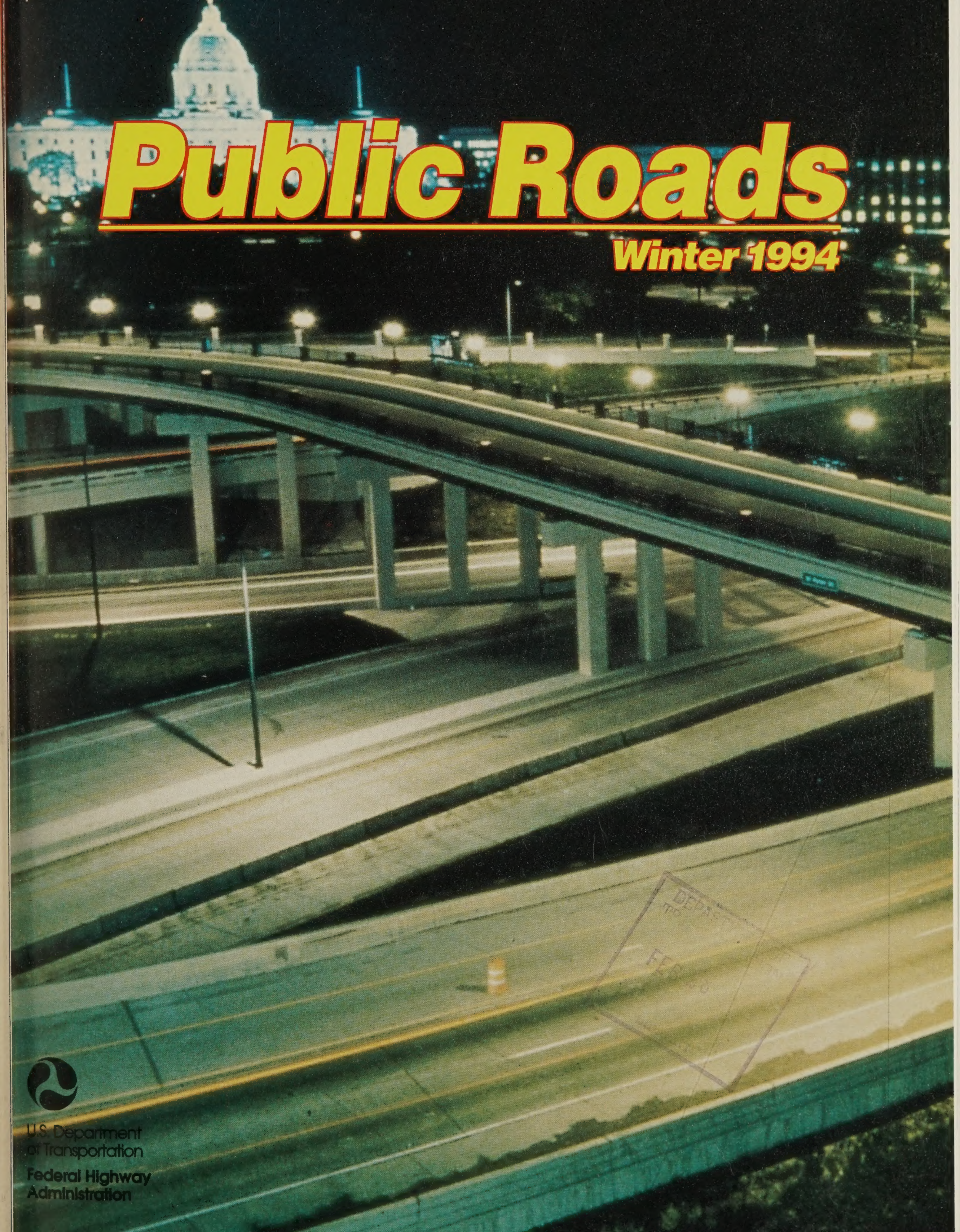
Public Roads

Winter 1994



U.S. Department
of Transportation

Federal Highway
Administration

Public Roads

Winter 1994 Vol. 57, No. 3

COVER:
The St. Peter Street Bridge is located in downtown St. Paul, Minn., and is one of the connecting links between the downtown area and the state capitol complex. It spans the Interstate 35E and Interstate 94 commons area. The structure consists of seven spans.

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THE National Highway System

Backbone of Our National Transportation Network

This article is adapted from a speech delivered by Federal Highway Administrator Rodney E. Slater on December 9, 1993, and from materials provided by the Federal Highway Administration (FHWA) Office of Program Development and the U.S. Department of Transportation (DOT) Office of the Assistant Secretary for Public Affairs.

On December 9, 1993, at Union Station in Washington, D.C., U.S. DOT Secretary Federico Peña and FHWA Administrator Slater announced the submission of the National Highway System (NHS) plan to Congress. Peña also outlined his principles and goals for a National Transportation System (NTS).

"Union Station serves as a fitting backdrop for the unveiling of the National Highway System," said Slater. "Just outside the station, Louisiana Avenue is part of the National Highway System—demonstrating how the National Highway System can provide links among the many modes that make up our transportation network. In fact, the National Highway System enhances the other modes by linking them.

"This is perhaps the most important event I will have the opportunity to participate in as your Federal Highway Administrator, because the National Highway System is going to be the backbone of our national transportation network in the 21st century. It's going to affect every American, directly or indirectly ...

"In the landmark Intermodal Surface Transportation Efficiency Act of 1991, known as ISTEA, Congress called on the Department of Transportation to submit a proposal identifying the routes that will be included in the National Highway System.

"The proposed National Highway System consists of nearly 159,000 miles of the most important roads in the United States.

"To put this in perspective, a National Highway System of this scale would include only four percent of the 3.9 million miles of our public roads. Nevertheless, the National Highway System will carry over 40 percent of the nation's highway traffic, carrying people and goods.

"That's strategic investment."

The United States spends nearly $1 trillion a year—17 percent of our gross domestic product—on transportation services. A 1-percent improvement in the overall efficiency of America's transportation system would translate into nearly $100 billion in savings across the economy within a decade.

On February 19, 1991, FHWA submitted an illustrative map of a proposed NHS to the House Committee on Public Works and Transportation and to the Senate Committee on Environment and Public Works. ISTEA directed DOT to use the illustrative system as the starting point for a report to Congress in two years, identifying highways proposed to be designated as part of a 155,000-mile NHS (plus or minus 15 percent). The approved elements of NHS are the interstate system, high-priority corridors identified in ISTEA, the Strategic Highway Network and its connectors, and selected principal arterials.

Following enactment of ISTEA, FHWA worked with state and local officials and the Department of Defense to prepare recommendations. A nationwide functional classification of the nation's roads, conducted by FHWA and state and local officials and completed in early 1993, identified all principal arterials. The state transportation departments then worked with local officials to develop recommendations on which principal arterials should be included in NHS. FHWA also worked with other DOT agencies to identify airport, maritime, port, rail, and transit facilities that were sufficiently important to be illustrated in the NHS report.

Under ISTEA, congressional approval of NHS is required by September 30, 1995. Since the enactment of ISTEA, the states have been able to use NHS funding on any road classified as a principal arterial. Following congressional approval, funding will be limited to routes in NHS.

With completion of the NHS report to Congress, DOT is taking the next important step by launching an effort to develop the National Transportation System.

"A comprehensive National Transportation System will help us meet the challenges of the 21st century global economy by enhancing all our different modes of transportation and their links—increasing the efficiency and productivity of our nation," Peña said.

NTS will incorporate from all the modes the most significant elements of the nation's transportation systems. Beginning with NHS, NTS will include airports, ports, waterways, rail, intercity bus lines, pipelines, and local transit systems with regional and national impact. NTS will also include systems moving both people and freight as well as facilities owned by both private business and the public sector.

NHS is the core of the future NTS.

Slater explained NHS in detail: "The first component of the proposed National Highway System is the 45,000-mile interstate system, which accounts for nearly 30 percent of the proposed system mileage.

"The second component includes 21 congressionally designated high-priority corridors as identified in the ISTEA. These corridors total 4,500 miles.

"The third component is the non-interstate portion of the Strategic Highway Corridor Network (STRAHNET), identified by the Department of Defense in cooperation with the Department of Transportation. It totals about 15,700 miles. Based on the most recent information, including plans for base closures, these corridors and the interstate system have been identified by the Department

NATIONAL HIGHWAY SYSTEM FACT SHEET

System Extent

Rural Mileage	118,834	(75%)
Urban Mileage	39,840	(25%)
Total Mileage	158,674	

Required Components

Interstate System	45,376 miles
Strategic Highway Network	15,668 miles
Major Strategic Highway Network Connectors for 242 Military Installations	1,890 miles
Congressional High Priority Corridors	4,506 miles

System Characteristics

Full Access Control

Interstate System	44,376 miles
Non-Interstate Routes	7,876 miles
Total	52,252 miles

Jurisdictional Control

State Owned (Estimated)	150,000 miles
Other Owned (Estimated)	9,000 miles

Travel Served

Rural (Percent of total rural vehicle miles of travel)	42% (Est.)
Urban (Percent of total urban vehicle miles of travel)	40% (Est.)

Intermodal Facilities (Illustrated on maps)

Water Ports	104
Airports	143
Amtrak Stations	321
Rail/Truck Terminals	191
Public Transportation Systems	319

Border Crossings

With Canada	32
With Mexico	21

State	Proposed NHS Rural
ALABAMA	2,630
ALASKA	1,489
ARIZONA	2,139
ARKANSAS	2,242
CALIFORNIA	4,922
COLORADO	2,612
CONNECTICUT	362
DELAWARE	210
DIST OF COL	0
FLORIDA	2,926
GEORGIA	3,479
HAWAII	148
IDAHO	2,207
ILLINOIS	3,299
INDIANA	2,097
IOWA	2,731
KANSAS	3,391
KENTUCKY	2,213
LOUISIANA	1,934
MAINE	980
MARYLAND	806
MASSACHUSETTS	486
MICHIGAN	3,041
MINNESOTA	3,261
MISSISSIPPI	2,339
MISSOURI	3,538
MONTANA	3,693
NEBRASKA	2,778
NEVADA	1,941
NEW HAMPSHIRE	634
NEW JERSEY	663
NEW MEXICO	2,660
NEW YORK	2,673
NORTH CAROLINA	2,972
NORTH DAKOTA	2,455
OHIO	2,876
OKLAHOMA	2,674
OREGON	3,224
PENNSYLVANIA	3,466
PUERTO RICO	179
RHODE ISLAND	88
SOUTH CAROLINA	2,016
SOUTH DAKOTA	2,850
TENNESSEE	2,377
TEXAS	8,771
UTAH	1,786
VERMONT	606
VIRGINIA	2,206
WASHINGTON	2,608
WEST VIRGINIA	1,446
WISCONSIN	3,207
WYOMING	2,507
TOTAL	118,838

of Defense as the most critical highway links in our transportation system. As we found during Desert Storm, highway mobility is essential to our national defense by giving us the ability to move troops and equipment to airports, to ports, to rail lines, and to other bases for rapid deployment.

"The fourth component is major Strategic Highway Corridor Network connectors. They consist of 1,900 miles of roads linking major military installations and other defense-related facilities to the STRAHNET corridors.

"Collectively, these four components—all specifically required by

ESTIMATED MILEAGE AND TRAVEL FOR PROPOSED NATIONAL HIGHWAY SYSTEM

ercent of otal Rural Miles	Estimated Travel Rural NHS (Millions)	Percent of Total Travel	Total NHS Urban Miles	Percent of Total Urban Miles	Estimated Travel Urban NHS (Millions)	Percent of Urban Travel	Total NHS Mileage
3.6%	9,012	41.4%	1,040	5.3%	8,550	35.9%	3,670
12.5%	992	46.8%	120	7.3%	838	42.9%	1,609
5.1%	6,617	49.4%	659	4.9%	7,607	35.3%	2,798
3.2%	5,798	40.4%	401	5.3%	3,376	41.7%	2,643
5.6%	27,916	53.6%	2,508	3.1%	95,460	45.5%	7,430
4.0%	5,846	52.3%	761	6.0%	8,107	48.1%	3,373
4.1%	2,556	42.6%	614	5.3%	10,013	47.9%	976
5.7%	1,437	51.3%	95	5.1%	1,432	35.6%	305
0.0%	0	0.0%	73	6.6%	1,426	40.7%	73
4.5%	17,884	50.7%	1,172	2.4%	21,739	22.3%	4,098
4.1%	11,331	36.4%	1,183	4.4%	14,813	36.5%	4,662
6.3%	752	31.1%	166	7.9%	2,096	32.0%	314
3.9%	3,382	45.3%	137	4.7%	1,004	28.4%	2,344
3.3%	10,413	39.6%	2,046	6.0%	25,408	41.4%	5,345
2.9%	10,511	35.7%	623	3.3%	7,262	27.6%	2,720
2.6%	5,715	38.4%	473	5.2%	2,490	30.7%	3,204
2.7%	5,624	43.8%	396	4.2%	3,540	31.5%	3,787
3.6%	8,157	38.1%	456	5.7%	5,835	35.0%	2,669
4.2%	6,250	36.5%	735	5.1%	7,984	39.3%	2,669
4.9%	3,094	35.9%	159	6.3%	1,066	34.9%	1,139
5.2%	6,360	49.5%	555	4.1%	13,157	45.3%	1,361
4.1%	4,064	49.2%	1,373	6.2%	17,527	43.2%	1,859
3.4%	11,142	38.0%	1,677	6.0%	23,412	44.5%	4,718
2.8%	6,733	35.9%	686	4.7%	8,870	43.3%	3,947
3.6%	6,362	38.1%	371	4.6%	2,403	29.3%	2,710
3.4%	11,902	48.3%	958	5.4%	12,853	41.2%	4,496
5.4%	3,420	55.5%	116	4.9%	446	20.4%	3,809
3.2%	3,981	44.6%	297	5.9%	2,140	37.9%	3,075
4.7%	3,656	66.0%	204	4.9%	4,344	39.0%	2,145
5.2%	2,366	39.1%	158	5.4%	1,650	42.4%	792
6.3%	5,884	57.0%	1,284	5.4%	22,550	46.1%	1,947
4.8%	5,652	45.8%	317	5.4%	2,434	36.6%	2,977
3.8%	10,157	33.1%	2,206	5.5%	34,317	42.4%	4,879
4.0%	13,718	41.4%	961	4.5%	10,535	36.4%	3,933
2.9%	1,792	40.7%	104	5.6%	395	25.2%	2,559
3.5%	13,488	35.7%	1,601	5.1%	22,617	39.3%	4,477
2.7%	6,798	39.8%	457	3.7%	5,621	30.7%	3,131
3.7%	7,794	52.9%	446	4.5%	5,454	42.5%	3,670
4.0%	15,425	41.4%	1,922	6.2%	19,675	38.1%	5,388
2.2%	1,116	33.0%	255	4.3%	3,473	34.6%	434
6.0%	494	58.9%	179	3.8%	2,265	36.1%	267
3.7%	8,869	42.7%	629	5.9%	5,579	40.4%	2,645
3.5%	1,783	41.3%	104	5.4%	343	26.6%	2,954
3.5%	10,864	42.8%	937	5.6%	11,026	39.4%	3,314
4.0%	26,781	46.2%	4,540	5.7%	56,548	47.5%	13,311
4.8%	3,438	60.7%	379	6.2%	4,598	46.5%	2,165
4.7%	1,734	41.8%	79	6.0%	385	23.1%	685
4.3%	11,627	43.4%	1,240	7.1%	14,205	41.4%	3,446
4.2%	7,084	49.6%	734	4.1%	12,351	41.0%	3,342
4.6%	4,930	43.9%	219	7.1%	1,961	41.1%	1,665
3.4%	9,962	39.7%	871	5.7%	7,624	32.5%	4,078
6.9%	2,867	59.2%	173	7.3%	529	31.4%	2,680
3.8%	**372,759**	**42.9%**	**39,849**	**5.0%**	**561,332**	**40.0%**	**158,687**

ISTEA—account for 67,500 miles or roughly 43 percent of the proposed system.

"The remainder of the proposed system—totalling 91,000 miles—is made up of other important arterial highways that serve interstate and interregional travel and that provide connections to major ports, airports, public transportation facilities, and other intermodal facilities ...

"Like so much that is important about ISTEA, the National Highway System is a flexible concept ... The National Highway System will not be another interstate system. Beyond the interstate portion, the National Highway System is mostly two-lane roads today and will likely remain that way.

"In fact, virtually all of the National Highway System is existing mileage. Less than 2 percent is new mileage, and that's because it's already in state plans.

"The advantage of the National Highway System concept is that it will encourage state transportation agencies to focus on a limited number of high priority routes for improvement with federal-aid funds. These improvements will address traffic needs safely and efficiently, generally within existing rights-of-way ...

"The National Highway System will also strengthen our links with Canada and Mexico, especially by providing some of the vitally needed north-south connectors. Today, even before NAFTA (North American Free Trade Agreement) goes into effect, trucks carry about 80 percent of freight shipments between the United States and Mexico and about 60 percent of freight shipments between the United States and Canada. When NAFTA removes trade barriers next year, as well as barriers to international trucking operations, traffic on all modes should increase significantly. The National Highway System will serve this traffic efficiently by linking with the Canadian and Mexican highway systems in a high-performance network spanning most of North America.

"The report we are releasing today stresses the economic benefits, but let me just outline a few of them:

- The National Highway System will provide what our retail, industrial, and other employers need—namely, a predictable, consistent, and reliable delivery system.
- It will provide low-cost, reliable, and flexible transportation to minimize costs, serve plants geared to just-in-time delivery, and make our companies more competitive in the global marketplace.

"Another economic benefit of the National Highway System is that it will help us confront the problems of traffic congestion by targeting current and projected bottlenecks. Whether you're a shipper, who lives by the principle that time is money, or a commuter trying to get to and from work with a minimum of hassles, congestion is an economic drain—estimated at about $40 billion a year in our major urban areas.

"That's not even counting the loss of our peace of mind and tranquility.

"Safe, efficient operation. That, in short, is what the National Highway System is all about!

"Today, we are transmitting our recommendations to Congress, which must take the next important step—approving the National Highway System.

"Our report calls for designation of the proposed National Highway System routes but also recommends that the Secretary of Transportation have the authority to modify the network, at the request of the states, to meet changing needs. In addition, we call for identification—within 2 years—of appropriate intermodal connections to the National Highway System.

"ISTEA sets a deadline of September 30, 1995, for congressional action. But I can assure you that the president, Secretary Peña, and I will be challenging the Congress to complete action on this vital transportation advancement long before then.

"Today, the National Highway System is the next generation—the next step to continuing the progress that has made the United States the most mobile nation in history."

New Guidelines for Accelerating the Use of Innovative Technologies by the Highway Industry

by Richard A. McComb and Daniel F. Larson

Introduction

The need to accelerate the integration of new technologies into the U.S. highway system has increased dramatically over the past decade as the Interstate Highway System has neared completion. Because Congress recognized the importance of technology application, it established the Applied Research and Technology (ART) Program. Authorized under section 6005 of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, the ART Program began in fiscal year 1992 with funding of $35 million and will receive $41 million per year in fiscal years 1993 through 1997. As called for in the legislation, the Federal Highway Administration (FHWA) has developed guidelines to carry out the ART Program. The program and guidelines to carry out part of the program are summarized in this article.

The ART Program aims to identify and promote technologies that are designed to improve the durability, efficiency, environmental effects, productivity, and safety of highway, transit, and intermodal transportation systems. Specifically, it will accelerate testing and evaluation of new technologies, both foreign and domestic.

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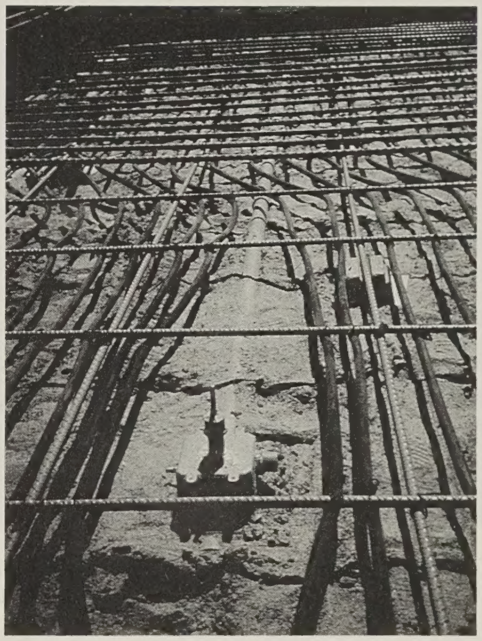
Background

The ART Program, as developed by FHWA, is composed of three elements—priority technologies, testing and evaluation, and applied research. The ART Program elements are summarized in table 1.

