIAL REPORT

The Fuel Tax

and Alternatives for Transportation Funding

JOSEPH R. MORRIS

The author is Senior Program Officer, TRB Division of Studies and Special Programs, and served as Study Director for this project.

The fuel tax has provided stable and growing revenue for transportation programs for many decades. But are this tax and other special taxes that highway users now pay becoming unreliable funding sources? Transportation officials see two possible threats to the viability of the established finance arrangements:

- Changes in automotive technology, increases in fuel prices, or the introduction of new regulations on energy or the environment could depress fuel consumption and fuel tax revenue; and
- The user-fee principle of highway financing may be eroding, as applications of user-fee revenues proliferate, and as dependence on revenue from sources other than user fees grows.

In an era when tax rate increases often seem politically infeasible, the vulnerability of excise tax revenue to inflation magnifies these concerns.

To assess the implication of recent trends for the future of traditional transportation finance, to identify financing alternatives and the criteria by which they should be evaluated, and to suggest ways for overcoming barriers to the acceptance of new approaches, the Transportation Research Board (TRB), through the National Research Council of the National Academies, convened the Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance (*see box, this page*). The Federal Highway Administration, TRB, and state departments of transportation—through the National Cooperative Highway Research Program—sponsored the study.

Focus on Performance

In judging the merits of the present system and alternatives, the TRB study committee focused on how finance arrangements affect the performance of the transportation system by influencing the decisions of travelers, as well as investment and management decisions by government. This led the committee to give special attention to methods of charging fees that could relate directly to the cost of providing services—in particular, tolls and mileage charges. The committee did not estimate how much governments should spend on transportation and did not devise revenue mechanisms to support increased levels of spending.

The committee concluded that the challenges evident today will not prevent the highway finance system from maintaining its historical performance over the next 15 years. The system should be able to fund growth in capacity and some service improvements, although not at a rate that will reduce congestion.

A reduction of 20 percent in average fuel consumption per vehicle-mile is possible by 2025 if regulation or sustained fuel price increases lead to improvements in fuel economy. Offsetting the revenue effect of such a reduction would not require unprecedented increases in fuel tax rates. The willingness of

Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance

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Martin Wachs, RAND Corporation, Santa Monica, California

legislatures to enact increases may be in question, but the current revenue sources will retain the capacity to fund transportation programs at historical levels.

In addition, the committee concluded that although the present highway finance system has contributed to the success of the highway program and can remain viable for some time, travelers and the public would benefit greatly from a transition to a fee structure that charged vehicle operators more directly for use of the roads. The transition to direct charging could improve operation of the road system and could target the most beneficial projects for investment. Because the charges would reflect the cost of providing service, the revenues would indicate accurately where capacity expansions would produce the most benefit.

Strengthening and Preparing

The committee's recommendations propose immediate changes to strengthen the highway and transit finance system, as well as actions to prepare the way for more fundamental reform in the long term.

◆ *Maintain and reinforce the user-fee finance system.* The nation must continue to rely on the present framework of transportation funding for at least the next decade. Therefore, governments must take every opportunity to reinforce the proven features of the present system—in particular, user-fee financing of the highway program.

◆ *Expand use of tolls and test road use metering.* Good models for toll road development can emerge only from the states. Therefore, the federal government should adopt a strategy of encouraging the states to experiment with arrangements for tolling and private-sector participation in road development. The states should be allowed to impose tolls on roads that were built with federal aid. The states and the federal government should explore the potential of road use metering and mileage charging with large-scale, fully functioning trial implementations.

◆ *Provide stable, broad-based tax support for transit.* Reforms of highway finance arrangements will raise the need to review and adjust the relationship between highway and transit funding.

◆ *Evaluate the impact of finance arrangements on transportation system performance.* Transportation agencies must develop new capabilities for research, evaluation, and public communication to manage finance reform over the next few decades to improve transportation system performance.

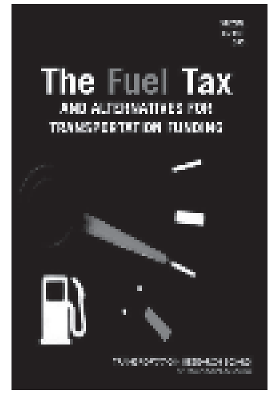
Opportunities at Hand

Opportunities are at hand for fundamentally new approaches that could provide a sound basis for transportation financing and at the same time improve the efficiency and quality of transportation services.

Progress in the technologies of toll collection and road use metering, for example, has greatly diminished the obstacles of cost and inconvenience. The application of these technologies would allow the metering of each customer's use of highway services, which then can be charged accordingly, just as customers pay today for utilities such as water and electricity.

Development of this revenue source would maintain the established practice of funding highways largely through fees paid by users, would link the fees more closely to the cost of providing service for each user, and would supply information to transportation agencies about which investments in capacity would yield the greatest benefits. Facilities that generate their own revenue would be candidates for operation by private-sector franchisees, supplementing public efforts with private capital and with the skills to carry out infrastructure projects.

Initial steps toward these new kinds of transportation finance arrangements are under way. Before these arrangements can become major components of the transportation finance system, however, their effectiveness must be demonstrated to the public's satisfaction and the institutional capabilities must be developed to manage them on a large scale. In the meantime, improving and refining the system's capacity to provide the right level of funding is worthwhile, to direct the funds to the best uses within the established structure of fees, revenue sources, and government responsibilities.



TRB Special Report 285, *The Fuel Tax and Alternatives for Transportation Funding,* is available from the TRB online bookstore, www.TRB.org/bookstore; to view the book online, www.TRB.org/publications/sr/sr285.pdf.

PHOTO: MINNESOTA DOT

Minnesota's MnPass uses a windshield-mounted transponder to record road use and deduct from drivers' prepaid accounts.

NEW TRB SPECIAL REPORT

Tires and Passenger Vehicle Fuel Economy

Informing Consumers, Improving Performance

THOMAS R. MENZIES, JR.

The author is Senior Program Officer, TRB Division of Studies and Special Programs, and served as Study Director for this project with the assistance of James Zucchetto, Director, Board on Energy and Environmental Systems, Division on Engineering and Physical Sciences, National Research Council of the National Academies.

Each year Americans spend about $20 billion to replace approximately 200 million tires on their passenger cars and light trucks. Although these tires last far longer today than they did 30 years ago, most must be replaced every 3 to 5 years because of wear. The choices consumers make when they replace their tires affect the handling, traction, comfort, and appearance of their vehicles, as well as the fuel economy.

Tires affect fuel economy mainly through rolling resistance. As a tire rolls, its shape changes repeatedly as it experiences recurring cycles of deformation and recovery. In the process, mechanical energy otherwise available to turn the wheels is converted into heat and dissipated from the tire. More fuel must be expended to replace this lost energy.

The 220 million passenger cars and light trucks in the United States consume approximately 130 billion gallons of fuel each year. Finding ways to reduce this energy consumption is a national goal for reasons that range from ensuring national security to improving local air quality and reducing greenhouse gas emissions.

Consumers prefer tires with longer wear, and maximizing wear life is desirable for controlling the generation of scrap tires. Yet the traction, handling, and operating characteristics of tires also are important because they influence the safety performance of vehicles on the nation's highways.

Congressional Request

Congress requested the National Highway Traffic Safety Administration (NHTSA) to sponsor a study to examine the rolling resistance characteristics of replacement tires for passenger vehicles and the effect of changes in tire designs and materials on rolling resistance and other tire attributes. Under the auspices of the National Research Council of the National Academies, the Transportation Research Board and the Board on Energy and Environmental Systems convened a committee to conduct the study (*see box, page 23*).

The committee examined ways of reducing rolling resistance in tires and the resultant effects on vehicle fuel consumption, tire wear life, and on aspects of tire operating performance that may relate to vehicle safety. The committee also estimated the impacts on replacement tire prices and on consumer spending for tires.

The study committee reviewed the technical literature, met with tire and vehicle experts, and analyzed available data on passenger tire rolling resistance, wear resistance, and traction characteristics. Many aspects of tire design, construction, and manufacturing are proprietary, which limits the availability of information on technologies to improve the energy performance of replacement tires. Nevertheless, sufficient quantitative and technical data are available in the public domain to draw some general conclusions about the feasibility of reducing rolling resistance in tires and the implications for other tire attributes and consumer spending.

Fuel Savings and Tire Performance

Reducing the average rolling resistance of replacement tires in the passenger vehicle fleet by 10 percent is technically and economically feasible. Such a reduction promises a 1 to 2 percent increase in the fuel economy of vehicles and would save approximately 1 billion to 2 billion gallons of gasoline and diesel fuel per year—equivalent to the fuel saved by taking 2 million to 4 million cars and light trucks off the road. The individual motorist would burn 6 to 12 fewer gallons of motor fuel per year, yielding an annual savings of $12 to $36 when fuel is priced at $2 to $3 per gallon.

Tires in the replacement market that are comparable in type, size, traction, wear resistance, and price often can differ more than 10 percent in rolling resistance, which suggests that rolling resistance can be lowered without major changes in tire technology. Original equipment tires typically are designed for lower rolling resistance than are replacement tires, because of the federal fuel economy standards for new passenger cars and light trucks. If the kinds of materials and technologies used in original equipment tires were used in the replacement market, rolling resistance would be lowered, but consumers would pay more for tires. The committee estimates that consumers would spend $1 to $2 more per year on replacement tires—which would offset a small portion of the savings from the improved fuel economy.

Tires with generally accepted levels of traction vary widely in rolling resistance, which suggests that one property does not necessarily hinge on the other. The committee could not find safety studies or vehicle crash data that provide insight into the safety impacts associated with large changes in tire traction capability, much less with the incremental changes in traction that may occur from modifying tire tread to reduce rolling resistance.

Maintaining resistance to wear and prolonging tire life while reducing rolling resistance will be critical, because of concerns about scrap tire disposal. Although various technologies are being developed and applied to reduce rolling resistance without significant effects on tread wear, the practical effects of these technologies on tire performance characteristics have not been established quantitatively. Continuing advances hold promise that rolling resistance can be reduced further without adverse effects on tire wear life and safety or increases in the volume of scrap tires.

Informing Consumer Choices

The committee observes that consumers now have little, if any, practical way of assessing how tire purchase choices can affect vehicle fuel economy. The committee therefore recommends that Congress authorize and make sufficient resources available for NHTSA to work with the tire industry in gathering and reporting information on the influence of passenger tires on vehicle fuel consumption.

The information should cover a large portion of passenger tires sold in the United States, be easy to understand, and be made widely available to tire buyers and sellers. NHTSA should consult with the U.S. Environmental Protection Agency on how to communicate the information to consumers and should review the effectiveness and utility of the information regularly.

Finally, as motorists receive advice about the energy performance of tires, they also should understand that all tires require proper inflation and maintenance to achieve the intended levels of energy, safety, wear, and operating performance. Motorists must be alerted that even small losses in inflation pressure can greatly reduce tire life, fuel economy, safety, and operating performance. The vigilant maintenance of inflation therefore must be a central message in communicating information to motorists about the energy performance of tires.

TRB Special Report 286, *Tires and Passenger Vehicle Fuel Economy: Informing Consumers, Improving Performance,* is available from the TRB online bookstore, www.TRB.org/bookstore; to view the book online, www.TRB.org/publications/sr/sr286.pdf.