Priority technologies

The priority technologies component involves the implementation and evaluation of technologies that are specified in the legislation and other priority new technologies that have been identified by FHWA and proposed for partnerships through general solicitations. The three technology areas specified in ISTEA include:

- *Heated bridge technologies.* Projects in this category will evaluate the costs and benefits of deck-heating technology on bridges that may be replaced or rehabilitated under section 144 of title 23 of the U.S. Code. Nine projects in seven states were funded during fiscal year 1993.

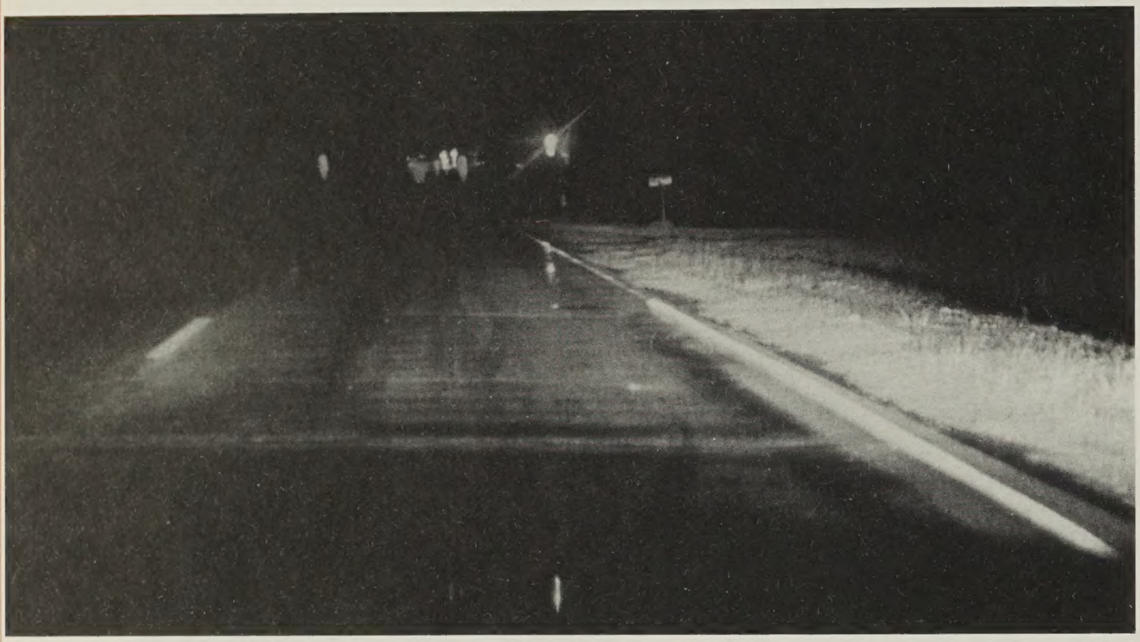


The hydronic hoses are in place prior to the bridge deck placement. Hot fluid circulating through the hoses heats the deck surface. A sensor device is shown in the foreground.

- *Thin-bonded overlay and surface lamination of pavement.* Projects in this category will incorporate uses of thin-bonded overlays (including inorganic bonding systems) as a part of highway pavement or bridge repair, rehabilitation, or upgrading. The projects will be designed to evaluate feasibility and costs and benefits; to minimize overlay thickness, initial lay-down costs, and out-of-service time; and to maximize life-cycle durability. Twenty-eight projects in 14 states were funded in fiscal year 1993.
- *All-weather pavement markings.* These projects will evaluate the use of all-weather pavement markings for durability and

safety. Project locations will be chosen to test the effects of varying climatic conditions, snow and ice control operations, and various traffic characteristics and pavement types. Seventy-seven projects in 17 states were funded in fiscal year 1993.

In addition, two individual projects were planned. A construction project planned for Missouri will use high-performance blended hydraulic cement in highway pavements or structures to evaluate the durability and construction efficiency of this material. Also pending is a project in New Jersey to evaluate the environmental and safety characteristics of elastomer-modified asphalt when used in highway pavement construction.



Potters Industries Inc.

After approximately two years of heavy traffic, the VISIBEAD road boundary line still provides good wet weather delineation.

Test and evaluation

Test and evaluation (T&E) projects involve the full-scale field testing and evaluation of new technologies. T&E projects originating in both the public and private sector will come through the Highway Innovative Technology Evaluation Center (HITEC). HITEC will serve as a focal point for evaluating innovative technologies and will provide a valuable network of experts to hasten the transfer of technology into practice. The *Guidelines for Implementing the ART Program* apply to this program element. (See HITEC article on page 9.)

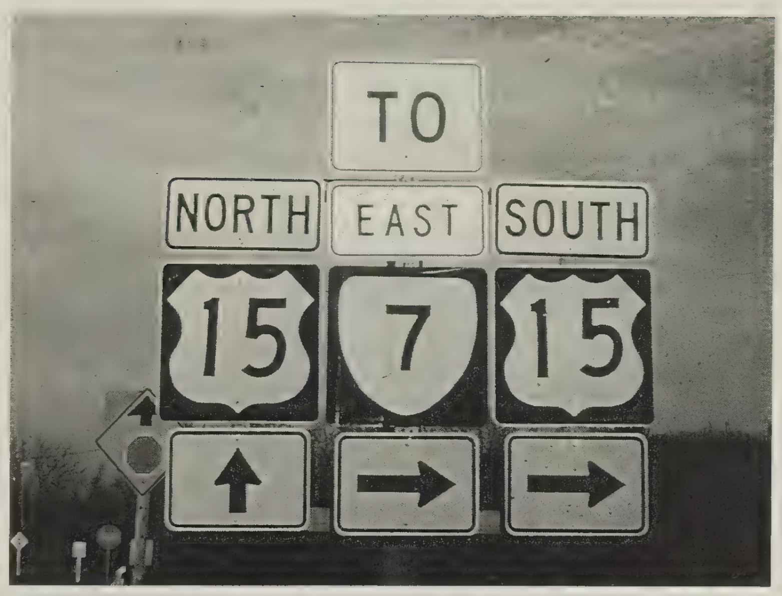
Applied research

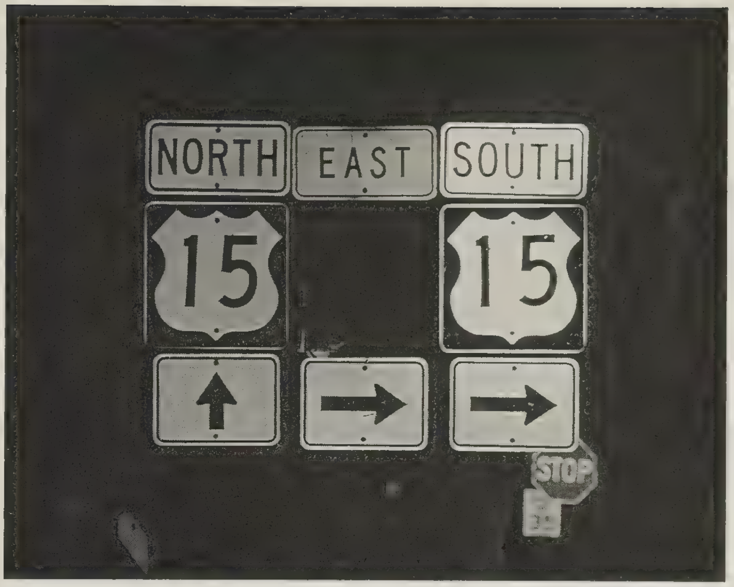
The applied research program promotes identification and development of foreign and domestic technologies and new methods for accelerated testing and evaluation. The program will include a variety of research and development (R&D) activities to develop products and technologies that meet the general objectives of the ART Program. The applied research program element has been used to fund some high-priority research areas, reviews of foreign technologies, and research of advanced topics. The applied research program element is also the key resource for providing technical assistance to states and local agencies participating in the T&E program.

ART Program Scope

A broad range of technologies are to be tested under the ART Program. The ART Program mandate encompasses the following technology areas:

- *Materials and procedures that accelerate construction.* Projects in this category will test and evaluate innovative uses and modifications of concrete, steel, plastics, composites, and other materials, and innovative procedures for accelerating construction. Examples would include rapid-curing materials, prefabricated components, plug-in replacement modules, automated construction equipment, and robots and sensors.
- *Environmentally beneficial materials and procedures.* These projects will test and evaluate the environmental benefits of alternative materials and procedures used in highway planning, design, construction, rehabilitation, operation, and maintenance. Examples would be air quality improvements and noise abatement systems for construction, environmentally benign materials for vegetation control, and environmentally safe paint removal.
- *Materials and techniques that enhance serviceability and longevity under adverse climatic, environmental, and load effects.* This category includes strength-enhancing additives or reinforcements, coatings and sealers, composite designs, in situ supplements, and alternative design or construction technologies.
- *Technologies that increase efficiency and productivity of vehicular travel.* This category includes vehicle and roadway projects; traffic control devices and systems; traffic management systems, strategies, and communications; information systems; and computer-based tools that permit analysis of areawide surface transportation needs and operational plans. Examples include innovative sensing and information transfer technologies, operational systems, software, and other technologies affecting vehicular travel and demand management.
- *Technologies that enhance safety and accessibility of vehicular transportation systems.* Projects that test and evaluate hardware, software, materials, equipment, and systems that address improved safety and accessibility of vehicular transportation systems will be covered by this category.





Signs with poor retroreflectivity cannot be easily seen at night and in adverse weather conditions.

Also included will be design, construction, and operational concepts for improved safety or accessibility of vehicular transportation systems, such as guidance and control systems, visibility and traction improvements, network operations, and monitoring and control systems.

Note that Intelligent Vehicle-Highway Systems (IVHS) technologies are not eligible for this program. IVHS technologies are specifically covered under IVHS programs administered by the Department of Transportation and other agencies; IVHS technologies will be referred to those programs.

Application Process

Proposals for T&E projects are invited from public agencies, private organizations, and individuals. The proposed T&E projects must be incorporated into projects constructed on highways eligible for federal-aid funding. All proposals will be routed through HITEC, which will assist in planning and implementing field tests and in developing evaluation plans for those proposals. Applications for testing will be accepted and evaluations will begin during fiscal year 1994.

ART application requirements will be simple and straightforward to encourage the participation of private innovators who are unfamiliar with the highway market. Proposals will include a project plan, a detailed plan for statistical data collection, a budget that includes itemized total and annual costs, and plans for disseminating the useful results of the project to the transportation community.

Proposal applications for technology testing and evaluation and possible ART funding should be submitted directly to HITEC. Public agencies should refer to HITEC all parties offering new technologies.

Cost-Sharing

Funding for T&E project costs will be shared; the program will provide funds to state highway agencies to finance up to 80 percent of the federal-aid cost to construct those new technologies. The federal share can fund the acquisition, installation, or construction of an approved T&E project. Additionally, project costs for testing, data collection, evaluation, and report preparation are eligible for 100-percent ART Program funding. If the technology fails on an operating highway, repair or replacement costs may be financed with normal federal-aid matching funds. The non-federal share of funding can include the value of materials, equipment, specially trained workers, or other tangible contributions of goods and labor related to the project, as well as a monetary match.

ART Program funding does not pay for the total cost of the construction. The program pays only the contract features and costs additional to or different from the features and costs associated exclusively with conventional projects or technologies. The ART guidelines refer to these as "delta costs" and identify three basic categories of features that may generate such costs:

- *Replacement or substitute for a conventional technology.* The delta costs would be the costs for the replacement or substitution, minus the cost of the conventional technology. An example would be a new binder used as a substitute for asphalt or portland cement.
- *Existing technology that has been modified.* The delta costs would be the costs of the additional technology and its incorporation into the project. An example would be the use of an asphalt modifier with the delta costs calculated as the cost of the modifier and the labor or equipment cost incurred in adding the modifier. If the modification also required an increase in preparation, handling, or placement costs over conventional costs, these increases would also be considered delta costs and would be eligible for funding.
- *Entirely new technology added to a project.* The delta costs in this category would be all of the costs for the new technology to be incorporated in the project, such as the installation of a

system for heating a bridge deck or the installation of a cathodic protection system for a bridge structure.

Note that delta costs do not include those costs normally associated with project construction, unless they are unique to the new technology in cost and character. For instance, restriping surfaces after overlays or redecking in conjunction with the installation of a bridge deck heating system would not be included in delta costs; however, traffic control during construction might qualify if the duration of construction was increased because of the incorporation of a new technology.

Evaluation Plans

If a technology requires a full-scale field T&E project, HITEC—working with the states—will assist applicants in developing and submitting evaluation plans for T&E projects to FHWA for possible ART Program funding.

Reporting Requirements

Annual progress reports will be required for each project during the third quarter of the calendar year. These reports will provide details about each project with statistical results and summaries of project activities, along with any proposed changes or modifications of the project plan. Both interim and final reports will be required. Final reports will document the project, the data collected, and the testing and evaluation results.

Selection Process and Criteria

HITEC will receive all proposal applications and will perform an initial screening to determine which are technically feasible as T&E projects. Incomplete or unacceptable applications will be returned with a debriefing; others may be routed to more appropriate federal programs. Standard processing for feasible proposals will include the establishment of a review panel, evaluation planning, and an applicant cost-sharing plan. HITEC will then recommend to FHWA those technologies to be tested and evaluated under the ART Program.

Selection by FHWA will be based on the following eight criteria, which are listed in descending order of priority:

1. Applicability of the project to one or more of the priority or general technologies.
2. Timeliness of the proposed project as part of an approved and funded construction project involving new construction, rehabilitation, upgrading, or replacement.
3. The clarity of focus and applicability of the new technology being evaluated relative to the areas of need.
4. The level of funding to be provided by the applicant.
5. The appropriateness of project costs and budget to the potential return on investment in terms of safety, serviceability, productivity, durability, economy, and environmental quality.
6. Completeness and technical quality of the project plan and design.
7. Suitability of the proposed location(s) for the technology being studied.
8. Quality, clarity, comprehensiveness, and applicability of the proposed technology transfer program.

Post-Selection

FHWA will announce which T&E projects have been selected for funding under the ART Program early in the first quarter of each fiscal year. FHWA will notify the states of the approved project(s) and the funding amount(s). The states will be requested to develop plans, specifications, and estimates for project construction, which will be the basis for the allocation of federal funds. Funding of the approved projects will be through the normal federal-aid procedures, and funding will be processed through FHWA field offices.

Summary

As detailed in the ART guidelines, T&E projects routed through HITEC will provide the funding and technical assistance needed to channel innovative technologies quickly into the highway system. The ART Program has the potential to improve the quality of U.S. highways significantly by matching, testing, and evaluating technologies and projects to accelerate the use of innovative technologies on a national scale.

For more information about this program, please contact Richard A. McComb at the Office of Technology Applications (HTA-2), (202) 366-2792.

Richard A. McComb is a special assistant to the director of the Office of Technology Applications (OTA). McComb manages the Applied Research and Technology Program. A career highway engineer with FHWA, McComb headed the Strategic Highway Research Program (SHRP) Implementation Staff upon the creation of OTA in 1990. In that capacity, he coordinated and planned a national and international marketing program to identify, develop, and promote adoption of innovative technologies and products from SHRP. He was chief of the Engineering and Operations Implementation Division at the Turner-Fairbank Highway Research Center in McLean, Va., from 1987 to 1990. From 1985 to 1987, he was assigned as loaned staff to the SHRP. McComb received his bachelor's and master's degrees in civil engineering from the University of Connecticut.

Daniel F. Larson is transportation programs director at Tonya, Inc., a consulting firm that provides full program support to FHWA for the Applied Research and Technology Program. Mr. Larson has more than 20 years of experience managing technical programs for such clients as the Federal Judiciary, the Federal Aviation Administration, AT&T, Baxter International, and the U.S. Department of Commerce. He was a study director and operations analyst at the Pentagon and he directed a government command and control center. He received his bachelor's degree from the U.S. Air Force Academy and his master's degree from the University of Rochester.

Overcoming Roadblocks to U.S. Innovation

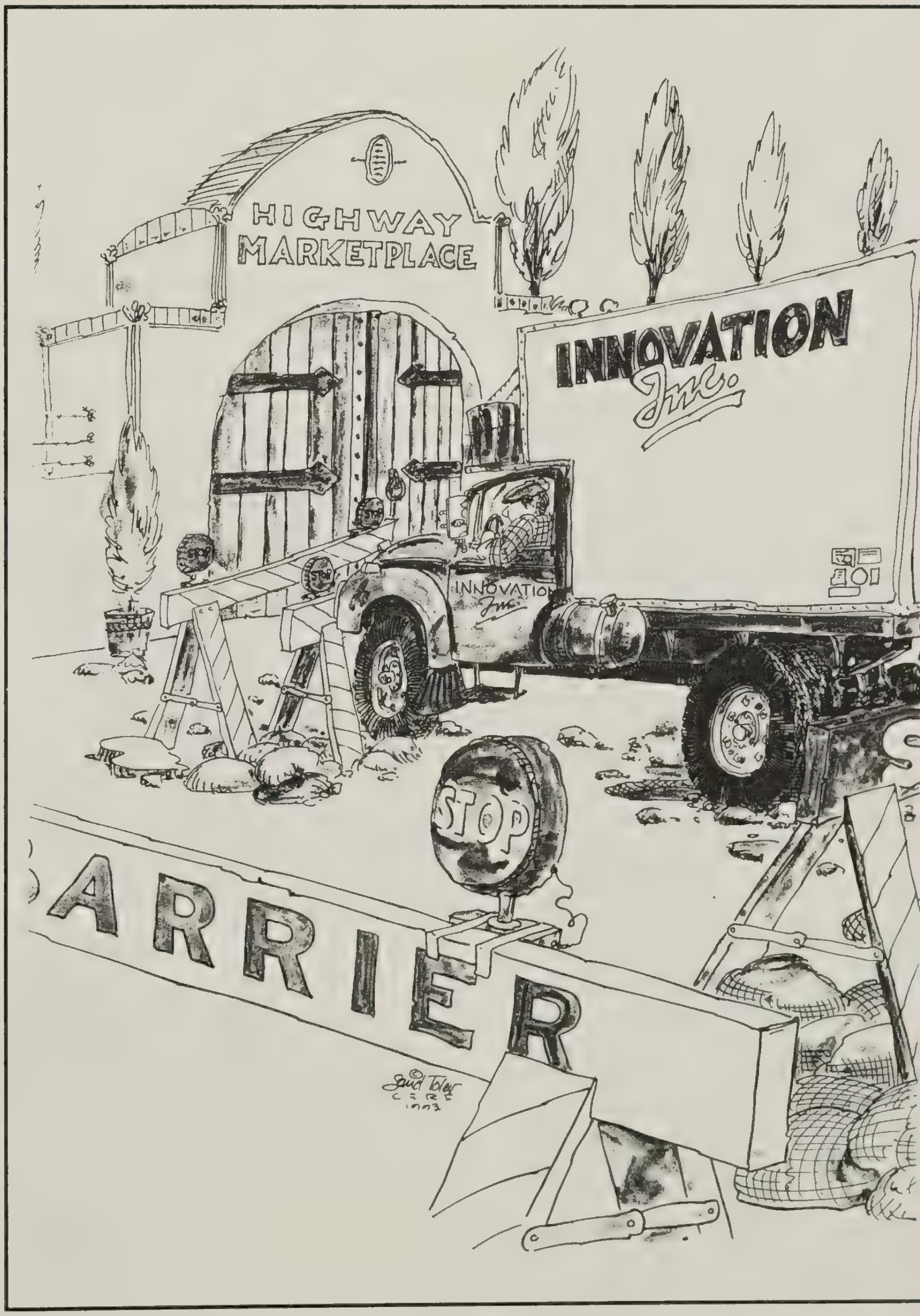
HIGHWAY INNOVATIVE TECHNOLOGY EVALUATION CENTER

by Louis Colucci and Robert Bryant

The Highway Innovative Technology Evaluation Center (HITEC), established in 1992 to serve as a nationally recognized service center and clearinghouse for evaluating innovative highway technologies, opened for business on January 4, 1994.