Committee for the National Tire Efficiency Study

Dale F. Stein, Michigan Technological University (retired), Tucson, Arizona, *Chair*
James E. Bernard, Iowa State University, Ames
John Eagleburger, Goodyear Tire Company (retired), North Canton, Ohio
Richard J. Farris, University of Massachusetts, Amherst
David Friedman, Union of Concerned Scientists, Washington, D.C.
Patricia S. Hu, Oak Ridge National Laboratory, Knoxville, Tennessee
Wolfgang G. Knauss, California Institute of Technology, Pasadena
Christopher L. Magee, Massachusetts Institute of Technology, Cambridge
Marion G. Pottinger, M'gineering, LLC, Akron, Ohio
Karl J. Springer, Southwest Research Institute (retired), San Antonio, Texas
Margaret A. Walls, Resources for the Future, Washington, D.C.
Joseph D. Walter, University of Akron, Ohio

Expanding the Capacity of Highway Bridges with High-Performance Concrete

Georgia's Experience

SUPRIYA KAMATKAR

The author is Research Engineer, Office of Materials and Research, Georgia Department of Transportation, Forest Park.

Bridges are integral to the Interstate Highway System and must be strong and durable, providing acceptable performance throughout a design service-life of 100 years. The widening of highways to accommodate increased traffic often requires the replacement of overpass bridges with longer-span structures. Research and application by the Georgia Department of Transportation and the Georgia Institute of Technology have confirmed the benefits and cost savings of high-performance concrete in increasing the span length and in reducing the size of precast, prestressed concrete girders.

Problem

Highway agencies often replace overpass bridges with longer-span bridges to accommodate the increased lanes of traffic below. If the same girder dimensions can be used for the longer span, the embankments will not have to be raised, saving substantial construction.

The weight of a precast girder affects the costs of its transportation and erection, and the number of girders contributes to the cost of the bridge. New materials and technologies for bridge girders are needed to realize the benefits from reducing the number of girders or increasing the span, while either maintaining or reducing the girder's cross section. Such innovations would be part of an effective asset management strategy for the Interstate Highway System.

Solution

In 1993, the Federal Highway Administration (FHWA) initiated a national program to implement the use of high-performance concrete (HPC) in bridges. In comparison with conventional concrete, HPC exhibits increased durability and higher strength, allowing the construction of long-lasting bridges with longer spans, fewer girders with wider spacing, the same girder cross section, and less maintenance.

The Georgia Department of Transportation (DOT) participated in FHWA's HPC program. The program included the construction of 18 demonstration bridges in 13 states and the dissemination of the technology and results at showcase workshops.[1] In 1996, in cooperation with the Georgia Institute of Technology, Georgia DOT initiated an investigation of the feasibility of HPC for precast, prestressed concrete bridges. Lawrence Kahn of the School of Civil and Environmental Engineering directed the investigation, which included the following activities:

- Analytical investigation of increased span length and girder spacing,
- Development and evaluation of HPC mixtures,
- Evaluation of the capability for producing HPC,
- Study of 0.6-in.-diameter prestressing strands,
- Laboratory testing of bridge girders,
- Development of criteria for selecting bridges for HPC, and
- Monitoring of field performance.

The analytical investigation concluded that the maximum span length of girders meeting the standards of the American Association of State Highway and Transportation Officials (AASHTO) could be increased by 40 percent with concrete at a strength of 13,000 pounds per square inch (psi) in combination with 0.6-inch-diameter prestressing strands. This is in comparison with the 6,000-psi concrete and 0.5-inch strand commonly used in bridge girders and at the same girder spacing.

HPC mixtures with design strengths of 7,000, 10,000, and 14,000 psi and with less than 2,000 coulombs of chloride permeability were developed and produced without difficulty in the laboratory, in ready-mix trucks, and at precasting plants with locally available materials—limestone and gran-

[1] Information on the showcase bridges is available at www.tfhrc.gov/structur/hpc/hpc.htm.

ite–gneiss coarse aggregates from across Georgia.

Two properties that greatly influence the design of precast, prestressed concrete girders are creep and shrinkage. Creep is the gradual increase in strain when hardened concrete is subjected to sustained loads, and shrinkage is the reduction in the volume of concrete unloaded at a constant temperature. Laboratory tests showed that creep and shrinkage for 10,000- and 14,000-psi HPC were much less than those for conventional concrete. Georgia DOT subsequently standardized 7,000- and 10,000-psi mixtures in its Special Provisions; the 14,000-psi mixture will be considered if the need arises.

The research showed that 0.6-inch-diameter prestressing strands could be used in place of 0.5-inch diameter strands. Tests on precast concrete beams with commonly used cross sections revealed that the performance of 0.6-inch, 270,000-psi prestressing strand in HPC exceeded that predicted according to the AASHTO bridge design standards.

Georgia DOT built its first HPC bridge—the Jonesboro Road Bridge—in 2002 over I-75 in Henry County, south of Atlanta. An 82-foot-span steel bridge was demolished and replaced with the HPC bridge. The new four-span bridge was built with two 127-foot spans to accommodate more traffic lanes on the bridge and the future widening of I-75 under the bridge, a 53-foot span at one end, and a 45-foot span at the other. The girder spacing was 7.30 feet.

The design concrete strengths at 56 days were 10,150 psi for the girders and 7,250 psi for the 8-inch-thick HPC deck. The HPC design required four fewer rows of girders per span than a conventional design—13 girders instead of 17. Construction of the HPC bridge cost approximately $51.38 per square foot of finished bridge deck; the average cost for a typical, precast, prestressed, normal-strength concrete bridge in Georgia was $56.65 per square foot—a savings of approximately 10 percent. Field measurements over 3 years indicate the potential for enhanced long-term performance.

The research clearly demonstrates that high-quality, long-span, precast, prestressed girders can be built with HPC using Georgia materials and at a lower cost than those built with conventional concrete.

Applications

After construction of the Jonesboro Road Bridge, Georgia DOT approved designs of precast, prestressed girders using HPC with compressive strengths up to 10,000 psi, and the Bridge Office has adopted that as a standard design. Georgia DOT expects to construct 5 to 10 HPC bridges per year.

With the success of HPC, Georgia DOT has started research on high-performance, lightweight concrete (HPLC) and ultra-high-performance concrete with compressive strengths greater than 22,000 psi. The HPLC beams with a density of 120 pounds per cubic foot and a compressive strength of 9,000 to 10,000 psi will be used in the Bullsboro Road bridge scheduled for construction over SR 34 in Coweta County later this year.

HPC girders of the Jonesboro Road Bridge during construction.

Benefits

The research and application of HPC demonstrate the following benefits:

- The production of 10,000-psi and 7,000-psi concrete with locally available materials;
- A span increase of approximately 40 percent for the same cross section of girder;
- A reduction in the depth of the superstructure, eliminating such potential problems and costs as raising the grade or purchasing additional land;
- Reducing the number of prestressing strands and increasing span length and girder spacing with 0.6-inch-diameter strand instead of 0.5-inch strand for precast, prestressed girders;
- Enhanced durability and reduced cracking, leading to lower maintenance cost and longer service life; and
- Potential cost savings in comparison with conventional concrete, estimated at 10 percent for a recently constructed bridge in Georgia.

For more information, contact Paul Liles, State Bridge and Structural Design Engineer, Georgia Department of Transportation, 2 Capitol Square, Atlanta, GA 30334-1002 (telephone 404-656-5280, e-mail paul.liles@dot.state.ga.us) or Supriya Kamatkar, Research Engineer, Office of Materials and Research, Georgia Department of Transportation, 15 Kennedy Drive, Forest Park, GA 30297-2534 (telephone 404-363-7586, e-mail Supriya.kamatkar@dot.state.ga.us).

EDITOR'S NOTE: Appreciation is expressed to Amir Hanna, Transportation Research Board, for his effort in developing this article.

Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).

John Dockendorf

Pennsylvania Department of Transportation

John Dockendorf has one of the largest collections of bus and transit memorabilia in the United States. Born and raised in Chicago, Illinois, he developed a personal interest in transportation and transportation-related issues at a young age, which eventually led him to pursue a career in public transportation.

As the current chief of the Urban Division of the Pennsylvania Department of Transportation (PennDOT), Dockendorf is responsible for managing the state's Urban Transit Operating Assistance and Urban Capital Assistance programs, and for supervising a division staff of three professional operating section and four professional capital section employees. In his 30 years at PennDOT, Dockendorf has focused on ensuring that proposed transportation research activities meet the needs of the transportation industry.

"The research activities of TRB, the State of Pennsylvania, and AASHTO have served to overcome the past disconnect between proposed and needed transportation research."

"When I joined PennDOT in 1976, research activities were often carried out by consultants and academicians who, in many cases, had little or no direct involvement in the management and operation of public transit agencies," Dockendorf recalls. "As a state transit official responsible for ongoing management of statewide operating and capital assistance, I often encountered the need for better information to make effective choices."

Dockendorf helped initiate the PennDOT annual public transportation research and demonstration grant program, which provides funding for innovative projects to improve the efficiency and effectiveness of public transportation. As a result of the program, PennDOT now annually solicits project proposals from transit organizations and operators, universities, and planning agencies. Approved project proposals are eligible for state funding of up to 80 percent of costs, and the program has provided more than $2 million in state dedicated Public Transportation Assistance Fund (PTAF) grants to more than 45 research and development projects.

Additionally, Dockendorf developed program procedures for Pennsylvania's two transit-dedicated fund initiatives, the 1991 PTAF and the 1997 Act 3 Revenue Enhancement Initiative. These programs have provided more than $3 billion worth of operating and capital assistance to Pennsylvania's urban transit systems.

Dockendorf believes that the gap between proposed transportation research and the research needed by the public transportation industry is being bridged. As evidence, he cites the work of the Transit Cooperative Research Program (TCRP) and National Cooperative Highway Research Program (NCHRP) at the national level, and increased state funding for transportation research at the PennDOT Bureau of Public Transportation.

"The research activities of the Transportation Research Board, the State of Pennsylvania, and the American Association of State Highway and Transportation Officials (AASHTO) have served to overcome the past disconnect between proposed and needed transportation research," he observes.

An active member of TRB for 26 years, Dockendorf is an emeritus member of the Committee on Bus Transit Systems, which he chaired from 1998 to 2004. He is currently a member of the TCRP Project Panel on Implementation Guidelines for Bus Rapid Transit Systems, the NCHRP Project Panel on Research for the AASHTO Standing Committee on Public Transportation, and the NCHRP Project Panel on Future Financing to Meet Highway and Transit Needs.

For those who are beginning careers in transportation, Dockendorf emphasizes the importance of becoming active in organizations—such as TRB, AASHTO, and the American Public Transportation Association—that have the responsibility to promote and oversee national and state research and development activity.

"It will take years for transportation industry newcomers to gain a broad perspective on transportation research needs," Dockendorf explains. "I recommend they become as active as possible in various transportation committees to determine the research needs of the industry, and assess which proposed research and development projects are likely to provide the greatest benefit."

Dockendorf received a bachelor's degree in business and economics from Illinois College in 1966, and a master's degree in economics from the University of Cincinnati in 1974. He has received many awards for his contributions to the transportation industry, including the Pennsylvania Association of Municipal Transportation Authorities' Service Award in 1999, the National American Public Transit Association's State Distinguished Service Award in 1993, and the AASHTO Multistate Technical Assistance Program Project Steering Committee's Outstanding Service Award in 1994.

In addition to his large collection of transit memorabilia, Dockendorf has the largest collection of toy buses in the United States. Some of the buses in his collection have been on display in the New York Transit Museum.

July–August 2006 NUMBER 245
TR NEWS

Anthony R. Kane
American Association of State Highway and Transportation Officials

"I have long been an advocate of the Baldrige quality concepts and see the construct as a way to advance transportation in each state."

Blending economics and engineering in a public policy framework is a hallmark of Anthony R. Kane's career in transportation. As director of engineering and technical services for the American Association of State Highway and Transportation Officials (AASHTO), Kane develops regulatory policy and legislation and supervises a team that comprises 70 persons working in such diverse areas as the AASHTO Materials and Reference Laboratory; designing guides for pavements, geometrics, and bridges; AASHTOWare software products; intelligent transportation systems (ITS) publications; the Federal Communications Commission Frequency Coordination Program; and transportation product evaluation.