The official grand opening ceremony was conducted on February 10. Congressman Norman Mineta (D-Calif.), chairman of the House Committee on Public Works and Transportation, and Federal Highway Administrator Rodney E. Slater were invited to participate. Congressman Mineta presented the keynote remarks at the 1992 workshop on highway innovation from which the HITEC concept was born.

At the inaugural meeting of the HITEC Executive Committee on May 12, 1993, Jane F. Garvey, deputy administrator of the Federal Highway Administration (FHWA), called HITEC "the key to restarting the engine of innovation." She also said, "It is a wonderful way to expedite the implementation of new technology into our highway system. Although an enormous undertaking, HITEC is crucial to the future of our highways. At no other time in history has the need for innovation in highways been greater. We must continue to seek ways to provide



Civil Engineering Research Foundation

a better product using fewer resources."

HITEC serves as a focal point for evaluating new technologies from both the public and private sectors and also serves to expedite the transfer of these new technologies into operating practice. Technologies evaluated by HITEC might include a new material to extend pavement life, a new piece of construction equipment, a new maintenance process, or a new bridge design feature.

HITEC will accept only those technologies (products, tools, and processes) for which research has been essentially completed and there are prototypes ready for adoption and for which there are no established standards or specifications. Where more research is needed, cases will be referred to existing programs such as the Small Business Innovation Research Program and the National Cooperative Highway Research Program (NCHRP) Innovations Deserving Exploratory Analysis (IDEA) program. Where standard technical acceptance already exists, cases will be referred to programs such as the National Transportation Product Evaluation Program of the American Association of State Highway and Transportation Officials (AASHTO) for comparative performance testing.

HITEC will help tear down some of the roadblocks to innovation in highway projects.

Harvey M. Bernstein, president of the Civil Engineering Research Foundation (CERF), and J. Peter Kissinger, director of Highway Innovative Research for CERF, explained some of these roadblocks in an article that was published by the *Construction Business Review*. "Presently, if an entrepreneur or manufacturer decides to develop a product for the U.S. highway system, the road to the marketplace is pitted with detours and roadblocks. The odds against getting the product considered and adopted by all the state and local jurisdictions is staggering. In fact, the more you know about the diverse design and construction industry, the less willing you will be to tackle the product acceptance process. The institutional barriers are too numerous, the market too fragmented, the level of reviews and approvals too diverse, and the return on investment too small ...

"Unfortunately, the design and construction industry, which must play a key role in rebuilding our deteriorating infrastructure, has reached a point in a litigious society where the uncertainty of product liability charges and least-cost contracts result in low risk designs rewarding practitioners for stability rather than innovation."

The benefits of HITEC include:

- Innovators can more quickly and easily get peer review of their products and access to the agencies.
- The agencies derive savings from use of the new products.
- The agencies can reduce their product acceptance committees and associated testing.
- The concept brings the users together to share information. This is already in evidence in AASHTO's newly formed National Transportation Product Evaluation Program that is establishing regional testing centers for comparative performance testing of materials, such as traffic paints.
- The HITEC concept builds on the experiences of similar programs underway in Canada, France, and other countries.
- The concept establishes a partnering relationship with industry.

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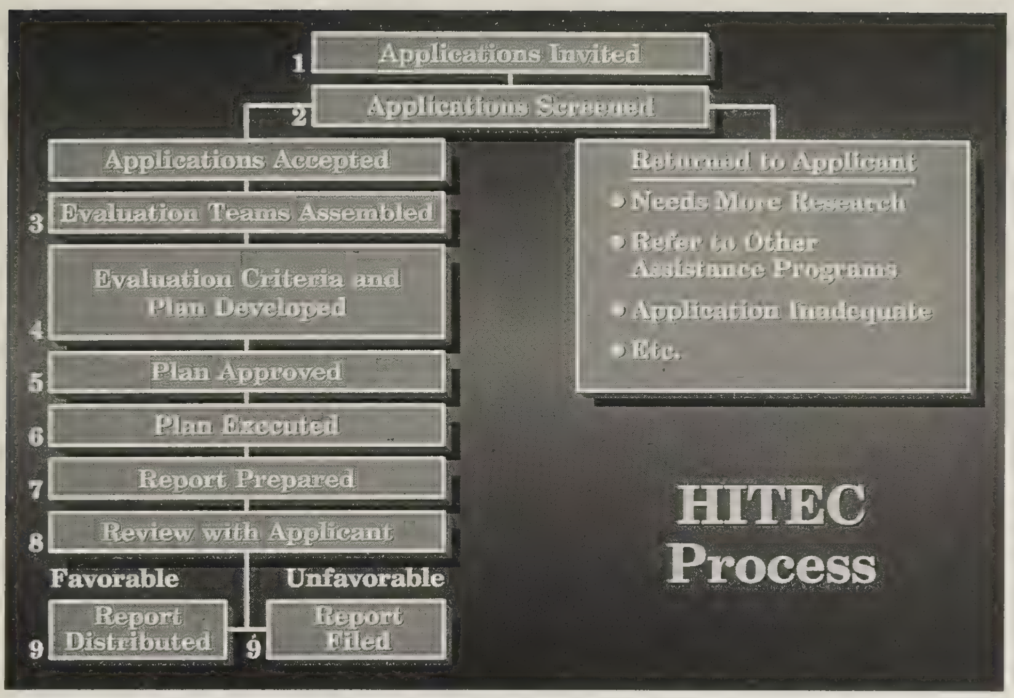

HITEC is administered and coordinated by CERF, part of the American Society of Civil Engineers, and will be partially funded initially under a four-year cooperative agreement between CERF and FHWA. HITEC is guided by an executive committee that includes public and private leaders of the highway community. The HITEC concept has already been suggested for establishing similar programs in the environmental and high-rise building technologies.

Although HITEC has a national focus, it is not a federal program. HITEC's goal is to become self-supporting. HITEC will charge fees for both the application process and evaluation plan development. These are funded by the applicant. It is expected that the initial screening fee will be less than $5,000, with the initial evaluation plan costing $20,000. The actual field or laboratory evaluation costs may well range from $100,000 to $1 million; the higher end of the range will be the exception.

Substantial assistance is expected from the private sector. When appropriate, funds from government programs, such as Section 6005 of the Intermodal Surface Transportation Efficiency Act of 1991, will also be used. The goal of HITEC is to build new alliances and consortia between government at all levels, private industry, research facilities, and other key elements of the highway community.

Innovators, private companies, and public entities with new products and services will work with technical panels organized by HITEC to plan and implement the necessary real-world evaluations to demonstrate to the highway user community how the product or service performs, where it would be applicable, and what benefits it will provide if used.

After the evaluation process is completed on each technology, the technical evaluation team with the HITEC staff will prepare a report. If the report is favorable—the product or process meets the technical requirements of the evaluation plan—then the report will be issued for public use. It is hoped that the favorable report will lead to:

- Rapid adoption of the technology by highway agencies.
- Enhanced product acceptance by the highway community.
- Further marketing by the applicant promoting technical acceptance.

The favorable report by HITEC is not an endorsement; it is a consensus of technical acceptance and integrity as claimed by the developer.

Unfavorable reports will not be released to the public. They will be reviewed confidentially by the technical team and HITEC staff with the applicant for further development, refinement, or action on the technology.

As stated by Bernstein and Kissinger, "By encouraging our industry and federal government to support and contribute to the establishment of nationally accepted test centers for innovation, we can open many of the doors blocking our path to the marketplace. We can establish a process for demonstrating the value of innovation nationwide, and thus foster the implementation of new materials, products, and methods, while simultaneously improving the global competitive position of our nation."

For more information on HITEC, please contact:

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Robert Bryant is the editor of *Public Roads*. He is employed by Walcoff and Associates as the project manager of an editorial support team in the FHWA's Office of Research and Development Operations and Support at the Turner-Fairbank Highway Research Center.

Modeling of Geotextiles and Other Membranes in the Prevention of Reflection Cracking in Asphaltic Resurfacing

by Luis F. Da Silva and Juan A. Confré

Abstract

An analytic study on the use of membranes in asphaltic resurfacing of fractured pavements is presented in this article. Based on general laws such as Hooke's Law, Paris' Law, and the energy conservation law plus some reasonable hypotheses, the Fabric Effectiveness Factor (FEF) has been determined. This factor indicates the increment in the service life of an asphaltic overlay. According to the results obtained, it is possible to conclude that geotextiles are physically the best membranes, followed by the wire mesh and some other alternatives. The results are general and provide a framework for future research (both theoretical and in the laboratory) on road service life related to thermal and traffic loading distresses.

Introduction

Asphaltic resurfacing is a way of rehabilitating deteriorated and fractured roads, providing a partial solution based mainly on economic considerations. Nevertheless, this solution is restrained, among other secondary factors, by the premature emergence of cracks on the new layer surface, as a consequence of reflection cracking from the original pavement.

Many different methods have been tried in order to prevent or delay this reflection. An attempt to delay the emergence of these cracks has also been made by incorporating such elements as geotextiles between the old pavement and the new layer.

Whether the geotextile delays crack propagation or not has been a matter of divided opinion. Nevertheless, our interest in doing research on it was originally based upon some successful experimentation developed in Chile (more specifically on the "El Cobre" Road), where excellent results have been obtained. Although its application is not that extensive yet in the country, new research on the subject is currently being conducted. (*1*) Some successful experiences in the United States also influenced our interest.

This theoretical study on the use of membranes for the prevention of reflection cracking in asphaltic resurfacing provides a theoretical framework for future research and gives credence to current empirical recommendations. Although approximate, its results are considered fairly acceptable; their interpretations will be given general treatment, focusing the analysis on the tendencies found.

Geotextiles in Pavements

A geotextile is defined as a synthetic permeable membrane, especially built for different uses related to soil engineering and whose materials belong to the great diversity of products manufactured by the polymer industry.

Geotextile influence on long-term behavior of asphaltic overlays, along with the asphalt reinforcement effect, constitute a complex mechanism that depends on the "geotextile-asphalt-impregnation-pavement structure-manufacturing" system. This mechanism should by no means be related only to the tensile strength of the geotextile.

In time, asphalt concrete roads will be exposed to cracking caused by temperature, asphalt aging, rutting, and flexural fatigue. In the resurfacing case, reflection cracking is also to be considered. This reflection is reduced and delayed by the seal and reinforcement properties of the geotextile considered. First, when saturated with asphaltic impregnation material, it forms an impermeable barrier that prevents water from reaching lower levels of the road; then, it dissipates stresses at each point. Requirements with which non-woven geotextiles must comply are indicated in table 1.

Theoretical Analysis of Traffic Loads

In order to elaborate the best possible theoretical model that simulates vertical crack propagation to an asphaltic overlay, the analysis is based upon two principles: crack propagation due to the transmission of traffic loads and crack propagation due to

Table 1—Geotextile Requirements

PROPERTY	NORM	UNIT	REQUIREMENTS
WEIGHT	ASTM D-3776	lb/in^2	1.99 - 2.27
TENSILE STRENGTH	TASK FORCE 25 MET-1	lb	81.4
MAXIMUM STRAIN	TASK FORCE 25 MET-1 ASTM D-4632	%	50.0
SATURATION	TASK FORCE 25 MET-8 IST 180.8 - 84	gal/in^2	1.3 E-04
FUSION	ASTM D-276	ºC	150.0

temperature variations. Consideration is also given to concepts and hypotheses leading to acceptable results when compared to those obtained through experimentation.

Pavement strength depends not only on maximum loads, but also on their frequency of occurrence. As for the effects due to traffic, this is a key aspect when it comes to loading trucks; it is under this point that the analysis of pavement design is conducted.

Fatigue law relates stress levels to the number of cycles required to produce an asphaltic overlay failure, assuming the rest of the variables are constant. This law can be expressed in the form:

$$N = a\sigma^b$$

where N is the number of times the load is repeated, σ is the maximum loading stress, and a, b are experimental parameters. (*2*)

Nevertheless, the system to be analyzed includes an asphaltic overlay on an even sealed fractured pavement. In addition, the analysis should rest mainly upon the crack propagation itself from the rigid pavement to the surface. Therefore, under this concept of fatigue of the material, it is necessary to introduce the parameter f of propagation of the crack to the surface, whose equation is:

$$\frac{df}{dN} = C\sigma^m$$

the so-called Paris' law, indicating how much a fracture propagates per repeated load to produce such an increment. Analogously, C and m are parameters. (*3*)

This criterion of resurfacing break will be defined at the time the crack reaches the surface. Due to the fact that this analysis deals essentially with the reflection phenomenon, it is necessary to say that it only considers upwards reflection cracking coming from a fractured concrete pavement.

The duration of the acting load caused by a moving vehicle at a point in the fractured zone is indeed very short, just fractions of a second; besides, the load suffers a dispersion as it moves downwards in the material. The resulting deflection could be considered "elastic." For preventing crack propagation, some reinforcement elements (e.g., a geotextile) are incorporated into the system before applying the new layer. Avoiding reflection cracking is actually not possible, but an attempt can be made to delay such propagation. Thereby, a longer service life can be attained. The membrane stuffs the small space between the two concrete blocks and spreads the motion in the zone through a wide enough section of the upper layer so the deformation can be absorbed, thus reducing fatigue. (See figure 1.) (*4*)

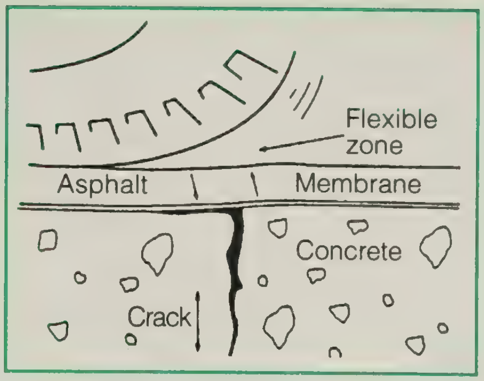

Figure 1—Possible mechanism for crack propogation delay due to a membrane layer.

If a load P is applied, a normal distribution of stresses $S_z(x,z)$ is verified at a given point of the membrane incorporated into the system, with:

$$S_z(x,z) = \frac{P}{z\sqrt{2\pi v}} \exp\left(\frac{-x^2}{2vz^2}\right)$$

this relationship makes a normal distribution of P, and the standard deviation is given by $z\sqrt{v}$, with v representing Poisson's coefficient. P is the load produced by the wheel, and its dimensions are force per unit width. (See figure 2.)

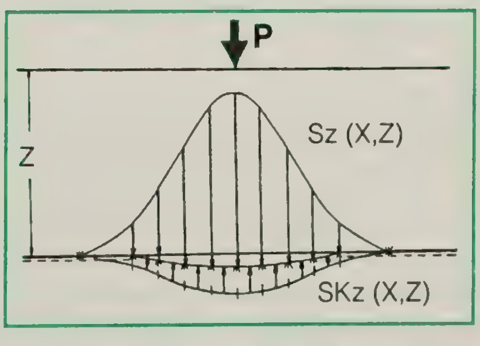

Figure 2—Normal distribution of forces.

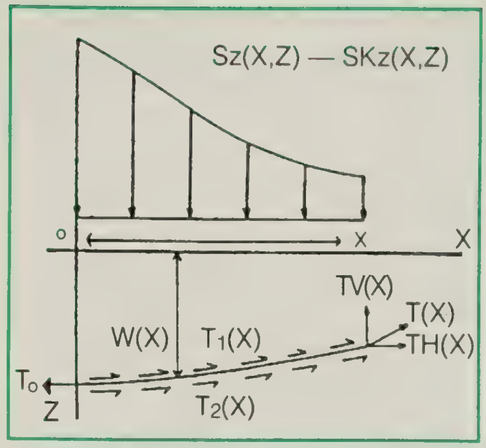

Figure 3—Equilibrium of forces in the membrane.

Assuming that materials behave as an isotropic homogenous mean, and also that traffic-loading distress produces small deformations within elastic limits, the following system of forces can be written with a general equation (according to figure 3):

$$TH(x)\left(\frac{d^2w}{dx^2}\right) + T(x)\left(\frac{dw}{dx}\right) + K_s w(x) = S_z(x,z) \quad (1)$$

where: $T(x) = T_1(x) + T_2(x)$,
$T1(x) = F_1 \cdot [S_z(x,z) + \Gamma \cdot Z]$,
superior tangential stress;

$T_2(x) = F_2 \cdot [K_s \cdot w(x,z) + \Gamma \cdot Z]$,
inferior tangential stress;

where Γ is the specific weight of the asphaltic mix; Z is the thickness of the asphaltic overlay; and F_1, F_2 are friction factors. The third term in equation (1) corresponds to an equation given by Winkler's modulus, where w(x) is the

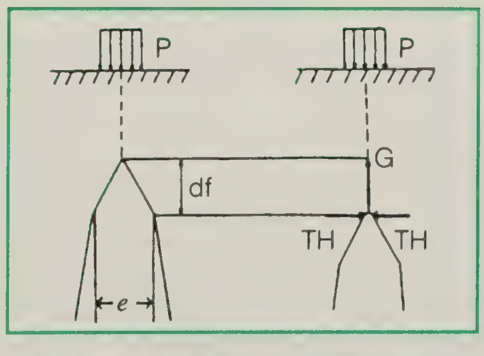

Figure 4—Balance of energy on top of the crack.

deflection at each point and K_s represents the reaction. The solution to this differential equation must comply with the condition of deformation compatibility.

In general, and as a consequence of vertical displacements suffered by the concrete pavement, this layer will derive the flexure produced by traffic loading to the overlay pavement, thus propagating the crack to the surface. Through energetic considerations, it is possible to state the following differential equation:

$$G \cdot df = dV - dU$$

where, by definition, $G \cdot df$ equals the work done by the splitting force G of a crack in a structure for a small propagation df (see figure 4); V is the work done by the external forces; and, U is the internal energy of the structure. (3)

According to Paris' law, mentioned above, it is possible to associate the increment in the differential df to the passing of a wheel by a fractured zone. The equation takes the form:

$$\frac{df}{dN} = cG^m$$

rearranging this equation we get:

$$\int_{f_0}^{f} \frac{df}{G^m} = c(N - N_0)$$

Thus, evaluating and regrouping constant terms in C, we obtain the equation:

$$N = \frac{1}{C} \frac{Z^{(m+1)}}{(m+1)T_0{}^m} \qquad (2)$$

Study with Membrane

When considering an overlay with the incorporation of such a membrane that leads to a prolongation of the service life, we would expect a greater loading frequency in order to reach the failure, that is, N (w/memb.) > N (wo/memb.). This could be possible through a reduction of the propagation force G, produced because of the work exerted by the external forces. The incorporation of a membrane such as a geotextile or a similar fabric ensures that the asphaltic overlay will be less loaded, owing to a greater elasticity supplied by the membrane.

Analogously, as done with equation (2), we get an equation that includes the membrane through its thickness h_g, and presents an expected maximum stress T_0 of smaller magnitude. Using N_2 and T_{02} for the new situation with membrane, we have:

$$N_2 = \frac{(Z + h_g)^{(m+1)}}{C(m+1)T_{02}{}^m} \qquad (3)$$

Assigning N_1 to the original system without membrane, and considering h_g=0 for case 1, from (2) and (3) we get the quotient:

$$\frac{N_2}{N_1} = \left(\frac{Z + h_g}{Z}\right)^{(m+1)} \bullet \left(\frac{T_{01}}{T_{02}}\right)^m \qquad (4)$$

N_1/N_2 represents how much the service life of an asphaltic resurface is prolonged by the incorporation of a membrane as a reinforcement element in order to control crack propagation produced by truck loadings. This quotient is actually the fabric effectiveness factor (FEF), supplied by manufacturers. (5) Nevertheless, the determination of FEF varies according to geometrical and loading conditions, presenting geotextile-different responses.

It is necessary to say that the above equations are theoretical; parameters C and m are experimentally obtained by means of correlations between several loading tests that measure their corresponding cycles and loads. We assume that for both cases, coefficient C is of a similar order of magnitude. Likewise, it is possible to regroup exponent m, obtaining a much more sensitive parameter in equation (4), which implicitly depends upon the characteristics of the material for the respective loading state. (3)

Distress produced by significant thermal variations is another important factor that affects pavements. These variations are cyclical, depending upon the maximum and minimum daily temperatures. The purpose of this analysis is to make it more convenient to consider daily, rather than yearly, temperature variations. This is the cycle that reduces service life of the pavement, having greater influence on crack propagation.