Kane joined AASHTO in 2001 as director of engineering and technical services. During his 6 years with the organization, he has increased the technical service program revenues substantially, recruited additional technical engineering staff, and launched new technical services.

"I have increased the size of my division's engineering team in the areas of operations, ITS, bridges, safety, and materials and product testing," Kane points out. "Their salaries are supported through a variety of mechanisms, including loaned senior staff from state DOTs, federal contracts, pooled-fund research funds, and voluntary technical contribution funds from state DOTs."

Before taking his position with AASHTO, Kane completed a distinguished 30-year career with the Federal Highway Administration, retiring as the agency's executive director. As executive director he managed a major restructuring and downsizing of the agency, which confronted the challenges of improving ways to meet customer needs and demands while working with a reduced staff. To improve customer service, he introduced changes at the field level, transferring decision-making authority that previously had resided with regional offices to the state-level offices.

During FHWA's downsizing and restructuring, Kane also launched the Quality Journey Program, a long-term effort to deliver higher-quality services to key FHWA customers and stakeholders. As FHWA executive director, Kane charged all FHWA units with the task of self-evaluation according to the criteria developed by Malcolm Baldrige of the National Institute of Standards and Technology. FHWA remains committed to applying the Baldrige criteria as a corporate management strategy and is sharing its practices with state DOTs.

"I have long been an advocate of the Baldrige quality concepts and see the construct as a way to advance transportation in each state," Kane explains. "There are seven criteria areas, or cornerstones, that organizations are assessed on—leadership, strategic planning, customer focus, information systems, process improvements, human resource development, and business results. The Baldrige concepts are about leadership and customer focus with an emphasis on results."

A strong supporter of TRB while at FHWA and in his current role at AASHTO, Kane has been active in TRB since 1982. He currently serves on the Committee on Performance Measurement, the Committee on Strategic Management, and many National Cooperative Highway Research Program project panels, including the Project Panels on Secure Communication Infrastructure, Surface Transportation Security Research, Administration of Highway and Transportation Agencies, and Future Options for the National System of Interstate and Defense Highways.

"Transportation professionals must get involved in TRB to share their ideas and to learn from international colleagues," Kane notes. "Future challenges in transportation safety, mobility, and finance require their expertise to continue to advance the world's economic growth and standard of living."

In January 2005, Kane was made an emeritus member of the Committee on Taxation and Finance. He has received the AASHTO President's Special Award of Merit, the American Society of Civil Engineers' Turner Lecture Award, U.S. Presidential Rank Award for Distinguished Service, the Secretary of Transportation's Award for Meritorious Service, and the FHWA Administrator's Superior Achievement Award. He was named a Rensselaer Polytechnic Institute (RPI) Alumni Association Fellow in 2000.

Kane graduated from RPI with a bachelor's degree in civil engineering in 1967; he went on to earn a master's degree in civil engineering from Northwestern University in 1969, and a doctorate in business administration from George Washington University in 1979. In 1987 he completed a program for senior managers at Harvard's Kennedy School of Government.

PHOTO: U.S. CUSTOMS AND BORDER PROTECTION

Traffic congestion at a U.S.–Mexico border crossing.

Plan to Fight Freight Congestion Unveiled

The U.S. Department of Transportation (DOT) will focus funding, staff, and technology on a national initiative to reduce passenger and freight congestion. Congestion is estimated to cost the American economy approximately $200 billion a year due to delays.

The U.S. DOT initiative would create Urban Partnership Agreements with communities that are willing to exhibit new strategies for dealing with congestion. The plan encourages states to pass legislation giving the private sector greater opportunity to invest in transportation.

Also sought are the deployment of new and state-of-the-art technologies and practices to eliminate traffic backups. These include such approaches as designating new interstate corridors, expanding aviation capacity, and targeting port and border congestion by establishing a senior-level team to work with the Department of Homeland Security to prioritize operational and infrastructure improvements at border crossings.

For more information, view the complete plan at http://isddc.dot.gov/OLPFiles/OST/012988.pdf.

Capital Tests Rubber Sidewalks

Washington, D.C., officials have joined nearly a dozen states in testing the effects of sidewalks made of rubber. Several blocks' worth of the rubber sidewalks have been installed in the Northeast section of the nation's capital.

The decision to install rubber sidewalks came in response to lawsuits from people injured by cracks and deformities in sidewalk concrete, pressed by the growth of tree roots. Tree roots break through the suffocating concrete to obtain air and water. Rubber sidewalks counter this problem with .25-inch spaces between slabs to allow air and water to penetrate the ground below—eliminating upward root growth.

Construction costs for the rubber sidewalks, however, totaled approximately $60,000—about three times the cost of concrete counterparts. The sidewalks are made from recycled tire rubber molded into squares and secured by pegs. The rubber slabs are shipped from a manufacturer in California, but a new manufacturing facility is planned for New York, to help reduce hefty freight costs. The slabs are available in many colors, and should outperform concrete with an expected 14-year life span in sections where tree roots may be a problem.

For more information, visit www.dc.gov.

INTERNATIONAL NEWS

Lime Confirmed as Soil Stabilizer

Lime stabilization of subgrade soils is an old practice in road construction that is being reexamined with new interest in Denmark. A recent test conducted by the Danish Road Directorate found that silty, or clayey, subgrade soils gain a considerable increase in load-bearing capacity when stabilized with lime.

Testing was conducted at two short stretches of highway near the counties of Fyn and Lolland, Denmark. The stabilization process was performed in the summer and fall of 2005, using lime percentages of 2 and 4 percent. During the process, lime was mixed with soil, and the stabilized material was compacted with a drum roller, leveled, and compacted again. The effects of the process were monitored by measuring the surface modulus with a lightweight deflectometer before stabilization and at intervals afterward.

Test results showed that even very soft soils with high water content can increase in load-bearing capacity when stabilized with lime. Additional benefits include a possible reduction in pavement thickness and a reduction in the raw materials needed for pavement. The increased bearing capacity of the stabilized subgrade also is expected to improve road durability, reducing long-term maintenance costs.

For more information, visit www.vti.se/nordic/1-06/soil.htm.

RESEARCH REQUEST—At a June meeting in the National Academies' Keck Center, Ashok G. Kaveeshwar, Administrator, Research and Innovative Technology Administration, U.S. Department of Transportation (DOT), and Martin Spitzer, professional staff member, Committee on Science, U.S. House of Representatives, explain the intent behind the congressional request for the U.S. DOT's 5-year strategic plan for research, development, and technology, and the independent review of the plan by the National Research Council.

CHINA FORUM—Sun Li-Jun, Dean of Tongji University's School of Transportation and Engineering, Shanghai, China, delivers a welcoming address at the opening of the TRB Data Analysis Working Group (DAWG) Forum on Pavement Performance Data Analysis, June 8, 2006. Chaired by Hans J. Ertman Larsen, Deputy Director of the Danish Road Institute, with the assistance of A. Robert Raab, Senior Program Officer in the TRB Studies and Special Programs Division, the DAWG Forum was conducted in conjunction with the Geo Shanghai 2006 International Conference, which was attended by more than 450 geotechnical professionals.

NEW IDEAS FOR SAFETY—At a July 13 meeting, the Safety Innovations Deserving Exploratory Analysis (IDEA) Committee discussed the evaluation and selection of proposals, heard presentations, and commented on a project to improve truck safety by detecting driver drowsiness or alertness. Funded by the Federal Motor Carrier Safety Administration and the Federal Railroad Administration, the Safety IDEA program promotes innovative approaches to improving railroad and intercity truck safety by supporting applied research and prototype testing.

(*Clockwise from foreground*) Jerry Robin, John Moore, Robert Gallamore, Claire Orth, and Richard Easley.

COOPERATIVE RESEARCH PROGRAMS NEWS

Top-Down Fatigue Cracking in Hot-Mix Asphalt Layers

Recent studies on load-related fatigue cracks in hot-mix asphalt (HMA) indicate that the cracks can be initiated on the pavement surface and then propagate downward through the HMA layer. The penetration of water and foreign debris into pavement cracks can accelerate the cracking process.

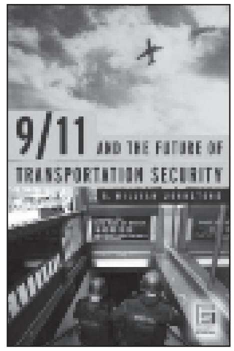
Hypotheses about top-down cracking have been suggested, test methods to evaluate the cracking have been proposed, and preliminary models for predicting crack initiation and propagation have been developed. Recent work under National Cooperative Highway Research Program (NCHRP) Project 1-42 has provided further review of issues related to top-down cracking. Additional research is needed to address the issues and to develop mechanistic-based models for predicting the cracking.

The University of Florida has been awarded a $360,000, 24-month contract (NCHRP 1-42A, FY 2003) to develop mechanistic-based models for predicting top-down cracking in HMA layers for use in mechanistic-empirical procedures for design and analysis of new and rehabilitated flexible pavements. The models will help account for the effects of top-down cracking on HMA performance and will serve to improve the analysis and design of flexible pavements.

For further information, contact Amir N. Hanna, TRB, 202-334-1892, ahanna@nas.edu.

MANAGING RISK—Panelists and researchers of NCHRP Project 20-59(17), including (*clockwise from left*) Robert Doll, Stephanie King, John Contestabile, Michael Smith, Sheila Rimal Duwadi, and Yuko Nakanishi, participated in discussion on the future direction and draft preparation of the Guide to Risk Management of Multimodal Transportation Infrastructure. The guide will provide state DOTs and other transportation entities with a risk management methodology that can be used to conduct threat, vulnerability, and critical assessments of their facilities, and to determine the cost-effective countermeasures to prevent, detect, and reduce threats to assets on a multimodal basis in an all-hazards context. The guide will be recommended as a replacement for the 2002 AASHTO *Guide to Highway Vulnerability Assessment for Critical Identification and Protection*.

9/11 and the Future of Transportation Security
R. William Johnstone. Praeger, 2006; 232 pp.; $49.95; 0-313-08136-0.



Former staff member of the National Commission on Terrorist Attacks Upon the United States (9/11 Commission), R. William Johnstone explains the aviation security failure on September 11, 2001, and evaluates post-9/11 transportation security measures. Based on the work of the 9/11 Commission, this three-part volume supplements and builds on the commission's findings.

Part one focuses on the history of aviation security and the reasons for the failure of aviation security measures on 9/11. Part two examines the changes made in transportation and aviation security since 9/11, including the 9/11 Commission's recommendations and the subsequent congressional response. Part three outlines a suggested approach for improving U.S. transportation security and posits fundamental policy questions.

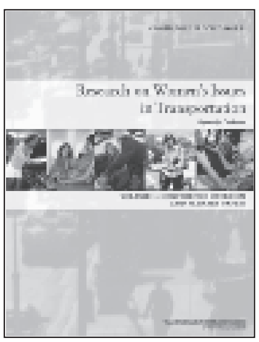
An Immigrant's Story
Ivan M. Viest. Xlibris, 2006; 549 pp.; $22.94; 1-4134-6762-8.

Former head of bridge research for the Highway Research Board during the American Association of State Highway Officials' historic Road Test, Ivan Viest recalls his upbringing in Slovakia, miscellaneous experiences during World War II, and his activities after emigrating to the United States.

Comprising five chapters, this book also chronicles Viest's significant contributions to the U.S. transportation community, provides commentary on a variety of momentous public developments, reflects on the differences and similarities of life in the United States and in his native Slovakia, and recounts his extensive travel experiences and other professional and personal activities.

The books in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS



Research on Women's Issues in Transportation, Volume 1: Conference Overview and Plenary Papers
Conference Proceedings 35
The conference on Research on Women's Issues in Transportation, held November 2004, in Chicago, Illinois, identified and explored research and data needed to inform transportation policy decision makers on addressing women's mobility, safety, and security needs.