Since we are studying an asphaltic overlay on the tip of an existing rigid pavement, consideration must be given to the fact that the response of each of these materials to thermal distress will be different. That is, when a pavement layer is subjected to these stresses, it tends to expand and contract at high and low temperatures, respectively. Therefore, an incompatibility between the deformation of the old pavement and the asphaltic overlay movement will occur.

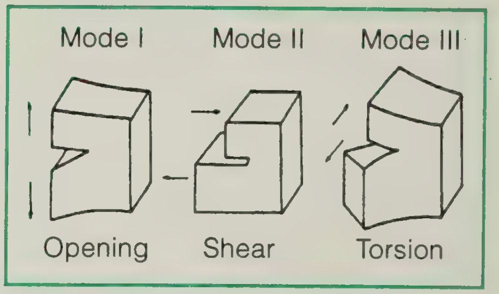

Figure 5—Modeling with Mode I.

For the effect of modeling the propagation, cracks in solids may be taken as discrete surfaces under a displacement field. In the case of flat cracks, potential displacements of these surfaces are given by three independent fracturing modes. (See figure 5.) When

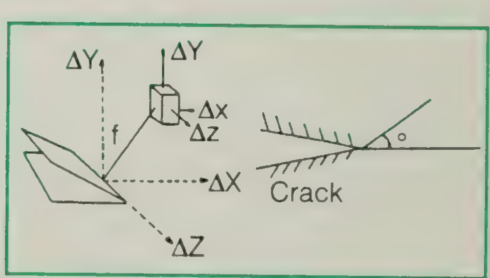

Figure 6—Stress on top of the crack diagrams for plane deformations.

analyzing upward vertical crack propagations, as in this study, the most suitable fracturing mode is Mode I, opening. (*6*) More explicitly, when the concrete layer contracts—producing cracks—a slipping plane that stresses the asphaltic mix is generated in the interface of the two layers, inducing the reflection.

One of the equations proposed for Mode I to relate displacements to stresses, outlined according to the reference system shown in figure 6, is given by the analytic equation:

$$e = \frac{K}{2G_0}\left(\frac{f}{2\pi}\right)^{\frac{1}{2}} \sin(\theta/2)[k - \cos\theta] \tag{5}$$

where K is the parameter that depends on loading (tensile intensity factor); e is the displacement normal to the direction of the crack (width of the transversal crack); G_0 is the tensile modulus ($G_0 = E/2(1 + V)$); E is the elasticity modulus; V is Poisson's Coefficient; f, θ are the ratio and the angle in polar coordinates, respectively; and $k = 3 - 4v$, is the flat deformation state. (*3*)

Pavement temperature is depth-dependent: the deeper, the lower (Thomlinson's criterion). This characteristic is represented by:

$$T(z) = T_s \cdot \exp(-\Gamma_d \cdot z) \tag{6}$$

where T_s is the temperature at the surface level; Γ_d is the coefficient dependent on thermal diffusiveness; and z is the depth at which temperature is T(z). (See figure 7.)

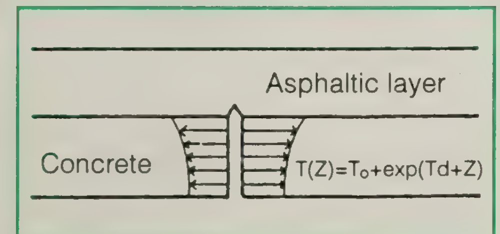

Figure 7—Thermic stress distribution.

The tensile intensity factor is calculated from equation (5), where propagation occurs vertically, that is, when $\theta = \pi$ (propagation angle is measured in relation to the propagation ratio). The general equation for this particular case takes the form:

$$e = \frac{4K(1-v)}{G_0}\left(\frac{f}{2\pi}\right)^{\frac{1}{2}} \tag{7}$$

The space e does not depend on the height of the crack. Nevertheless, it is proportional to the temperature variation on the plane at depth z. Rearranging, from (6) and (7) we get:

$$K = A \bullet T_s \bullet \exp(\Gamma_d \bullet z) \bullet \frac{G_0}{4(1-V)} \bullet \left(\frac{f}{2\pi}\right)^{\left(-\frac{1}{2}\right)}$$

Using Paris' law for the case of a thermal distress, we have:

$$\frac{df}{dN} = c \bullet (\delta K)^m$$

Under the boundary conditions stated above, we can obtain:

$$N = \frac{1}{B(1 + m/2)} \bullet \exp(-m \bullet \Gamma_d \bullet z) \bullet z^{(1+m/2)} \tag{8}$$

where

$$B = C \bullet \left(A \bullet \delta T \bullet \frac{G_0}{2(1-V)} \bullet \sqrt{2\pi}\right)^m$$

From this equation, it is possible to conclude that the time to reach failure is proportional to two terms, both depending on thickness Z, from which the exponential term $\exp(-m \cdot \Gamma_d \cdot z)$ represents the gravitation of the thermal protection.

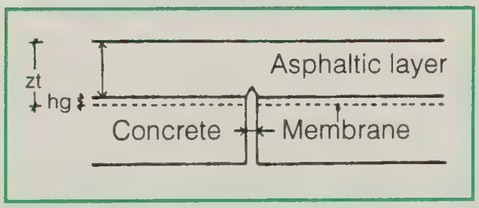

Figure 8—Modeling with equivalent membrane.

A composed configuration that can be modeled by the following equation is shown in figure 8:

$$e_q = A_q \bullet \delta T \bullet \exp(-\Gamma_{dq} \bullet Z_t) \tag{9}$$

where e_q represents the opening of the crack the propagation will develop when trespassing a membrane-overlay system whose thickness is determined by a multilayer system; Z_t is the overall thickness of this multilayer system; A_q is the equivalent proportionality coefficient; Γ_{dq} is a factor that depends on the thermal diffusiveness of both materials; and δT is the temperature difference that for all subsequent calculations will be considered constant and equal to 40 °C.

Considering a multilayer model, we have:

$$Z_t = Z + h_g$$

$$\tau_{dq} = \frac{Z \bullet \Gamma_d + h_g \bullet \Gamma_{dg}}{Z_t} \tag{10}$$

$$A_q = \sqrt{(A_g \bullet A)}$$

where h_g is the thickness of the membrane, Γ_{dg} is the thermal diffusiveness of the membrane, and A_g is the proportionality coefficient for the corresponding membrane.

If we want N to increase in equation (8) with the incorporation of the geotextile, then we must have:

$$A_q = \sqrt{(A_g \bullet A)} < A \tag{11}$$

i.e., $A_g < A$, which is true if $e_q = e \cdot f$, with:

$$f = \frac{1}{\sqrt{\exp(1 \bullet h_g)}}$$

According to the proposed hypotheses, the condition proportionality that coefficient A must comply with to prolong the service life is valid.

Using equations (8) and (10) for the cases with and without membrane, the following quotient is obtained:

$$\frac{N_1}{N_2} = \left(\frac{A}{A_g}\right)^{\frac{m}{2}} \bullet \exp(h_g \Gamma_{dg} \bullet m) \bullet \left(\frac{Z + h_g}{Z}\right)^{\left(1+\frac{m}{2}\right)} \quad (12)$$

Equation (12) allows quantification of the increment in the number of loading cycles—hence, of the service life—needed by the reflective crack coming from the concrete pavement in order to reach the surface of the asphaltic overlay. This equation gives the prolongation of the service life as a function of the thermal diffusiveness of the membrane; the thickness of the membrane; the thickness of the asphaltic overlay; exponent m and experimental parameter characteristics of bituminous materials; and coefficient A, obtained for each material.

In addition, this quotient defines parameter FEF for the case of thermal distress, and is composed by three terms, the first two presenting a greater gravitation on the value of FEF: first, a relationship between coefficient A; second, an exponential term that is a function of parameter Γ_d (depending on the thermal diffusiveness of the membrane constitutive material); and third, a term whose components are comparable in magnitude, having thus a lesser gravitation.

Equivalent Membrane

The porous nature of a non-woven membrane allows its elastic properties to be affected by the retention of asphaltic mix, forming an asphalt-membrane system that generates an equivalent membrane. At depth Z from the surface, there is a plane whose elastic properties are affected by the presence of a polymer fabric or some other material. Hence, an elasticity modulus o wing either to the incorporation of a membrane impregnated with asphalt or to the intrusion of asphaltic mix, depending on the case, is to be considered when modeling.

This effect leads to an equivalent elasticity modulus, given by the equation:

$$E_q \text{ (M.E.M.EQ)} = \alpha \cdot E_a + ß \cdot E_m$$

where E_q represents the term corresponding to the equivalent elasticity modulus; E_a corresponds to the stiffness of the asphalt in the mix, depending on loading frequency, temperature of application, penetration index, and temperature at penetration 800 (Van der Poel); and E_m corresponds to the value of the membrane elasticity modulus that shows a linear behavior and is determined by the tensile fatigue and the corresponding strain.

The equivalent membrane is indeed a membrane that suffers less stress under the same deformation. α and ß are interpreted as the ratio between the volume of the material and the total volume; their determination is obtained from the percentage of asphalt retention in the membrane, given that the areas are directly proportional to the part of the volume occupied by the material.

From the equations obtained in the previous chapters, it is possible to implement a model where both events interact, under equal initial conditions, in a cracked concrete layer covered by an asphaltic overlay. The methodology to be followed consists of the determination of FEF, i.e., the increment in the number of loading and temperature distresses that will affect an asphaltic overlay.

The final results are expressed in terms of the increment produced by the incorporation of a membrane in the loading cycle necessary to reach the failure; for this, we have to compare the systems with and without membrane, respectively.

The model simulates a fake membrane whose material is an asphaltic mix; its thickness is the same as that of the equivalent membrane for the woven type, with which it will be compared by means of quotients.

Parameters

To operate, the model requires all the data related to properties of materials and to the geometry of the system under consideration. To this end, we use the data contained in the different catalogs available for membranes like geotextiles, and other materials like iron or polyester-woven structures. Nevertheless, in the case of burlap, and due to the lack of information on its properties, data on geotextiles of low-tensile strength and smaller thickness are used.

- Burlap: The information used for this material is based on geotextile BIDIM type U14: tensile strength of 28 lb/in (4.91 kN/m), elongation 40 percent. (*7*)
- Geotextile: A geotextile BIDIM type OP-30 is used: maximum stress of 11430 lbf/in (20 kN/m), elongation 30 percent, retention 30 percent. (*10*)
- Wire mesh: This is composed of iron 37-24 of 0.17 in (4.2 mm) diameter. The screen corresponds to an iron wire net welded at the intersection points every 100 mm.
- Polyester-woven structure: Type 6030 ARMAPAL, fiber glass, a tensile strength of 342.12 lb/in (60 kN/m), elongation 12 percent, and a thickness of 0.08 in (2.0 mm). (*8*)

Table 2 indicates the parameters used in the model, where A_g is the proportionality constant between the width of the base of the crack and the temperature on the plane containing the vent of the crack, and gamma is the parameter that depends on thermal diffusiveness.

Discussion and Conclusions

In drawing the conclusions, we must stress the fact that the methodology used is based upon an analytic formulation, whose hypotheses are associated with the widely accepted elasticity theory and the fatigue laws.

First of all, the simulation established that the deflection produced by temporary loads generates similar results to those obtained through the use of a deflectometer in a currently active highway. This fact allows the attainment of good approximations in the calculation of real stresses.

It is possible to prove that the stresses under the asphaltic layer decrease as a consequence of a

Table 2—Membranes Physical and Mechanical Property				
PROPERTY	BURLAP	GEO-TEXTILE	WIRE NET	POLYESTER NET
THICKNESS [in]	0.04	0.10	0.17	0.08
TENSILE STRENGTH [lb/in]	28.0	114.3	5.633	342.13
PARAMETER [1/in]	0.43	0.85	0.06	0.85
PROPORTIONAL COEFFICIENT "Ag"	7.36 E-04	7.25 E-04	5.28 E-04	7.37 E-04
ELASTICITY [lb/in]	69.85	372.55	492,860.0	2,794.0

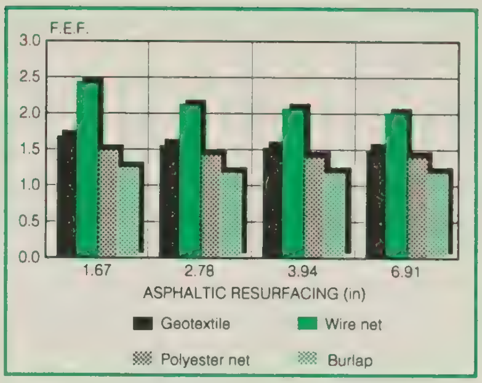

Figure 11—FEF variation v/s asphaltic thickness; different types of materials; propagation temperature delay.

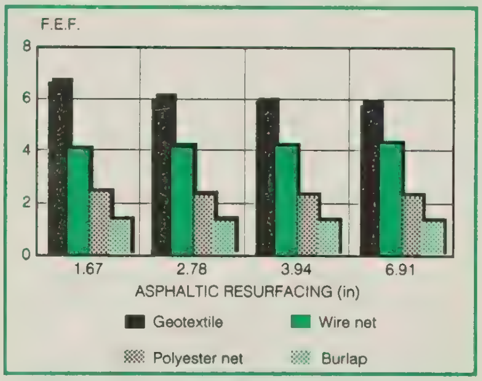

Figure 12—FEF variation v/s asphaltic thickness; different types of materials; propagation traffic delay.

larger loading action area. Hence, the normal distribution used represents a good approximation.

The incorporation of a membrane, such as a geotextile, provides a greater elasticity on the plane of stress located under the asphaltic overlay. This fact should be interpreted as an element that arrests distresses by modifying the elasticity modulus of the asphaltic material.

A geotextile does not provide a greater strength to the system, but rather a greater flexibility in the cracked zone by reducing the stresses, generating a smaller vertical propagation force.

Geotextiles do not allow control over deflections, but their smaller elasticity modulus lets them work at a smaller stress.

Figure 9 of stress v/s thickness shows that for thicknesses greater than 3.94 in (10 cm), the incorporation of a geotextile has no gravitation. The effectiveness of these elements in reducing stresses becomes apparent in overlays whose thicknesses are between 1.57 and 2.76 in (4 and 7 cm). It is also possible to prove that the thicker the overlay, the greater the prolongation of the service life.

To obtain a mixed material formed by bitumen and polymer, supplied by a geotextile, a concept of equivalent membrane was defined, corresponding to a membrane with retained bituminous material, which in the case of geotextiles is determined by the absorption parameter.

The fabric absorption parameter is associated with the retention capacity, conforming an impermeable membrane whose elastic property allows a greater flexibility under a reduction of stresses.

The compatibility between absorption and elasticity properties must be in equilibrium with the amount of bitumen contained in the membrane. Figure 10 tells that the elasticity supplied by the model increases the fabric effectiveness factor (FEF) of the resurfacing, and it is a function of the amount of bitumen; the membrane is saturated, reducing its effectiveness. Nevertheless, there is the limitation represented by the retention of bitumen; the effectiveness factor grows as the retention capacity increases. (9) For smaller absorption percentages, FEF goes down due to a low irrigation.

The result of this analysis confirms an optimum absorption value of about 30 percent, implying a saturation amount of 1.3 x 10^{-4} gal/in^2 (0.9 L/m^2) for a geotextile-type membrane, according to recommendations by *Task Force 25*.

It is important to state that only a good manufacturing process will allow an optimum outcome, since the goal of attaining an impregnated membrane that complies with the mentioned specifications requires a proper execution. One technique consists of using a roadroller when the tack coat is

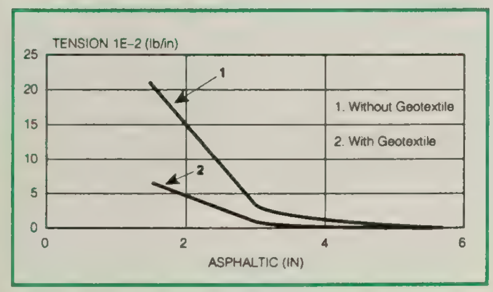

Figure 9—Tension v/s thickness; geotextile; concrete paving 7.87 [in]; equivalent axis 18.000 [lb]; C.B.R.=40%.

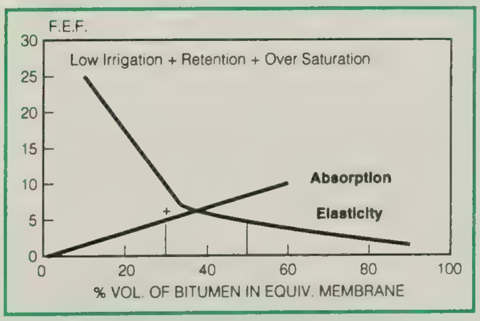

Figure 10—Impregnation; curve of elasticity determined by the model in the equivalent membrane.

applied, allowing saturation of the membrane.

On the other hand, from figures 11 and 12, we can infer that for the same distresses, the greater the thickness of the asphaltic overlay, the smaller the value of FEF; this fact re-stresses the importance of membranes for thinner layers.

We must take into account that for more elastic materials, that is, polyester screens (polyester-woven) and geotextiles, the value found for FEF is a consequence of

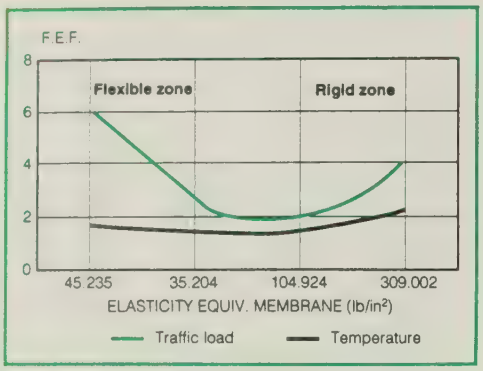

Figure 13—FEF variation with elasticity; behavior in flexible-rigid range; temperature and loading effects; bitumen elasticity for different types of membranes.

the greater flexibility developed in the interlayer, which is indicated in figure 13. In contrast, for a wire mesh whose elasticity modulus is high, the FEF obtained is associated with the greater strength produced by a greater stiffness supplied to the system by the iron material.

According to the general results obtained, it is possible to conclude that the geotextile is physically the best membrane, reaching the greater increment in the service life due to traffic loading, followed by the wire mesh, the woven structure, and, finally, the sackcloth.

It is important to state that the prolongation of the service life through the incorporation of a geotextile would theoretically indicate a global amplification of four times. Nevertheless, precisely because of the theoretical approach of the analysis, only the trends in the results of the simulation are to be interpreted; these trends corroborate the excellent outcomes obtained in constructions that followed proper manufacturing processes.

Due to the complex nature of the problem, it must be stressed that the parameters used were only those directly weighing on the propagation phenomenon. With this in mind, the asphalt aging process was not incorporated into the analysis, as well as the organic distresses the geotextile suffers; the goal sought is well-defined by the variables considered most important in the analysis.

Consideration must be given to the fact that this research is based upon an analytic study done with little data provided by actual experiences, and with information supplied by catalogs. No laboratory experimentation was done; if it had been, certainly more precise results would have been reached through equation adjustment.

In conclusion, we have to point out that the use of different sorts of materials leads to different theoretical behaviors, not necessarily reflecting reality, thus serving only as a reference framework. The importance of geotextiles derives from this fact, without denying possible advantages in the use of other materials.

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HYSIM: The Next Best Thing to Being on the Road

by Elizabeth Alicandri

Introduction

The Federal Highway Administration's (FHWA) Human Factors Laboratory has operated a Highway Driving Simulator (HYSIM) at the Turner-Fairbank Highway Research Center (TFHRC) since the early 1980s. The HYSIM is a fixed-base, interactive driving simulator that uses computer-generated imagery for its visual display. The HYSIM is an excellent test bed for a wide variety of studies of driver performance.

This article discusses the utility of driving simulators for human factors research, HYSIM's evolution over the past 10 years, ongoing and planned HYSIM research efforts, and FHWA's anticipated direction in the field of driving simulation.

Driving Simulation

Driving simulators offer a number of advantages over other testing environments. Unlike field studies, simulators offer complete control of environmental factors and are highly cost-effective for setup and data collection. Furthermore, simulators offer a safe environment in which to test conditions that may be too dangerous to evaluate in a real-world environment. Unlike other laboratory situations, however, simulators offer a dynamic driving environment with workload and tasks similar to actual driving. Driving simulators complement other laboratory methods and field testing, in many cases providing the best of both worlds.

A wide variety of features and configurations can be applied to driving simulators. Driving simulators can be fully interactive, meaning that all the control actions taken by the driver are reflected in the scene. These systems allow a wide range of driving situations to be evaluated in a realistic setting. Partially interactive or part-task simulators, although more limited in the range of experimental situations, are less costly to develop and maintain and can provide useful information for a number of human factors issues. Computer-generated imagery allows tremendous flexibility; any required roadway and surrounding environment can be developed. But the visual image may lack the rich detail seen in the real world. Real-world footage, through film or video mediums, can display the full visual complexity of the driving environment, but scenes are limited to existing roadways and are not fully interactive. Motion-based simulators provide increased face validity to the system. They are important for laboratory investigations of emergency responses and vehicle handling. However, compared to fixed-base systems, motion-based simulators require significantly greater fiscal resources, computer power, space, maintenance, and staffing.

History of HYSIM

In 1980, Systems Technology Incorporated completed a feasibility study for the Department of Transportation (DOT)/FHWA Highway Driving Simulator. Subsequently, HYSIM was built and tested under federal oversight in California. The original system was installed at TFHRC, tested, and became operational in 1983. The HYSIM was designed and built in

The Federal Highway Administration's Highway Driving Simulator: HYSIM.

a modular fashion, allowing subsystems to be upgraded as the state of the art in various technologies advanced.

Basically, HYSIM consists of a car cab that provides a realistic driving environment, a variety of computers to control the simulation, and two primary visual systems. A wide-screen projection system is used to display the roadway, the surrounding environment, and other vehicles. Four 35-mm slide projectors with zoom lenses and affiliated yaw mirrors add signs to the scenario. The capability of showing high-resolution signs in real time is what continues to set HYSIM apart from other driving simulators.

Visual scene from the original HYSIM using the Evans and Sutherland PS2 graphics system.

Visual scene from the upgraded HYSIM using the Star Graphicon G2000 Image Generator.

First-Generation HYSIM

The original HYSIM consisted of nine modules. The Car Cab Module, still with HYSIM, is a modified 1980 Ford Fairmont. Except for the engine, drive train, and wheels, the car cab is intact. It provides a realistic automobile environment for the driver. Driver manipulation of controls in the car cab is reflected in the simulated driving environment.

The Graphics Computer Module was a DEC PDP 11/34. It received input from the car cab controls to provide updated car position and velocity to the scenario computer for navigational calculations. The graphics computer also controlled the vehicle dynamics of the HYSIM.

The Scenario Computer Module was also a DEC PDP 11/34. This module provided primary control of the experimental scenario, performed navigational calculations, controlled other modules, and executed data collection.

The Graphics-Generation Module was an Evans and Sutherland Picture System 2. This module transformed the aerial view of a predefined roadway generated by the graphics computer into a perspective view. The output was displayed on a high-resolution color monitor.

The Roadway Projection Module consisted of a Sharp XC-802RA color television camera and an Aquastar 80090 television projection system. The camera viewed the high-resolution display of the graphics-generation module and output the image to the Aquastar, which was mounted in a gantry above the car cab. The Aquastar then displayed the roadway onto a screen mounted in front of the car cab.

The Sign-Generation Module consisted of four Mast Random Access slide projectors, also mounted in the gantry above the car cab. Affiliated 7:1 zoom lenses allowed the static 35-mm slides of signs to grow in size as the driver approached them, and computer-controlled yaw mirrors maintained the appropriate lateral placement of signs on the roadway. The sign-generation module was monitored and controlled by the scenario computer and projected realistic sign images onto the screen in front of the car cab.

The Sound-Generation Module received output from both computers. It provided crash sounds, sirens, wind noise, engine sounds, and tire squeals to the simulation through speakers located in the doors of the car cab.

The Psychophysiological Module was a Gould system that allowed for collection of various physiological measures, including respiration rate, heart rate, and galvanic skin response.

The Operator Control Center Module was located in a separate room from the vehicle. This workstation included a variety of monitors that allowed experimenters to remotely monitor the progress of experiments and to view the projected image or the subject. All of the electrical wiring for the HYSIM I/O devices was routed through the control center to facilitate troubleshooting and the addition of ancillary devices.

This first-generation HYSIM represented the state of the art in driving simulation in the United States, and although highly sophisticated for its time, it provided a relatively sterile visual environment. The graphics-generation module displayed roadway delineation, and the sign generators provided highway signs. The image was that of a flat road at night with no surrounding environment or other vehicles.

Even with these limitations, the first-generation HYSIM provided a safe, controlled driving environment and was a highly successful test bed for numerous important research investigations.

Many of these studies required increased capabilities in the HYSIM, and over the years, additional modules were added. The Space Module, which provided the capability to simulate active signs and signals, was added in 1985. By rapidly alternating between two slides, this module allows signal lights to change and signs to flash. In 1988, the Vehicle Module was added to provide another vehicle in the scenario. This system used a video mixer to combine the roadway image with an image of a model car or truck for presentation through the roadway projector.

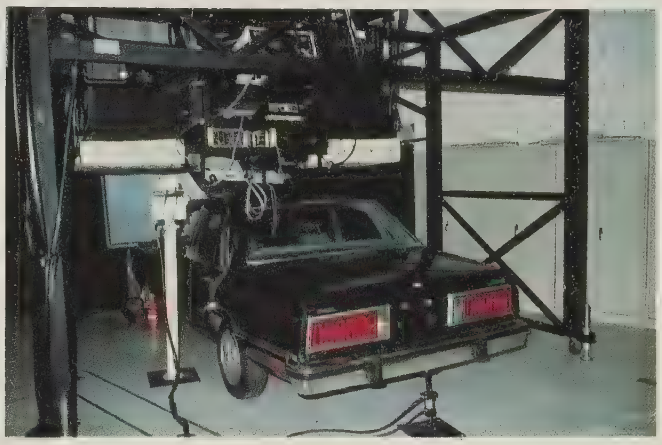
Individual subsystems in the HYSIM were also upgraded over the years. The zoom range of the sign generators was increased; the quality of the roadway projector was improved; the size of the screen changed; and the projection equipment was relocated to provide rear-projection images of better quality and brightness.

Although these changes increased the utility and realism of the HYSIM, the basic system remained unchanged. In the early 1990s, a major system change was made to the HYSIM, resulting in the second-generation HYSIM.

Second-Generation HYSIM

By 1990, the state of the art in computer graphics made it possible to cost-effectively simulate complex visual scenes in real time. The graphics-generation module was replaced with a polygon-based system. This system allowed for display of color images for the roadway and the surrounding environment, significantly enhancing the utility of the HYSIM.

The second-generation HYSIM retains many of the features of the original system and uses the same basic modular design. The Computer/Graphics Module is now contained in a single system. The second-generation HYSIM is based



Original HYSIM laboratory with visual projection system above car cab.

Upgraded HYSIM laboratory with visual projection system behind screen.

on a STAR Graphicon G2000 Image Generator using a Silicon Graphics IRIS 4D/35TG workstation as the controlling host. This system can display 3000 textured, anti-aliased polygons per frame at a 30-Hz frame rate. The workstation provides all control functions for the experimental scenario, performs navigational calculations, and controls peripheral devices and data collection. The vehicle dynamics simulation is housed in this system as well.

The Roadway Display Module is fed by the image-generation system and outputs the image through a BarcoGraphics 1200 video projection system to a screen placed in front of the vehicle. The input signal is a 1280 X 1024 pixel image, which is directly routed to the projector via an RGB (red-green-blue) signal. The projector is located behind the screen and is positioned to present an angular field of view of approximately 70 degrees horizontally and 35 degrees vertically.

The basic design of the Sign-Generation Module has not changed, but the affiliated equipment is significantly more sophisticated than the original. These devices are now located behind the rear-projection screen located in front of the car cab. The system now uses four Navitar 750-watt Xenon arc lamp 35-mm random-access slide projectors and 17:1 zoom lenses. The affiliated yaw mirrors can move both laterally and vertically to allow signs to rise over a hill.

A small-scale Motion System Module has been added to the system. Four pneumatic pistons, with affiliated coil springs and shock absorbers, are located in each wheel well of the car cab. This system simulates the normal vibrations experienced while driving and can provide minimal car cab pitch for each corner of the car cab.

A Grass Model 12 Neuro-Data Acquisition System has been added to the Psychophysiological Module to allow for conditioning and recording of electroencephalogram data.

Minor changes have been made to the Car Cab Module to enhance the feel of the controls. A high-torque servo-motor and a system of cables and weights have been added to increase the realism of the steering wheel system.

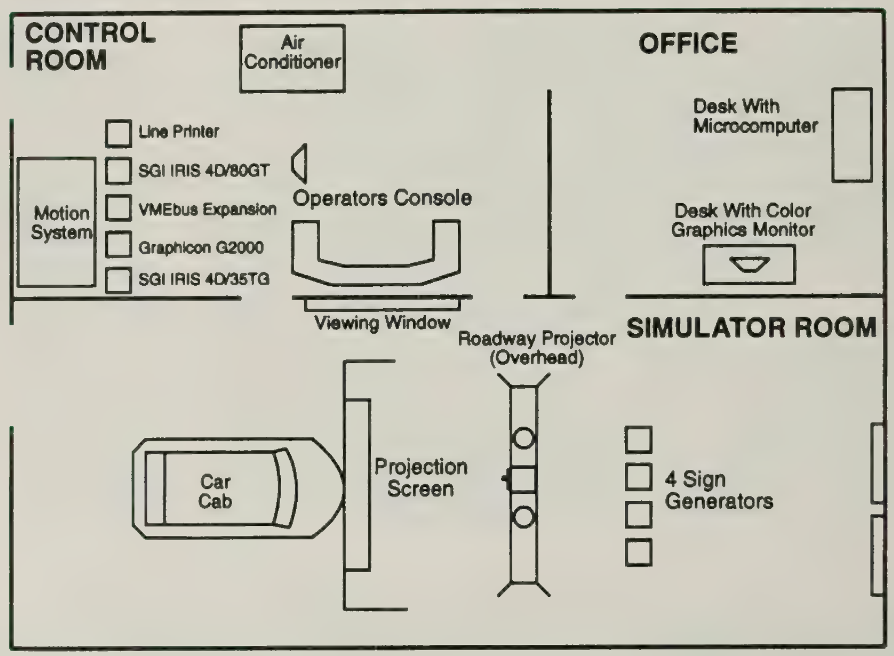
The Sound-Generation Module, the Operator Control Center Module, and the Space Module are essentially unchanged from the original design.

The significant changes between the first- and second-generation HYSIM have greatly enhanced the utility of the system for human factors research. The new graphics system provides the capability for simulation of daytime scenarios that were lacking in the original system. Also, with the capability to produce trees, buildings, and other environmental features, the visual scene is much more representative of real-world driving, and it increases the visual loading on the driver. The new graphics system also permits adding up to three other moving vehicles in the scenario, increasing the vigilance required by the driver, and providing a wider range of experimental situations.

The upgraded sign generators increase the brightness and visual range of signs in the simulation. The additional vertical yaw mirrors will allow vertical curves to be added to HYSIM scenarios.

Other enhancements, including the motion system and the steering wheel torque system, provide increased face validity, and the upgraded psychophysiological system provides a greater range of data availability than the original system.

HYSIM Laboratory Floor Plan



Ongoing HYSIM Investigations

Second-generation HYSIM validation study

Because the second-generation HYSIM is significantly different from the previous version, another validation study is required. To ensure that results obtained in the HYSIM are generalized to the real world, drivers' responses and behaviors in the HYSIM must, within certain design constraints, correspond to their real-world responses.

Subjects will drive a 15-mile scenario encompassing various speed limits, road delineations, highway signs, and traffic volumes—both on the road in TFHRC's fieldtest vehicle and in the same scenario programmed on the HYSIM. Driver performance measures will be collected in both settings and systematically compared. This will provide a clear understanding of HYSIM's validity as a research test bed and serve as the basis for the design and implementation of future HYSIM enhancements.

Factors affecting vehicle headway selection

The distance a driver travels behind a lead vehicle is referred to as headway. Understanding how external factors influence headway selection has critical safety and efficiency ramifications. The amount of headway a driver selects may function as a behavior-based safety surrogate or predictor of rear-end collisions. Furthermore, if external highway features influence headway selection, highway design elements can be modified to assist drivers in choosing appropriate headways for specific situations.

Subjects from a variety of age groups will drive a scenario that encompasses a variety of roadway features. Geometric design, environmental complexity, and behavior of other vehicles will be manipulated to determine which factors affect driver headway selection.

Partial sleep deprivation and driving performance

Extended periods of partial sleep deprivation appear to affect cognitive skills more than psychomotor skills. It is hypothesized that operators of heavy vehicles may be sleep-deprived on a regular basis, and fatigue is often cited as a contributing or causal factor in truck accidents. Drivers of personal vehicles also operate under conditions of partial sleep deprivation, but controlled investigations of the effect of sleep deprivation on driving performance can be dangerous to perform. FHWA is planning a HYSIM study in collaboration with staff from the Walter Reed Army Institute of Research to investigate the effects of various levels of sleep deprivation on driving performance.

Subjects will drive a simulator scenario containing a number of emergency events under both normal sleep and partially sleep-deprived conditions. They will be allowed one, two, four, or eight hours of sleep per night over the course of several days before participating in the second simulator run. A variety of psychophysiological measures, including brain activity (electroencephalogram) and heart rate will be collected and analyzed. Driving performance measures will also be analyzed, including appropriateness and reaction time for emergency responses, speed, and lateral placement. Results will delineate the effects of various levels of partial sleep deprivation on driving performance.

FHWA's Simulator Plans

HYSIM is particularly suited to the needs of FHWA's Human Factors research program. Highway signing research will remain an important component of the program, but the HYSIM will also be used in other areas. Older driver issues will continue to be addressed in the HYSIM, as well as important issues related to the design of Intelligent Vehicle-Highway Systems. Investigations in new human factors program areas, including hazard identification and younger driver issues, will also be performed in the HYSIM.

In the near term, HYSIM upgrades will include the capability of simulating vertical curves and the continued development of additional intelligent, interactive vehicles that behave like real traffic. Future longer term enhancements will be based on the results of the validation study and a careful review of research needs in the FHWA human factors programs. When system components become more sophisticated and less costly, they will be added to the HYSIM as research needs dictate.

Over the course of HYSIM's development, a number of other driving research simulators with different capabilities have been developed elsewhere. As needs arise for simulation research that requires higher fidelity or different capabilities (such as wider field of view or motion) than available in HYSIM, the human factors team will pursue other simulators as test beds. For example, the University of Iowa currently operates a motion-based driving simulator, the Iowa Driving Simulator (IDS), which is being used for ongoing FHWA research efforts.

Summary

HYSIM, in all its configurations, is an effective research tool for FHWA human factors investigations. Studies conducted in HYSIM range from traffic control device investigations to driver risk perception studies to Intelligent Vehicle-Highway Systems experiments. HYSIM has been upgraded over the years to enhance the capabilities of the system and to meet the needs of changing research programs. Complex human factors issues in the Intelligent Vehicle-Highway Systems program require further simulation experiments, as will older and younger driver investigations and hazard identification studies. HYSIM provides the necessary capabilities to perform these studies.

Human factors research at FHWA is greatly enhanced by HYSIM. The flexibility of the system configuration permits a wide variety of critical investigations of driver performance to be performed under controlled and safe conditions. The modular system configuration permits the modules to be upgraded as the state of the art improves in various areas. Additional modules have been added over the years to ensure that human factors research needs are met. The new graphics system significantly increases HYSIM's capabilities, and new system upgrades will be made to ensure that the system continues to meet the needs of the human factors research program.

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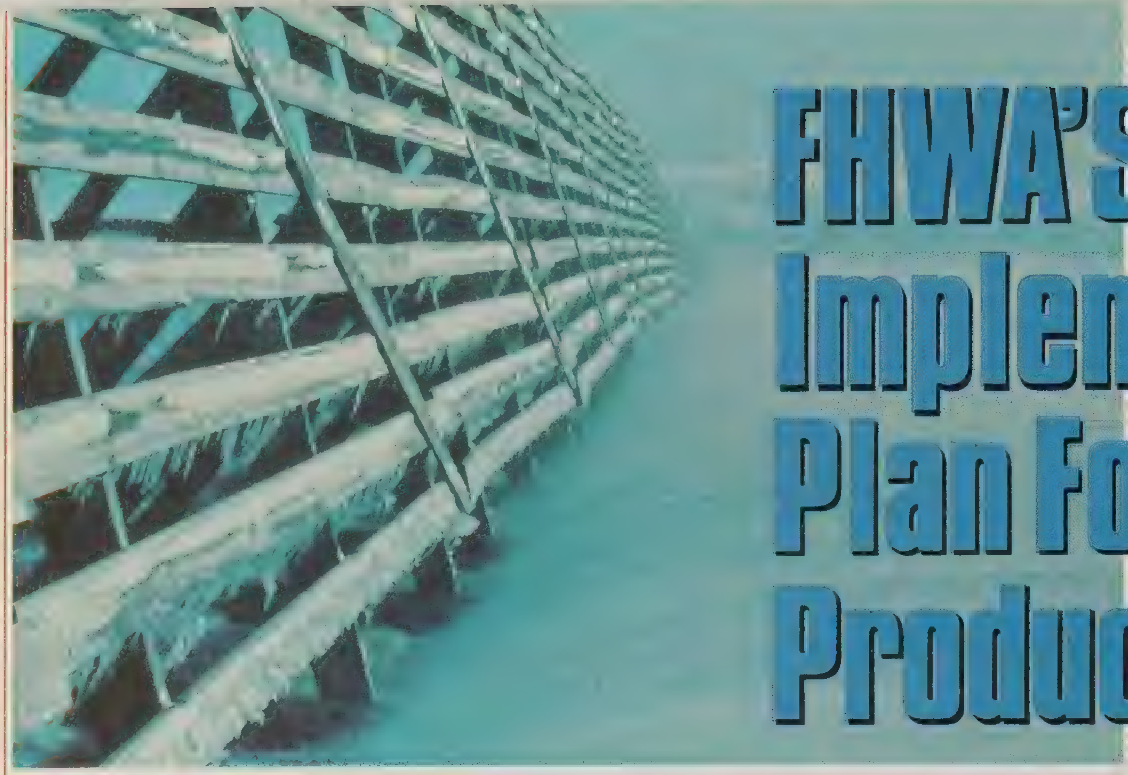


FHWA'S Implementation Plan For SHRP Products

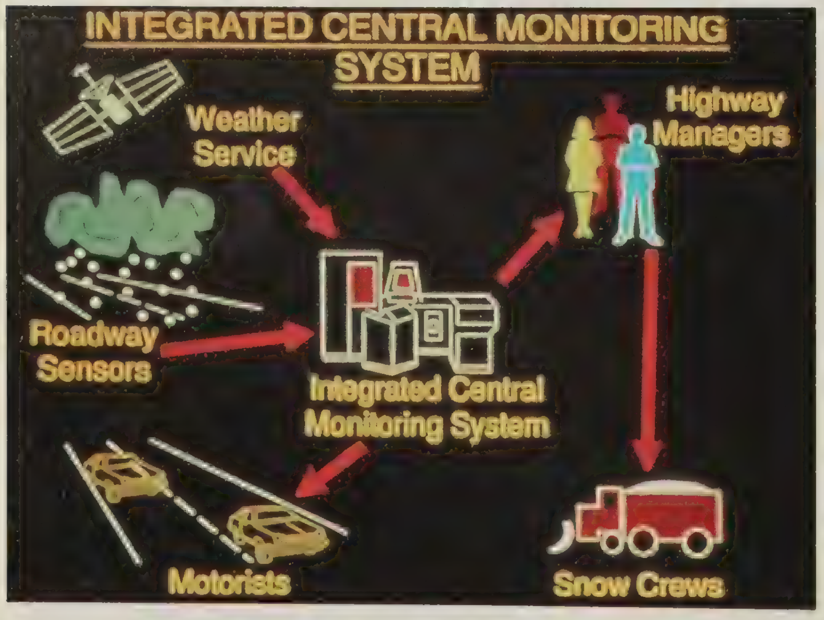
by Charles J. Churilla

SHRP-developed snow fence reduces blowing snow and snow plowing.