Volume 1 contains a conference summary; four peer-reviewed overview papers presented by authors Ann Frye, Sandra Rosenbloom, Susan Handy, Sarah A. Ferguson, and Keli A. Braitman; and a list of conference participants.

2006; 65 pp.; TRB affiliates, $32.25; nonaffiliates, $43. Subscriber categories: planning and administration (IA) ; safety and human performance (IVB).

Intelligent Transportation Systems and Vehicle–Highway Automation 2005
Transportation Research Record 1910
Papers in this volume examine such topics as the design of alert criteria for an intersection decision support system, a probabilistic approach for validation of advanced driver assistance systems, effective and sustainable development of the Chinese national intelligent transportation system architecture, approaches for introducing intelligent transportation systems into developing countries, and the upstream and downstream traffic features of the Bosporus Bridge toll plaza in Istanbul, Turkey.

2005; 115 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber category: highway operations, capacity, and traffic control (IVA).

Maintenance Management and Operations Services
Transportation Research Record 1911
Authors address topics in maintenance management, work zone traffic control, signing and marking materials, and winter maintenance. Specific subjects include a life-cycle comparison of signpost materials and types, an evaluation of late-merge traffic control in work zones, the effectiveness of automated work zone information systems, the wet night visibility of pavement markings, and the development of a storm severity index.

2005; 159 pp.; TRB affiliates, $39.75; nonaffiliates, $53. Subscriber category: maintenance (IIIC).

Geometric Design and the Effects on Traffic Operations 2005
Transportation Research Record 1912
Authors examine operational and safety effects of U-turns at signalized intersections, an actual driving data analysis for design consistency evaluation, speed factors on two-lane rural highways in free-flow conditions, new concepts for context-based designs of streets and highways, and findings on the safety of U-turns at unsignalized median openings.

2005; 81 pp.; TRB affiliates, $32.25; nonaffiliates, $43. Subscriber category: highway and facility design (IIA).

TRB PUBLICATIONS *(continued)*

Geology and Properties of Earth Materials 2005
Transportation Research Record 1913
The topics of this five-part volume encompass quality assurance tests and performance prediction models for aggregates, soil parameters for pavement design and subgrade resilient modulus, management of climatic and seasonal effects on low-volume roads, the use of fiber-optic sensor and three-dimensional data applications, and containment measures for slope hazards.

2005; 213 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber category: soils, geology, and foundations (IIIA).

Concrete Materials 2005
Transportation Research Record 1914
Findings are presented on the properties of crumb rubber concrete, the use of lithium nitrate in controlling alkali–silica reactivity in concrete pavement, the performance and uniformity of self-compacting concrete, and the influence of supplementary cementitious materials on the strength development of concrete subjected to different curing regimens.

2005; 104 pp.; TRB affiliates, $33.75; nonaffiliates, $45. Subscriber category: materials and construction (IIIB).

Airports, Airspace, and Passenger Management
Transportation Research Record 1915
Models are applied to the analysis of passenger flow systemwide in a hub-and-spoke system, to air traffic controllers' adoption and adaptation of new technologies, to variation in landing time intervals at a major airport, and to cost savings from the simultaneous completion of fleet assignment and aircraft routing steps.

2005; 123 pp.; TRB affiliates, $34.50; nonaffiliates, $46. Subscriber category: aviation (V).

Evaluating Cultural Resource Significance: Implementation Tools
NCHRP Report 542 (with supporting material on 2 CD-ROMs)
This report presents the findings of a research project to develop information technology tools to improve and streamline the evaluation of cultural resources in the National Register. The researchers developed two prototypes: the Historic Property Screening Tool (HPST) and the Electronic Cultural Resource Evaluation Library (ECREL). The HPST is a searchable database of historic contexts and cultural resource inventory information that also includes National Register eligibility decisions. ECREL provides a flexible tool for improving National Register eligibility determinations. The HPST and ECREL are provided on CDs packaged with the report.

2005; 56 pp.; TRB affiliates, $14.25; nonaffiliates, $19. Subscriber category: energy and environment (IB).

Effective Slab Width for Composite Steel Bridge Members
NCHRP Report 543 (with supporting material on CD-ROM)
Recommended revisions to AASHTO's specifications for the effective slab width of composite steel bridge members are presented. The recommended specifications are applicable to all types of composite steel bridge superstructures and are suitable for design office use. The accompanying CD-ROM contains extensive supporting information, along with the recommended specifications and design examples.

2005; 153 pp.; TRB affiliates, $27.75; nonaffiliates, $37. Subscriber category: bridges, other structures, hydraulics and hydrology (IIC).

Access Rights
NCHRP Synthesis 351
This synthesis documents the state of the practice for limiting roadway access to manage highway safety and mobility. Successful practices are documented, along with current policies, legal and real estate literature, and other publications that address the subject. Findings focus on acquisition, management, and disposal of access rights.

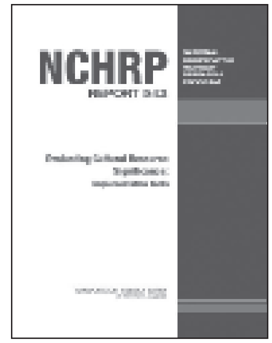
2005; 82 pp.; TRB affiliates, $13.50; nonaffiliates, $18. Subscriber categories: highway and facility design (IIA); highway operations, capacity, and traffic control (IVA).

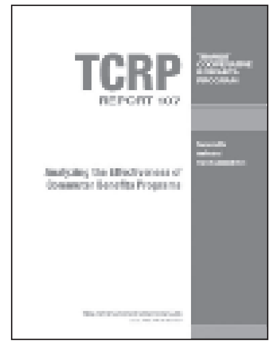
Analyzing the Effectiveness of Commuter Benefits Programs
TCRP Report 107
This report is designed to help employers, transit agencies, policy makers, and organizations involved in promoting commuter benefits to understand the effects that can be expected from a commuter benefits program and how to quantify the effects. Because data on vanpool benefits are limited, this report focuses on transit benefits programs.

2005; 75 pp.; TRB affiliates, $15.75; nonaffiliates, $21. Subscriber categories: planning and administration (IA); public transit (VI).

Integration of Bicycles and Transit
TCRP Synthesis 62
This synthesis provides practical information on how bicycles are integrated with public transportation in the United States and Canada. The information can be used by transit agencies to improve bicycle services and by communities in developing new bicycle and transit services. This synthesis updates *TCRP Synthesis 4* (1994).

2005; 70 pp.; TRB affiliates, $12.75; nonaffiliates, $17. Subscriber category: public transit (VI).





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CALENDAR

TRB Meetings 2006

September

10–14 9th International Level Crossing Safety and Trespass Prevention Symposium
Montreal, Quebec, Canada
Richard Cunard

13–15 10th National Conference on Transportation Planning for Small and Medium-Sized Communities: Tools of the Trade
Nashville, Tennessee

16–20 Joint Meeting of the Committee on Critical Transportation Infrastructure Protection and AASHTO SCOTS
Orlando, Florida
Joedy Cambridge

18–19 Aviation Forecast Assumption Workshops: Airports (*by invitation*)
Washington, D.C.
Christine Gerencher

18–20 5th National Seismic Conference on Bridges and Highways*
San Mateo, California

25–26 National Security, Natural Disasters, Logistics, and Transportation: Assessing the Risks and Responses
Kingston, Rhode Island

25–27 Freight Demand Modeling: A Conference on Improving Analysis and Forecasting Tools for Public-Sector Decision Making
Washington, D.C.
Elaine King

26 Symposium on Applications of Geophysics for Geotechnical Projects
Breckenridge, Colorado

October

2–5 Plastic Pipes XIII Conference*
Washington, D.C.

5–6 Aviation Forecast Assumption Workshops: Business Aviation (*by invitation*)
Washington, D.C.
Christine Gerencher

17–18 Research Initiatives in Radio Frequency Identification
Washington, D.C.

22–25 17th National Rural Public and Intercity Bus Transportation Conference
Stevenson, Washington

23–26 International Visualization in Transportation Symposium and Workshop: The Spectrum of Benefit
Denver, Colorado

25–26 International Conference on Long-Life Concrete Pavements*
Chicago, Illinois

November

5–7 International Joint Conference on Synergies for an Efficient Waterways System in Europe and the United States
Brussels, Belgium

12–14 Key Issues in Transportation Programming: 2nd National Conference
Seattle, Washington
Kimberly Fisher

28–Dec. 1 2nd Conference on Incident and Special Events Management
Newport, California
Richard Cunard

December

5–7 2006 Highway Geophysics Conference
St. Louis, Missouri

6–8 TRB-FAA Aviation Environmental Design Tool and Aviation Environmental Portfolio Management Tool Workshop
Washington, D.C.

2007

January

16–19 Geosynthetics Conference 2007*
Washington, D.C.

21–25 TRB 86th Annual Meeting
Washington, D.C.
Linda Karson

February

8–9 Disaster Planning for the Carless
New Orleans, Louisiana
Richard Pain

Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar). To reach the TRB staff contacts, telephone 202-334-2934, fax 202-334-2003, or e-mail lkarson@nas.edu. Meetings listed without a TRB staff contact have direct links from the TRB calendar web page.

*TRB is cosponsor of the meeting.

INFORMATION FOR CONTRIBUTORS TO

TR NEWS

TR News welcomes the submission of manuscripts for possible publication in the categories listed below. All manuscripts submitted are subject to review by the Editorial Board and other reviewers to determine suitability for *TR News*; authors will be advised of acceptance of articles with or without revision. All manuscripts accepted for publication are subject to editing for conciseness and appropriate language and style. Authors receive a copy of the edited manuscript for review. Original artwork is returned only on request.

FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, geology, law, environmental concerns, energy, etc.). Manuscripts should be no longer than 3,000 to 4,000 words (12 to 16 double-spaced, typed pages). Authors also should provide appropriate and professionally drawn line drawings, charts, or tables, and glossy, black-and-white, high-quality photographs with corresponding captions. Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes, whether they pertain to improved transport of people and goods or provision of better facilities and equipment that permits such transport. Articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by one or two illustrations that may improve a reader's understanding of the article.

NEWS BRIEFS are short (100- to 750-word) items of interest and usually are not attributed to an author. They may be either text or photographs or a combination of both. Line drawings, charts, or tables may be used where appropriate. Articles may be related to construction, administration, planning, design, operations, maintenance, research, legal matters, or applications of special interest. Articles involving brand names or names of manufacturers may be determined to be inappropriate; however, no endorsement by TRB is implied when such information appears. Foreign news articles should describe projects or methods that have universal instead of local application.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality illustrations, and are subject to review and editing. Readers are also invited to submit comments on published points of view.

CALENDAR covers (*a*) TRB-sponsored conferences, workshops, and symposia, and (*b*) functions sponsored by other agencies of interest to readers. Notices of meetings should be submitted at least 4 to 6 months before the event.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, and ISBN. Publishers are invited to submit copies of new publications for announcement.

LETTERS provide readers with the opportunity to comment on the information and views expressed in published articles, TRB activities, or transportation matters in general. All letters must be signed and contain constructive comments. Letters may be edited for style and space considerations.

SUBMISSION REQUIREMENTS: Manuscripts submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the Director, Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, telephone 202-334-2972, or e-mail jawan@nas.edu.

◆ All manuscripts should be supplied in 12-point type, double-spaced, in Microsoft Word 6.0 or WordPerfect 6.1 or higher versions, on a diskette or as an e-mail attachment.

◆ Submit original artwork if possible. Glossy, high-quality black-and-white photographs, color photographs, and slides are acceptable. Digital continuous-tone images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi or greater. A caption should be supplied for each graphic element.

◆ Use the units of measurement from the research described and provide conversions in parentheses, as appropriate. The International System of Units (SI), the updated version of the metric system, is preferred. In the text, the SI units should be followed, when appropriate, by the U.S. customary equivalent units in parentheses. In figures and tables, the base unit conversions should be provided in a footnote.

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