Introduction

Promising new equipment and improved materials, specifications, and tests are now becoming available as a result of the five-year Strategic Highway Research Program (SHRP). More than 100 new products and techniques were developed between 1987 and 1993 through the $150-million research program. SHRP research was targeted to improve highway technology in four specific areas: asphalt, concrete and structures, highway operations, and long-term pavement performance (LTPP).

All sectors of the U.S. highway community worked together in partnership to guide the research so that the resulting products could be moved into application as soon as possible. Top administrators and technical experts from state highway agencies, university-based highway research organizations, and industry helped plan the research program, steer its progress, review results, and test and refine products. SHRP operated through a cooperative arrangement among the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Research Council.



Improved roadway weather information systems can help highway agencies respond more quickly and efficiently to inclement weather conditions.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) authorized $108 million—administered by FHWA over six years—to help states and industry put SHRP research results to work and to continue the LTPP studies.

To accomplish this, FHWA modified the structure of its existing technology transfer program to capture and continue the cooperative spirit so successfully nurtured in the SHRP research phase. The key features of this modified structure are:

- Partnerships at the national and regional/state levels.
- Showcase contracts.
- Flexibility to respond to regional/state conditions.

Implementation Plan Purpose and Goals

FHWA's SHRP Product Implementation Program encourages and facilitates the application of research findings that improve the quality, efficiency, safety, performance, and productivity of our nation's highway system. The goals of the implementation process are to:

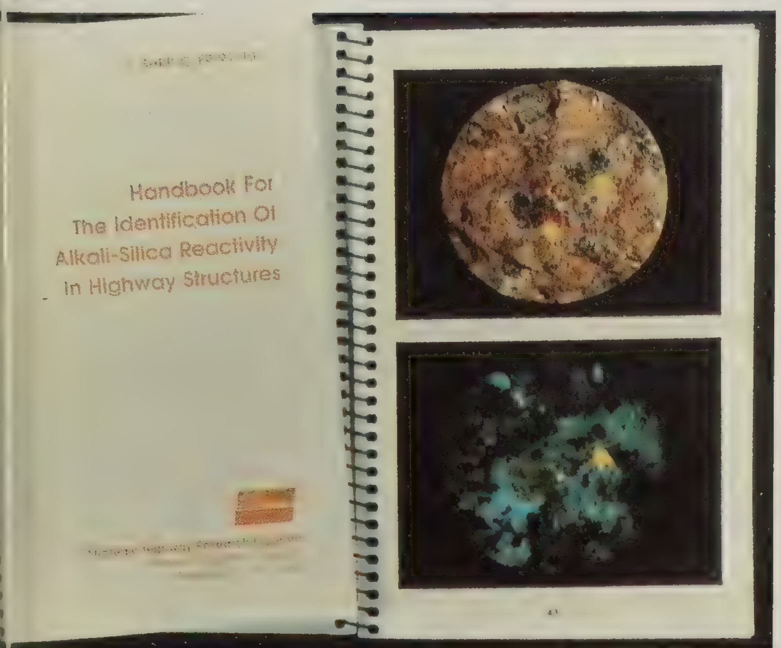
- Ensure that the U.S. highway community is fully aware of SHRP products.
- Develop and implement short- and long-range marketing strategies for SHRP products, exploiting a variety of existing and innovative technology transfer delivery systems.

The stop/slow paddle with flashing lights gets immediate attention from drivers.

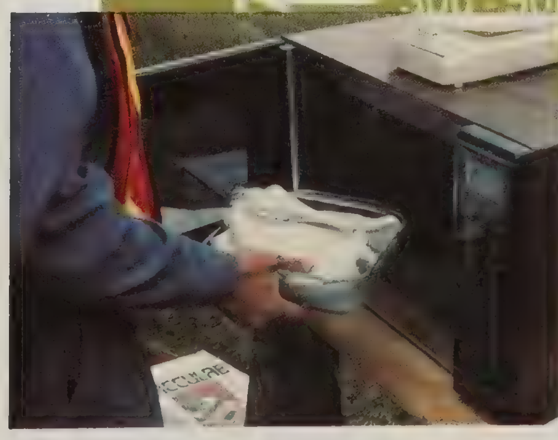
SHRP-improved methods for the sampling and testing of chlorides in concrete.

A new test procedure offers an alternative method for evaluating the freeze/thaw resistance of concrete.

SHRP intrusion alarms warn workers of errant vehicles.



A handbook for the visual identification of alkali-silica reactivity in concrete.



Determining the water content of plastic concrete using a microwave oven.

Organizational Overview

The three-tier management structure of the FHWA SHRP Product Implementation Program involves top managers and technical experts throughout the highway community in committees and technical working groups (TWGs). (See figure 1.)

The first tier is composed of senior executives who address resource allocation and long-range policy. The second tier is made up of SHRP senior program managers who ensure proper coordination and policy execution within certain technical disciplines. The technical experts in the third tier address detailed technical issues arising from specific research or technology activities.

To pull everything together, FHWA created the SHRP Implementation Coordination Group (SICG) under the Research and Technology Executive Board (RTEB). The mission of SICG is to form a working partnership of federal, state, industrial, and academic elements. SIGC develops policies, priorities, and program budgets to put into practice technology developed by SHRP. SICG's responsibilities include:

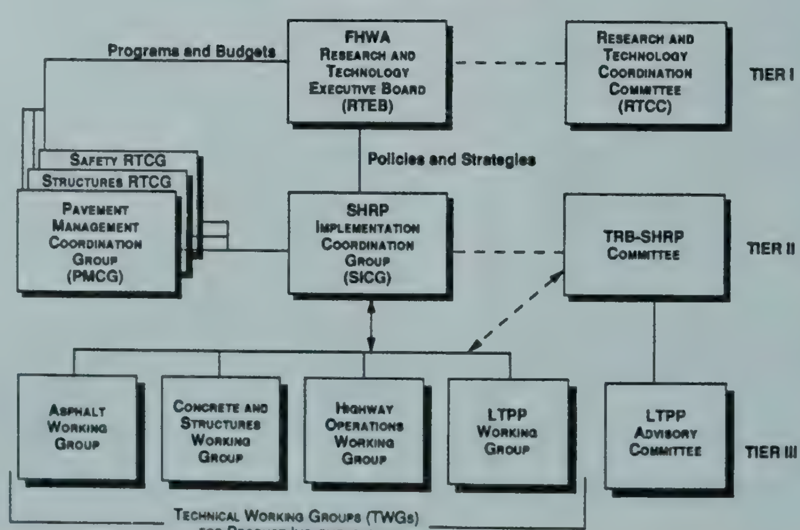
- Developing program and policy recommendations for RTEB.
- Working with the Pavement Management Coordinating Group and the Structures and Safety Research and Technology Coordinating Groups to advance SHRP implementation programs and budgets to the RTEB and to develop SHRP products for which additional research or development has been identified by the TWGs.
- Coordinating with the Transportation Research Board (TRB)-SHRP Committee and the AASHTO Task Force on SHRP Implementation.
- Encouraging field office involvement in SHRP implementation.
- Coordinating and reviewing TWG activities in the four SHRP technical areas and in other ongoing programs.
- Establishing priorities and identifying needed resources for the TWGs.

TWGs operate under SICG. Just as the original research plans for SHRP were developed by several committees representing both management and technical perspectives, the specifics of FHWA's SHRP implementation plan will be developed through TWGs. TWGs members are managers and technical personnel; they form a powerful partnership that will ensure that the implementation program is responsive to participants' needs and environmental concerns.

TWGs will:

- Assess and evaluate the SHRP products.
- Prepare technology development, implementation, and marketing strategies and associated schedules.
- Aggressively execute implementation activities.
- Identify specific implementation objectives and appropriate measures of attainment.
- Identify products that need further research and/or development.
- Develop SHRP implementation activities for the action of SICG.
- Provide information and identify resource needs to SICG.
- Ensure communication and coordination with and involvement of additional technical partners, technology users, states, AASHTO, and industry, as required.
- Respond to queries from the TRB-SHRP Committee as appropriate.
- Recommend the establishment of specific expert task groups under the TWGs.
- Review the work of expert task groups that are addressing details of specific technologies.

STRATEGIC HIGHWAY RESEARCH PROGRAM
SHRP IMPLEMENTATION



SHRP-developed specifications for the preventive maintenance of asphalt and concrete pavements.

- Develop SHRP products and techniques that are essentially complete and can be used with minimal training and evaluation.
- Promote customer evaluation of SHRP products that require local materials and adaptation to regional, state, or specific industry practices.
- Advance promising SHRP products and processes through further research, development, test and evaluation, standard setting, and institutional awareness.
- Provide technical and financial assistance to public and private agencies for the evaluation and ultimate adoption of SHRP research products.
- Provide training to use SHRP products and initiate activities to enhance long-range educational efforts.
- Promote activities by standard-setting organizations such as AASHTO, the American Concrete Institute, and the American Society for Testing and Materials that enhance the acceptability and credibility of SHRP products.

Innovation Through Partnerships

To meet the challenge of presenting and adopting a large amount of technology to a wide audience in a short period of time, FHWA works in partnership with the states, industry, AASHTO, the National Research Council, and university-based research centers. Overall directional and technical issues are addressed through the committees and technical working groups (TWGs). However, to adapt the technology to varied regional, state, and local conditions, the implementation effort must operate with a minimum level of central oversight.

FHWA is encouraging states to organize their own state-level SHRP implementation committees and to develop SHRP implementation plans. These committees should pinpoint the products that most interest them and establish product-specific implementation plans, goals, and schedules. For example, as of June 1993, SHRP implementation programs were either under way or in the planning stages in Indiana, Minnesota, Missouri, New Jersey, Pennsylvania, Texas, Virginia, and Washington. The state programs frequently include a SHRP implementation manager and a SHRP products task force. The managers coordinate with industry and universities in their states and regions. They also maintain contact with SHRP coordinators at their FHWA division offices, and they support and participate in FHWA implementation activities, including the showcase contracts described below.

Funds to assist state implementation activities are available through FHWA's Office of Technology Applications or through federal-aid programs, where appropriate. Determination and use of all appropriate federal-aid

The SHRP dynamic shear rheometer measures the stiffness of an asphalt binder.

funds will be coordinated by the division offices.

AASHTO plays a key role in the application of SHRP products; it established a task force to identify barriers to implementation and to make appropriate recommendations. FHWA representatives serving on this task force will keep AASHTO informed of implementation activity status and explore options for mutual assistance. Additionally, to expedite the incorporation of SHRP technology into its national standards and guides, AASHTO hired a SHRP product implementation coordinator.

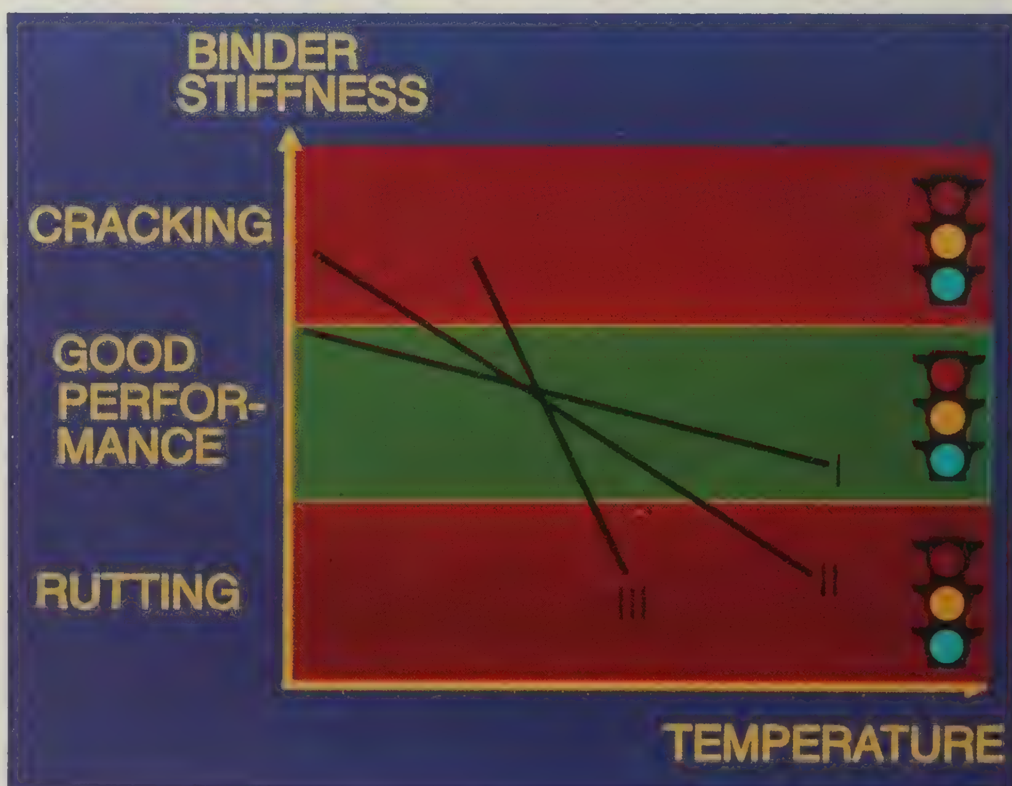
SHRP leadership was previously provided by an executive committee that included chief administrative officers and chief engineers from state highway agencies, top FHWA officials, the executive directors of major trade associations, and senior faculty members from respected university-based highway research organizations. This committee lent crucial direction and support to SHRP during the program's research phase.

To ensure the continued involvement of highway industry leaders, the Transportation Research Board (TRB)—under contract to the FHWA—has organized a new committee, the TRB-SHRP Committee. Members will provide guidance for the continuing FHWA LTPP program (a 20-year performance study, the first five years of which were conducted under SHRP); they will also offer guidance on overcoming institutional barriers to implementation of SHRP products. The TRB-SHRP Committee will coordinate closely with the SHRP Implementation Coordination Group.

Showcase Contracts

In the past, FHWA technology transfer packages were delivered to the field by a small group of headquarters engineers. As the agency increasingly views technology as central to its mission—and as more field engineers assume technical responsibilities—a new and bold approach to technology transfer becomes possible.

FHWA proposes to package SHRP technology into discreet showcase packages and present these to the states through the FHWA regional structure. Specifically, contractors will develop technology transfer packages for groups of SHRP products and technologies and will present them across the country to private



One component of the SHRP SUPERPAVE is a performance-based asphalt binder specification.

and public sector engineers in comprehensive workshops. After these workshops, the contractors will develop—in conjunction with regional technical working groups composed of representatives of the states, industry, and FHWA regional and division offices—a tailored implementation strategy.

The workshops will feature product demonstrations, loaner sets of equipment, videotapes, manuals, etc. Ultimately, all SHRP products will be highlighted in the workshops, and recommendations for further efforts will be provided by the TWGs. Approximately 10 showcase packages have been conceptualized as of this writing—five in the area of concrete and structures, four in highway operations, and one in asphalt.

Flexibility to Respond to Regional and State Conditions

FHWA is taking the lead to help state and local highway agencies effectively use SHRP products. The implementation effort must be flexible to permit the adaptation of these products and technology to regional, state, and local conditions.

Therefore, the implementation program is being carried out in a number of ways in addition to the showcase contracts. For example, activities related to SHRP's asphalt binder tests and specifications are well under way with equipment buys, national training, mobile asphalt laboratories, etc. FHWA sent an implementation work plan for 11 of the work-zone safety products to its regional offices, requesting state participation in the trial use of those products. Also, FHWA project engineers began implementation activities for four LTPP spin-off products—the *Distress Identification Manual,* the faultmeter, falling-weight deflectometer software, and the resilient modulus test procedures.

The SHRP long-term pavement performance (LTPP) test pavements will produce many tools to improve pavement management.

Summary

New technology developed under the SHRP can potentially save the nation millions of dollars a year. FHWA has developed an enthusiastic, innovative, and flexible implementation program and is committed to work with its partners in the highway industry to realize these benefits as efficiently and expeditiously as possible.

References

(*1*) *Implementation Plan: Strategic Highway Research Program Products,* Publication No. FHWA-SA-93-054, Federal Highway Administration, Washington, D.C., June 1993.

(*2*) *FHWA's Implementation Plan for SHRP Products: Organizational Membership,* Publication No. FHWA-SA-93-055, Federal Highway Administration, Washington, D.C., revised October 1993.

Charles J. Churilla is Federal Highway Administration's SHRP Implementation Coordinator in the Office of Technology Applications.

Environmental Research:

HELPING HIGHWAYS IMPROVE THE QUALITY OF LIFE

by Ginny Finch

"The American public insists that our highway program be consistent with environmental goals and values. That's a challenge for all of us, and the environmental research program is a vital tool in our effort to meet this challenge while maintaining America's mobility."
—Anthony R. Kane, Associate Administrator for Program Development

Over the past few years, technological advancements and protecting the environment have been catalysts for change in the policies and procedures of many federal agencies. "Environment" has become one of the most significant political buzzwords of the 1980s and 90s, but for the Federal Highway Administration (FHWA), environmental concerns are much more than a buzzword. FHWA is committed to contributing to an enhanced environment with improved tools and technologies for alleviating highway intermodal impacts on air quality, noise, wetlands, hazardous waste sites, water quality, and historic resources.

This commitment is shared by FHWA Administrator Rodney E. Slater. "Our goal in all of our transportation investments is long term," he said in a July 1993 speech at the Pacific Rim TransTech Conference. "We believe that, if we invest wisely and build partnerships, we can spur the development of new technologies—even whole industries—and contribute to a cleaner environment at the same time."

To accomplish this goal, the experts involved in FHWA's environmental research program are developing research products ranging from air quality models to case studies of successful and innovative highway designs. Not only do these research products carry out FHWA's commitment to the environment and mobility, they are also designed to help states and metropolitan areas in their ongoing planning and project development.

The environmental research program was launched on October 1, 1991, and in fiscal year 1993, the program included 42 projects and a budget of $4.1 million. The program is carried out by the Office of Environment and Planning, whose other responsibilities include drafting regulations, reviewing environmental impact statements, providing technical assistance, and developing policies and guidance.

Many of the research projects now underway were first identified in 1991 at a national conference in Denver co-sponsored by FHWA and the Transportation Research Board (TRB). The conference, "Environmental Research Needs in Transportation," brought together FHWA, other federal agencies, state highway agencies, local governments, consultants, academicians, and environmentalists, who laid out an ambitious agenda for multifaceted research on specific issues in transportation and the environment. The Denver conference not only helped establish FHWA's "core" environmental research, it also laid the foundation for FHWA participation with TRB, the American Association of State Highway and Transportation Officials, the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers, and others on a variety of research projects.

Water quality issues, air quality concerns, and environmentally and socially sensitive highway design practices are three focus areas of the new research program. In one study, ecologists are looking at the water quality impacts of existing highways and further highway construction. In another study, co-funded by the National Academy of Sciences, transportation and air quality experts are investigating carbon monoxide emissions at intersections. In still another study, researchers are examining possible highway design alternatives, exploring solutions for specific design problems, and identifying creative design approaches that are both environmentally sensitive and safe.

"Water quality issues, air quality concerns, and environmentally and socially sensitive highway design practices are three focus areas of the environmental research program."

Here are some details about each of these three representative projects.

The passage of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and earlier technological changes, such as the introduction of unleaded gasoline, have stimulated new interest in the study of water quality problems associated with highway use. To meet the new challenge—to accurately predict impacts and develop effective mitigation techniques—the "Highways and Water Resources" research team is developing improved evaluation methods and innovative "best management" tools. Nationally and internationally, the team is looking at the "bigger picture"—the way in which highway water quality and storm water issues are part of all water resource problems associated with highways. These researchers are also coordinating with other agencies to ensure that both FHWA and states' policies and procedures are consistent with federal storm water and non-point source pollution policies. When the project is completed in about six years, researchers will know much more about the best ways to control ground water pollution from highway sources. They will have quantifiable information about the effects of deicing chemicals on aquifers. They will also be able to develop hydrogeological guidelines for wetland restoration. And they will understand more clearly how to treat and dispose of lead paint debris so it will not contaminate water supplies and resources.

Just as technology and the passage of ISTEA have renewed interest in water quality research, passage of the 1990 Clean Air Act Amendments has created new challenges. To meet the standards of the act for maximum carbon monoxide (CO) levels, the states must not only avoid violations, they must also actively seek to reduce the number and severity of violations. FHWA and the National Academy of Science's National Cooperative Highway Research Program have launched a three-year study of highway intersections, using EPA "hot spot guidelines" to develop computer models. At six to eight intersections throughout the country, researchers will study how air moves, how traffic moves, and how engines operate. Project designers chose intersections on heavily traveled roads, since these locations tend to have the highest CO concentrations. They will examine the affects of "queue length" (number of cars stopped), wind speed, time of day, amount of sunlight, temperature, traffic speed, and acceleration rates on the concentration of CO. As a result of this study, states and metropolitan planning organizations (MPOs) will be better able to predict and minimize the impacts of traffic on air quality.

Like the air quality intersection project, "Improving Aesthetic Design Elements of Urban, Suburban, and Rural Roads" will aid decision-making. The project will help engineers design highways that create a "sense of place"—for example, retaining scenic and historic features along roads where safety standards must be upgraded. The timeliness of this highway design research project is reinforced by ISTEA, which allows state highway agencies greater flexibility in highway design. To make design professionals more aware of the broad range of design options, project researchers will develop a handbook and case studies detailing innovative solutions to certain design conflicts. They will also create a catalog of visual design approaches—a catalog that includes a multimedia, computerized version and a video. The entire effort is aimed at helping states improve and enhance their highway designs without compromising the safety of pedestrians, bicyclists, and motorists.

The environmental research program is a "strategic transportation investment." It is a young program that will soon be paying big dividends, enabling states and MPOs to implement cost-effective strategies to simultaneously enhance mobility and protect the environment.

"We must work together to save wetlands and at the same time explore transportation alternatives that reduce the need for more roads."

—Secretary of Transportation Federico Peña

Ginny Finch is a program analyst and communications specialist in FHWA's Environmental Analysis Division. She recently created a 40-page, color brochure, "Wetlands and Highways: A Natural Approach," 30,000 copies of which were distributed.

Looking for a Few Good IDEAs

by K. Thirumalai

The Innovations Deserving Exploratory Analysis (IDEA) Program of the National Research Council's (NRC) Transportation Research Board (TRB) is designed to nurture innovative concepts for technologies, systems, methods, and processes for application to highway and intermodal transportation practice.

The IDEA program approach was first implemented as part of the five-year Strategic Highway Research Program (SHRP) from 1987-1993. The new TRB IDEA program adopts several of the successful features of SHRP-IDEA and applies them to solicit a broad range of technical innovations for highways, intelligent vehicle-highway systems (IVHS), and transit systems. The program provides an excellent opportunity for proposing innovative approaches for transportation systems and for transferring advanced technologies that have not yet been applied, tested, or used in the highway or intermodal transportation practice.

Any individual or institution in the United States or from abroad is eligible to submit proposals to the following three IDEA program areas:

- *National Cooperative Highway Research Program (NCHRP) IDEA Program.* The NCHRP IDEA Program is funded by the Federal Highway Administration (FHWA) and state highway agencies in cooperation with the American Association of State Highway Transportation Officials (AASHTO). NCHRP IDEA seeks to introduce new technologies, methods, or processes for application to highways and intermodal surface transportation through the development and testing of nontraditional and innovative concepts.
- *Transit IDEA Program.* The Transit IDEA Program is funded by a cooperative agreement with the Federal Transit Administration (FTA) and the Transit Development Corporation (TDC). Transit IDEA is designed to foster the development and application of innovative technologies, methods, management processes, materials and systems for application to transit practice.
- *IVHS IDEA Program.* The IVHS IDEA Program is funded by the FHWA and the National Highway Traffic Safety Administration (NHTSA) of the Department of Transportation (DOT). IVHS IDEA is designed to produce new concepts and innovative products that would accelerate the development and implementation of IVHS in the nation's highways, vehicles, and intermodal surface transportation and transit systems.

Proposals submitted under any of the IDEA programs should have one or more of the following features:

- Technically credible but unproven concept that may require high-risk investigation to prove its feasibility but offers potential for significant breakthrough and large payoffs.
- A concept that offers the potential for advancing the state of the art of IVHS, highway and transit systems, or one that may emerge into new areas for followup research by a national program.
- An advanced method, technique, process, technology, or system developed for other industries such as aerospace engineering, communications, modern material processes, information, computers, robotics, and automation, but not yet tested, applied, or available to IVHS, highway, transit, or multimodal transportation systems.

Two types of IDEA proposals are available. A Feasibility Phase (Type I) IDEA investigation would include an evaluation of an innovative technical concept for which adequate knowledge, technical information, or data are not currently available. An Advanced Testing Phase (Type II) IDEA investigation would perform a larger scale test or field testing of a proven feasible concept.

All IDEA awards typically are fixed price contracts not to exceed $100,000 and must be completed within 12 months. Cost sharing is encouraged but is not a requirement for IDEA proposals. Researchers from all disciplines and with no prior experience in transportation research or systems development are encouraged to submit IDEA proposals.

Individuals interested in one or more of the IDEA programs may request copies by phoning the IDEA Program Office at (202) 334-3568 or by writing to Dr. K. Thirumalai, IDEA Program Manager, Transportation Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

Dr. K. Thirumalai is the IDEA Program Manager for the Transportation Research Board.

The National Quality Initiative

by Donald Tuggle

Introduction

Quality Management (QM) is a broad term for the overall process of ensuring quality products. Within the highway community, it encompasses such issues as contractor/consultant process control, owner acceptance issues, personnel qualifications and training, information management systems, performance-related specifications, innovative contracting practices to achieve quality, incentive/disincentive provisions, performance recognition, improved materials/tests/equipment, and quality improvement techniques. A formalized QM program can be applied to all aspects of highway engineering and operations.

FHWA Demonstration Project No. 89 Workshop

In 1989, the Federal Highway Administration's (FHWA's) Construction and Maintenance Division began discussions with the Office of Technology Applications to initiate a demonstration project (DP) on QM that would both reemphasize earlier concepts and address the broader topic of total quality management, which had just begun to receive widespread attention.

As the first activity under DP No. 89, FHWA sponsored a workshop (held on December 12-13, 1990) for approximately 30 top leaders in the QM field from state highway agencies, the construction industry, construction associations, academia, and FHWA.

Workshop attendees made the following specific recommendations:

- A broad-based national initiative on quality is essential.
- Top management's understanding and commitment to quality products and delivery is critical.
- A national statement or policy should be a part of an initiative to show national commitment. This posture should be developed jointly by FHWA, American Association of State Highway and Transportation Officials (AASHTO), and industry leaders.
- FHWA should provide leadership in launching a national initiative on quality.
- One element of this initiative should be a DP focused on construction and materials quality.
- A major emphasis should be placed on a partnership between designers, owners, contractors, and suppliers in achieving quality results.
- Technical skills and tools (including certification programs such as sound, statistical specifications and a long-term commitment to technical training) are essential, and they should be provided.
- A long-range plan for implementing a national initiative on quality should also be developed and followed.

Workshop participants also suggested the establishment of a panel of top managers from FHWA, AASHTO, and various industries to address the broad issue of quality improvement in the highway community and to discuss the need, form, and content of a national policy on highway quality.

Following the DP No. 89 workshop, the AASHTO Standing Committee on Highways (SCOH) on June 9, 1991, stated AASHTO's commitment to a "Constructive Quality Assurance Initiative" with FHWA and the construction industry and took several other actions aimed at the overall improvement of highway construction quality.

Following the creation of the National Quality Initiative (NQI) Steering Committee, the newly elected president of AASHTO, Wayne Muri, declared he would break with AASHTO's tradition of creating multiple emphasis areas for the year. He declared that there would be but one emphasis during his tenure and that would simply be *Quality.*

Early NQI Activities

The first meeting of the steering committee was held in January 1992 during the Annual Transportation Research Board Meeting. The focus of the effort, which started out primarily in the construction arena, was soon broadened to include all aspects of the constructed product, since each phase of the project is dependent on the previous phase in order to advance a quality end-product to the highway user.

The joint FHWA/AASHTO/industry steering committee currently consists of the following organizations:

American Association of State Highway and Transportation Officials (AASHTO)
American Consulting Engineers Council (ACEC)
American Concrete Pavement Association (ACPA)
Associated General Contractors of America (AGCA)

American Public Works Association (APWA)
American Road and Transportation Builders Association (ARTBA)
Federal Highway Administration (FHWA)
National Asphalt Pavement Association (NAPA)
National Ready-Mixed Concrete Association (NRMCA)

During that meeting, the steering committee established the mission for the NQI. The ultimate goal would be to place a national emphasis—from all corners of the highway industry—on producing quality products. The overall objectives of the NQI are:

- Improving the technical quality of the nation's transportation systems and responsiveness to public needs.
- Increasing the strength and competitiveness of the U.S. transportation industry in the global marketplace through quality emphasis and improvement.
- Advancing the quality of transportation delivery systems through partnership efforts among FHWA, AASHTO, industry, and academia.
- Maximizing the use of transportation investment through better system and product performance.
- Encouraging technological developments and innovations through quality incentives.

An implementation strategy was then developed. First, a "National Policy on the Quality of Highways" would be developed to establish some of the common quality principles among the associations and to create a partnering agreement indicating a unified industry approach and commitment toward quality products. The second phase of the NQI involved a series of seminars with the objective of educating managers on quality principles and the importance of technical excellence to achieve a quality product.

The first of the seminar series was the November 10, 1992, "Partnerships for Quality" seminar held at the Dallas/Fort Worth Hyatt Airport Hotel. Nearly 250 top state highway officials, FHWA managers, and key industry officials attended the seminar, where the newly formed "National Policy on the Quality of Highways" was signed.

The policy concludes by saying, "The development and preservation of a high-quality highway system requires a close partnership between all stakeholders; therefore, the undersigned organizations have cooperatively developed this national policy and will strive to fulfill its principles." In fact, the element of cooperation among each of the participating organizations has been the cornerstone of the success of the NQI to date. The national seminar was funded under the National Cooperative Highway Research Program.

NQI is a partnership of AASHTO, industry, and FHWA to place a national emphasis—from all corners of the highway industry—on producing quality products.

Next, there were four followup "NQI Regional Quality Seminars" (one per AASHTO region) held in April and May of 1993. Approximately 1200 top career state highway agency (SHA) personnel, FHWA mid-level managers, local governments, industry representatives, academicians, consultants, suppliers, and others attended these regional seminars. There has been very good feedback received from these seminars that were funded by FHWA.

Current and Future Activities

Beginning in the fall of 1993, the SHAs will receive technically oriented workshop materials, references, and training aids to allow the program to be presented around the country to a broader range of mid-level managers. These workshops will provide an overview of quality management and provide a synopsis of the technical tools available. Training courses can be developed for project-level personnel from both the public and private sectors with those technical tools.

A memorandum to FHWA field offices is being developed that outlines the suggested process for each state to follow in developing a state-level quality initiative. This memorandum will also state that DP No. 89 will provide financial assistance in conducting these seminars. The level of this assistance will be at least $5000 per state. This funding will be provided by FHWA.

The steering committee believes it is important to market the NQI and the subject of quality both within and outside the highway community. One element of a marketing plan that is already being pursued by the steering committee is the development of a videotape on the NQI effort. This can be used in the state-level seminars as well as for the other activities.

In addition, congressionally mandated studies on quality (Sections 1043 and 6014) in the Intermodal Surface Transportation Efficiency Act of 1991 indicate increased attention to the quality issue by members of Congress.

At a meeting held in April 1993, the steering committee developed an initial long-range plan to move into some of the more pervasive quality issues in the highway industry. This long-range plan is intended to be a flexible document that will be modified as necessary. The initial plan was conceived to provide a long-term commitment to continuous improvement rather than a short-term program or merely increased emphasis.

Some of the overall objectives of the long-range plan include:

- Considering international applications and technology for possible use.
- Building regional and national consensus on issues in this country that may enhance cost, quality, and performance of our highway system. This includes such issues as specifications, designs and design assumptions, training and certification requirements, laboratory quality control requirements and accreditation, and so forth.
- Improving the technology and technology sharing through research, training, incentives, demonstration, and use of information-sharing techniques.
- Heightening awareness for the need for quality and encouraging the use of quality improvement techniques, partnering, and state-of-the-art planning, design, construction, and maintenance techniques in the highway industry.
- Providing a followup mechanism for Transportation Circular 386 on "Innovative Contracting Practices" to explore new ways of contracting and providing increased quality and quality incentives in the highway industry.

The specifics of certain elements of the long-range plan are still in the development stage; however, a number of workshops are being planned to address some of the issues identified. Separate efforts are also underway in the areas of training and information sharing. Funding and responsible organization will be identified in the plan. FHWA will support many of these activities under DP No. 89.

FHWA Future Actions

FHWA has been a major force behind the NQI effort, however, we have emphasized throughout this process that this is a cooperative effort of the entire highway industry. It is essential to the long-term success of the NQI that it not be viewed as one organization's program. Top management support for the partnership of federal and state agencies and the private sector will be needed to ensure that the momentum that has recently begun will continue. While it is recognized that each party must maintain their separate responsibilities, the NQI has demonstrated that this diverse highway industry group can work successfully toward achieving a common goal. The ultimate goal for FHWA is to continue to foster this long-term partnership approach in the highway industry and to maximize the public investment through an emphasis on quality

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Donald Tuggle is in the Construction and Maintenance Division of FHWA's Office of Program Development. He is also the secretary of the NQI Steering Committee.

National Quality Initiative Steering Committee

AASHTO Representatives:

* Dwight M. Bower, Dep. Dir., Colo. Dept. of Highways
Ken Morefield, State Highway Engr., Fla. DOT
Gary Robinson, State Engineer, Ariz. DOT
Don Lucas, Chief Highway Engr., Ind. DOT
Joseph Filippino, Dir., Bureau of Construction and Materials, Pa. DOT
Wayne Murphy, State Construction Engr., Minn. DOT
Gary Robson, Dir., Materials Div., W.Va. DOT
Jim McManus, Dep. Chief Engr., Div. of State/Local Project Development, Calif. DOT

Industry Representatives:

* Peter K.W. Wert, V.P., Haskell Lemon Construction Co., AGC
William R. Cape, Pres., James Cape & Sons Co., ARTBA
Richard D. Gaynor, Exec. Dir., NRMCA
Michael Acott, Pres., NAPA
Sanford P. LaHue, Dir. of Engineering Highways, ACPA
Richard Sparlin, Sr. V.P., Centennial Engineering, ACEC

APWA Representative:

R. Giancola, Bureau Chief, Highways and Transportation, Frederick County

FHWA Representatives:

E. Dean Carlson, Exec. Dir.
William Weseman, Chief, Construction and Maintenance Div.
Thomas Ptak, Regional Administrator, Region 9

Secretary:

Donald Tuggle, Construction and Maintenance Div., FHWA

* indicates co-chairman

"Along the Road" is a hodgepodge of items of general interest to the highway community. But this is more than a miscellaneous section; "Along the Road" is the place to look for information about current and upcoming activities, developments, and trends. This information comes from Federal Highway Administration (FHWA) sources unless otherwise indicated. Your suggestions and input are welcome. Let's meet along the road.

Workshops on Motor Carrier Safety Rating Process Held Around the Country

FHWA has scheduled eight one-day workshops around the country from November 30 through March 24, 1994, to seek ideas about how the motor carrier safety rating process could be improved. The Office of Motor Carriers wants to hear industry opinions on the current rating system as well as other possible approaches. The office is also currently reviewing the existing evaluation process, including the possibility of self-assessment certification.

Georgia DOT is Developing Rideshare Program for the Atlanta Region

A team is developing an interim rideshare program for the Atlanta region. In early 1994, this program will transition into the Atlanta Regional Rideshare Program that will tie together rideshare efforts that are underway by the Georgia Department of Transportation (DOT), the Atlanta Regional Commission, the Atlanta Chamber of Commerce, and the Olympic Planning Committee.

Federal Lands Highway Office and Forest Service Meet

On November 16-18, representatives from the Federal Lands Highway Office met with the Forest Service in Denver, Colo., to discuss the October 5, 1993, Notice of Proposed Rulemaking for the Forest Highway Program. The rule pertains to transportation planning (including designation of routes, inventory and condition, and bridge, pavement, and management systems), design, construction, and maintenance activities.

Travel Demand Management (TDM) Symposium Held

FHWA, the Federal Transit Administration (FTA), and the Transportation Research Board (TRB) cosponsored "Setting a Strategic Agenda for Travel Demand Management (TDM)" on November 15-16 in Arlington, Va. More than one hundred experts in the demand management area participated in presentations, discussions, and workshops designed to develop ideas, options, and recommendations to advance the state of TDM into the next century.

FHWA Sponsors Incident Management Conference

FHWA sponsored a one-day Incident Management Conference in Buffalo, N.Y., on November 12. One of more than a dozen conferences held nationwide, this conference attracted several hundred participants from federal, state, and local governments, as well as police, fire departments, and trucking firms. In an effort to assist Buffalo with its incident management, Demo 86 (a three-day incident management course sponsored by the Office of Technology Applications) will be offered in the spring.

Missouri Chief Engineer and Assistant Chief Engineer Announce Retirement

On November 5, Chief Engineer Wayne Muri and Assistant Chief Engineer Walt Vandelicht announced their retirements effective June 30 and March 1, respectively. Muri, a 38-year veteran of the Missouri DOT, also served as president of the American Association of State Highway and Transportation Officials (AASHTO) during the past year. Vandelicht has been with the department for 44 years.

1994 DOT Appropriations Act Restricts Use of Federal Funds for Metric Signs

Section 331 of Fiscal Year (FY) 1994 DOT Appropriations Act, signed by President Clinton, restricts use of funds for highway signs using metric measurements. FHWA still plans to develop a policy to ensure that uniform metric units and practices such as this one-year moratorium on the funding of metric signs should not affect the progress made by FHWA and the states in other areas of the program. Also, there is no prohibition that precludes the states from using their own funds to erect or modify signs with messages using metric units.

First ISTEA Roundtable Held in Connecticut

On November 5, Deputy Secretary of Transportation Mortimer Downey and a team from the U.S. DOT, including the deputy administrators of FHWA and FTA, conducted the first of a nationwide series of meetings addressing the implementation of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). The meeting was held at the University of Hartford in Hartford, Conn. Approximately 100 state and local officials, business leaders, planners, and citizens from throughout New England discussed the progress being made under ISTEA and shared their concerns and issues that have developed during the first two years under ISTEA. A second roundtable is scheduled for November 17 in New York City.

New U.S. DOT Civil Rights Director Discusses Initiatives

Antonio J. Califa, the new Director of Civil Rights for the U.S. DOT, visited the Volpe National Transportation Systems Center in Cambridge, Mass., on November 5, and he used the opportunity to briefly discuss the DOT secretary's initiatives on civil rights issues. Most notably, Califa indicated that he intended to increase the civil rights activities of his office, and he expressed his interest in addressing sexual harassment incidents and taking a proactive approach toward promoting diversity within DOT.

Partnering Is a Key to Quality in New Jersey

On November 4 about 200 contractors, consultants, state and federal officials met in Princeton, N.J., for a jointly sponsored Partnering Seminar. This was an initiative flowing from the National Quality Initiative (NQI) regional meeting last summer in Monticello, N.Y., and will be followed by another NQI program for New Jersey in February 1994. At this meeting, there were presentations about partnering from the owner and contractor perspectives and a three-hour feedback session that enabled everyone to get their "hands-on" partnering. Currently, New Jersey has six projects with partnering, and state officials plan to expand that number.

Russian and U.S. Engineers Collaborate on Roads

The first phase of a $340-million, World Bank loan to Russia will involve 200 to 300 kilometers of four-lane roads that are to be designed by a team of Russian and U.S. engineers this winter. By March 1994, contracts will be awarded for road repair and rehabilitation work on Russian highways.

Executive Council of Civil Rights Directors Organized

On November 3, civil rights personnel from the eight states in Region 4 met and organized an Executive Council of Civil Rights Directors. The purpose of the council is to: (1) advocate civil rights programs, (2) promote accountability and awareness among federal and state administrators, (3) act as a resource group for the exchange of ideas, resolution of problems, and sharing of information, and (4) achieve the basic philosophies of all civil rights legislation and ensure equitable distribution of federal and state programs. The council was also given a presentation on a pilot, regional program to assist disadvantaged businesses in getting contracts with state DOTs.

Ozone and Carbon Monoxide Violations Have Decreased Significantly

The Environmental Protection Agency (EPA) released its 1992 *National Air Quality and Emissions Trends Report* on November 2. The report reveals a decrease of 65 percent in violations of ozone standards and 94 percent fewer violations of the carbon monoxide standards since 1983, despite a 37-percent increase in vehicle miles traveled. The report also noted a decrease in lead emissions.

FHWA, BTS, and Others Undertake Review of European Travel Survey Techniques

On November 2, a six-country European visit by a review team to discuss various issues related to national travel surveys was recently completed. The visits to England, Netherlands, Sweden, Denmark, France, and Germany by representatives of FHWA, Bureau of Transportation Statistics (BTS), and state and metropolitan planning organizations provided valuable input in the planning of the 1995 Nationwide Personal Transportation Survey as well as the 1995 National Passenger Flow Study planned by the BTS. U.S. procedural techniques compared favorably with the European experience; however, there was a significant difference in the level of funding with the Europeans devoting more money to this area than the United States.

Maryland State Highway Association Wins Governor's Quality Award

On November 1, the Maryland State Highway Administration was announced as the winner of the Governor's Quality Award. This eight-year-old, total quality program is based on customer service, participation, continuous improvement, and measurement.

Swedish Representatives Meet with FHWA

Swedish Road Administration officials met with FHWA representatives on November 1 to discuss their Intelligent Vehicle-Highway Systems (IVHS) research work and view electronic toll- collection operations on Route 400 in Atlanta, Ga. The Swedish IVHS work is in cooperation with the European Community Programs, DRIVE and PROMETHEUS.

Interagency Agreement Implementing ISTEA Provisions Is Signed

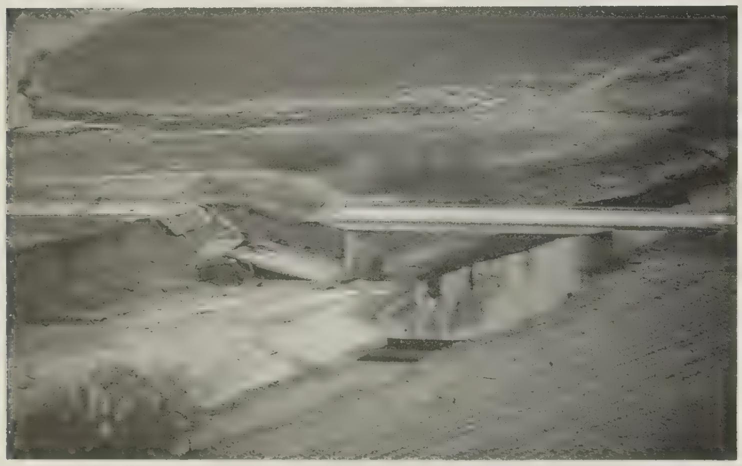
FHWA Administrator Slater and the Director of the Bureau of Land Management (BLM) signed an interagency agreement on October 29, implementing ISTEA provisions relative to Public Lands Highways on nearly 122 million hectares of public lands with a specific emphasis on transportation planning and resource management.

National Quality Initiative Steering Committee Meets

On October 27-28, the National Quality Initiative (NQI) Steering Committee met in Detroit, Mich., following the Annual American Association of State Highway and Transportation Officials (AASHTO) Meeting. Forty states have indicated definite plans to hold state-level NQI seminars in the near future. At the meeting, AASHTO approved formation of a "Standing Committee on Quality." The NQI Steering Committee foresees a need to coordinate with this committee as well as with other permanent committees on quality in NQI member organizations. Also, the Steering Committee is finalizing a long-range plan that details a number of future NQI activities.

IVHS Representatives Meet with Metropolitan Transportation Officials

On October 23, FHWA IVHS staffers and IVHS AMERICA officials met with representatives of 13 metropolitan planning organizations (MPOs) from 10 different states and the District of Columbia to discuss the role of MPOs in moving IVHS forward in their jurisdictions. IVHS AMERICA is offering free one-year memberships to MPOs and other local government entities to facilitate their involvement, which is vital to the ultimate success of IVHS.



Although there were no major bridge failures along the Mississippi and Missouri Rivers during the great flood of 1993, long-term stream stability problems on tributaries caused damage to several bridges. At top, lateral migration of the Nemaha River channel in Nebraska resulted in the collapse of a bridge on state Route 8. At bottom, the bridge over Brushy Creek on Iowa state Route 71 is a classic example of failure caused by abutment scour.

FHWA/EPA Sponsor Symposium on Reuse of Construction Materials and By-Products

On October 19-22, FHWA and EPA sponsored "Recovery and Effective Reuse of Discarded Materials and By-Products for Construction of Highway Facilities" in Denver, Colo. Representatives from nine companies presented products ranging from recycled plastic posts and delineators to retaining walls made from scrap tire rubber to the more than 150 people in attendance.

Florida Motorists Can Call Highway Patrol for Free

On October 22, the Florida Highway Patrol (FHP) and Florida DOT began a joint effort with GTE Mobilnet to allow motorists with cellular phones to call FHP without charge to report suspicious activity, hazardous road conditions, or request help. Currently, the service is available in 17 counties across west central Florida. Signs with the message HIGHWAY ASSISTANCE DIAL *FHP will be placed along the roadside. The agencies hope to make this service available statewide.

FHWA Issues Guidance On Wetlands and Other Waters of the United States

On October 19, FHWA issued guidance to the field concerning recent changes to the rules governing Section 404 of the Clean Water Act, which regulates placement of fill in wetlands and other waters of the United States. The changes, published jointly by EPA and the Corps of Engineers on August 25, are effective immediately. An example of a rule change that could affect transportation-related activities is the exclusion of most highway drainage ditches as regulated wetlands. The purpose of this new rule and others is to close several loopholes in the existing regulation and expand wetland protection.

Gold Medal Presented to Flood Relief Workers

The Secretary of Transportation's Award for Outstanding Achievement, the "Gold Medal," was presented on October 19 to all DOT employees who assisted in the Midwest flood relief efforts. Secretary Peña acknowledged employees who contributed in numerous ways, including rescuing individuals trapped by rising water, reviewing washed-out roads and bridges, organizing delivery of emergency supplies and equipment, providing transportation coordination around the clock, and preparing daily updates on the impact of the flood on transportation systems. The secretary presented a Gold Medal to Ken Jensen, FHWA Regional Administrator for Region 7, as the representative of other FHWA employees and for Jensen's personal efforts. Jensen was the focal point in Region 7 (Iowa, Kansas, Missouri, and

Nebraska) for all of DOT's emergency activities pertaining to highways, aviation, water, and rail.

Road Construction Costs Decline for Second Quarter of 1993

FHWA announced that highway construction costs decreased 0.6 percent in the second quarter of 1993. The second quarter results lowered the FHWA's composite index for highway construction costs to 109 percent of the 1987 base index (1987 average costs equal 100 percent). Decreases in the unit prices for portland cement concrete, bituminous concrete, and structural steel lowered the index for the quarter. There were increases in the unit prices for common excavation, reinforced steel, and structural concrete.

Alabama Law Outlawing Tinted Windows Is Unconstitutional

In mid-October, the Alabama Court of Criminal Appeals ruled that the State Vehicle Window Tinting Statute prohibiting window tinting "to the extent or manufactured in such a way that occupants of the vehicle cannot be easily identified or recognized" was unconstitutional. The court also stated that the "... promulgation of the rule was an unconstitutional usurpation of the legislature's authority to make law."

Committee Recommends Regional Traffic Information Center

On October 12, the Advisory Committee for the Tampa Bay Area Early Deployment Project conducted its final meeting. The study, funded by Section 6058 of ISTEA, was initiated a year ago with the intent of outlining an integrated transportation information system for the Tampa Bay area. The final report recommends the construction of a regional, real-time traffic information center that would display a real-time, regional congestion map, color-coded to indicate degrees of congestion. Efforts to implement the recommendations of the committee are currently underway.

Bond-Financing Symposium Conducted

FHWA, in conjunction with the FTA and the Office of the Secretary of Transportation, sponsored a one-day symposium, "Bond-Financing and Transportation Infrastructure: Exploring Concepts and Roles," in Washington, D.C., on September 28. More than 100 people representing virtually every DOT mode, Congress, the Office of Management and Budget, other federal agencies, states, and other experts shared their perspectives. The symposium focused on the fundamentals of the tax-exempt bond market and transportation infrastructure, intergovernmental perspectives, and bond-financing mechanisms, such as credit enhancement and revolving funds. A number of followup topics will be considered by FHWA and the other sponsors. The symposium will be summarized in the FHWA "Searching for Solutions" policy series. The summary will be available in February 1994. Mr. Tom Howard may be contacted on 202-366-2833 for additional information.

South Carolina Plans First Statewide Safety Conference

On October 15, representatives of the South Carolina Department of Public Safety met with local FHWA and National Highway Traffic Safety Administration (NHTSA) officials to begin preparing for South Carolina's first statewide highway safety conference. The conference will be held on March 6-9, 1994, in Myrtle Beach, and will address a wide range of highway, driver, and vehicular safety issues. The goals of the conference are to build community safety networks and to enhance ongoing efforts in the areas of public education, technical assistance, and information sharing.

Caltrans Receives APTA Award

In mid-October, the American Public Transit Association presented the California DOT (Caltrans) with its Public Agency Award for its accomplishments in the field of multimodalism. Caltrans hopes this award will be one more step in changing the public perception of Caltrans as "just a highway agency."

Intermodal Management System Scoping Study

In mid-October, the Port of Portland, working with the Oregon DOT, metropolitan officials, and FHWA, selected a consultant to conduct a scoping study for Oregon's Intermodal Management System (IMS). The study, which is scheduled for completion in late December, will produce a scope of work that will be used for a Request for Proposals to develop a statewide IMS.

Idaho Consortium Agreement Signed

On October 15, the Idaho Transportation Department, FHWA, Idaho Engineering Laboratory, and the University of Idaho signed an agreement to form a consortium for advanced transportation research.

Groundbreaking for Transportation Technology Center in Idaho

A groundbreaking for the National Center for Advanced Transportation Technology was held on the University of Idaho campus on October 15. This center was funded under the ISTEA of 1991 with matching funds coming from private sources. Construction is expected to start in the spring of 1994.

Mississippi Wins Kudos for Seat Belt Program

Mississippi's seat belt program, "Get it on Mississippi," was awarded one gold and two silver Awards for Excellence in Public Affairs Programs by the International Association of Business Communicators.

Yakima Indians Exempted from Washington State Gasoline Tax

Early in October, a U.S. district court judge granted a preli- minary injunction against collection of gasoline taxes from members of the Yakima Indian Nation who buy fuel at a reservation store. However, the judge ordered the business and the Yakima Indian Nation to post a bond for $20,000—an amount equal to the total annual taxes—pending trial on the issue next year. The state's 23-cents-per-gallon tax will continue to be collected on gasoline sales to non-Indians. The tribe contends that Congress never granted authority to the state to collect gas taxes from tribal members on the reservation. The tribe also argued that the collection of state gas taxes would place an unfair burden on tribal businesses because the tribe collects its own gasoline tax of 5.5 cents/gallon.

Japanese Delegates Attend Advanced Technology Workshop in Virginia

The Second U.S./Japan Workshop on Advanced Technology in Highway Engineering and U.S. Study Tour was held on October 10-18. Nine Japanese delegates from the Ministry of Construction and the Public Works Research Institute and more than 50 representatives from FHWA met on October 11 at the Airlie Conference Center in Virginia to present ongoing activities and define areas for joint cooperation. On October 12, representatives met at the Turner-Fairbank Highway Research Center (TFHRC) in McLean, Va., to summarize the discussions and finalize future plans. Following the workshop, the Japanese delegation, accompanied by representatives from TFHRC and the FHWA Office of International Programs, conducted a study tour to Boston, Minneapolis, and Los Angeles. A wide variety of topics were covered including the design and construction of Boston's Central Artery/Third Harbor Tunnel, the 3M Transportation Center, the Minnesota MNRoad project, the intermodal facilities at the Port of Long Beach, the newly-opened Glenn Anderson (Century) Freeway, and the IVHS-related research being conducted by Hughes Aircraft.

During the OECD strategic planning seminar, international transportation research directors tour the Federal Outdoor Impact Laboratory at the Turner-Fairbank Highway Research Center.

FHWA Kicks Off Development of IVHS Architecture

FHWA kicked off the first phase of the U.S. DOT's IVHS Architecture Development Program on October 12 at DOT Headquarters in Washington, D.C. This was the first time that all four successful bidders met with the program team, which includes representatives from FHWA, NHTSA, FTA, the Jet Propulsion Lab (JPL), and the MITRE Corporation. During the course of the three-day meeting, the contractor teams were briefed on details of the IVHS architecture program, as well as other significant IVHS efforts that will have to be considered during architecture development. The four contractor consortia are headed by Hughes Aircraft Company, IBM Federal Systems, Rockwell International, and the Westinghouse Electric Corporation.

Strategic Planning Seminar Opens

International transportation research directors assembled at the TFHRC on October 4 for the opening of the Organisation for Economic Co-operation and Development (OECD) Seminar on Strategic Planning for Road Research Programs. Following their introduction to the U.S. highway research programs, the group moved to Williamsburg, Va., for the continuation of the seminar through October 8.

Federal-Aid Sanctions Imposed

Federal-aid withholding sanctions affecting funds for the National Highway System (NHS), Surface Transportation Program (STP), and Interstate Construction and Maintenance, as specified in 23 U.S.C. 159 (Drug Offenders Drivers License Suspension), have been imposed against the 11 states that are not in compliance. Twenty-eight states are not in compliance with 23 U.S.C. 153 (Safety Belt and Motorcycle Helmet Use) and, therefore, are subject to transfer penalties that affect NHS, STP, and Congestion Mitigation/Air Quality apportionments beginning in FY 1995. Additionally, since Puerto Rico does not have a law establishing the minimum drinking age at 21 years, a 10-percent withholding penalty has been applied to its FY 1994 NHS, STP, and Interstate Maintenance apportionments.

Florida Rest Areas/Welcome Centers Get 24-Hour Armed Security

The Florida DOT has contracted with a private security firm to provide 24-hour security protection at all of its rest areas and welcome centers. Those rest areas without facilities will be closed. The security firm replaced state law enforcement officers who were assigned to rest areas immediately after a foreign tourist was fatally shot at a rest area. As an added measure, the one-mile advance signs will display the message 24-HOUR SECURITY under the sign. On the exit ramps and in the rest/welcome centers, other signs with the logo THIS AREA PATROLLED BY ARMED SECURITY have been installed.

Georgia—When it Comes to Improving Transportation, Nobody Does it Better

Georgians for Better Transportation (GBT) received a national award last month for their support and advocacy of improved transportation. The award, known as the Excel Award, was presented at the Annual National Transportation Public Affairs Workshop in Minneapolis, Minn. This is a joint meeting between the AASHTO Public Affairs Subcommittee and the Transportation Advocacy Groups from their respective states. GBT was chosen for this prestigious award by their counterparts from 48 states. The award is presented to the group that has provided the most effective and dedicated support to transportation improvement in their state during the past year.

IVHS Holds Meeting with Representatives of HBCUs and MBEs

On September 14, Thomas A. Farrington, president of the Input-Output Computer Services Inc. of Waltham, Mass., and others met with FHWA Administrator Slater and IVHS staff from FHWA, NHTSA, FTA, and IVHS-AMERICA to discuss opportunities in the IVHS program for minority-owned businesses (MBEs) and historically black colleges and universities (HBCUs).

Workshop Focuses on Challenges to Integrated Land Use/Transportation Planning

FHWA, in conjunction with FTA, the Office of the Secretary of DOT, and the Lincoln Institute of Land Policy, sponsored a two-day workshop, "Metropolitan America in Transition: Implications for Land Use and Transportation Planning," in Arlington, Va., on September 9-10. The workshop focused on the challenges to integrated land use and transportation policy planning posed by current metropolitan development patterns. Integration with air quality planning was also highlighted as was the need to address access of unemployed central city workers to suburban jobs. A number of policy and research recommendations emerged from the conference.

DOT Publishes Request for IVHS Operational Test Proposals

DOT has issued a notice in the September 8 *Federal Register* seeking offers from the public and private sectors to form partnerships for participation in the IVHS Operational Test Program. The notice identifies five IVHS user-service areas in which the desired benefits can be evaluated under live transportation conditions: (1) emergency notification and personal security, (2) automated roadside safety inspections and commercial vehicle administrative processes, (3) travel-demand management, (4) enroute driver advisory and traveler services information, and (5) personalized public transit and public travel security. DOT has given potential participants until January 6, 1994, to form partnerships and submit project proposals. This ensures that proposals will be received in time for consideration for FY 1994 federal IVHS funding.

Intermodal Technical Assistance Available

In mid-September, FHWA made available the *Intermodal Technical Assistance Activities for Transportation Planners* report through its electronic bulletin board system (FEBBS). This document identifies intermodal technical assistance activities originating with U.S. DOT that should be of use to MPOs and state and local planners in fulfilling their responsibilities under ISTEA and the Clean Air Act Amendments of 1990.

Georgia DOT Holds Forum on the Future of Transportation

On September 2, the Georgia DOT held the first of 11 regional public forums as part of its "Transportation 2000—The Vision Mission" initiative. Initiated in 1993, Transportation 2000 is an independent advisory commission initiated by GDOT. Its purpose is to look toward the future and craft a vision of where Georgia's transportation system can and should be in the years ahead. The commission is comprised of over 70 individuals from across the state representing government, chambers of commerce, and environmental groups and individuals. The purpose of the regional forums is to gather public opinion regarding the future of transportation in the state on issues such as bicycle and pedestrian ways, congestion management, economic development and tourism, energy efficiency, environmental quality, mobility and accessibility, transportation financing, transportation safety, and rural and urban transit.

Request for Comments on the Metric Conversion of Traffic Control Signs

On August 31, the *Federal Register* contained a notice—a request for comments on Options for Coordinating the Metric Conversion of Traffic Control Signs. The notice contained three options for which FHWA is requesting comments: (1) conversion through routine sign maintenance, (2) quick conversion, and (3) transition with dual metric and English units. During the 60-day comment period, the public is requested to specifically comment on the desirability of converting signs to metric, advantages and disadvantages of the option proposed, and the cost implications of the three options.

First IVHS World Congress Is In the Works

Organizational meetings were held August 30-31 for the first IVHS World Congress, "Towards an Intelligent Transport System," to be held in December 1994. The World Congress will provide for presentation and discussion of IVHS concepts and deployment activities, including a major exhibition of new equipment systems and operating practices. This first annual event is being directed cooperatively by representatives of public and private entities from Europe, Japan, and the United States, including the FHWA.

MADD Issues Report Card

Mothers Against Drunk Driving (MADD) released their annual report card on the nation's attempt to combat drunk driving. According to the report, while the nation has made strides to combat drunken driving, budget problems are hindering law enforcement, and underage drinking remains a widespread concern. MADD gave the country as a whole a "B-minus" in dealing with the drunken driving problem while acknowledging that the number of traffic fatalities involving alcohol has declined by nearly one-third over the past decade. MADD evaluated each state on how well it has dealt with drunk driving, including budgeting, legislation, enforcement and dealing with victims. The percentage rates shown in the list to the right indicate the rate of fatal accidents in 1992 that were alcohol-related.

State	Grade	Percent
Alabama	D+	45.4
Alaska	C	60.2
Arizona	B+	49.7
Arkansas	C+	46.9
California	B	46.9
Colorado	B	48.9
Connecticut	C	48.3
Delaware	C	42.1
D.C.	C	46
Florida	C+	45.1
Georgia	C	40.1
Hawaii	C+	51.2
Idaho	D+	45.3
Illinois	A-	48.6
Indiana	C	41.4
Iowa	C+	39.1
Kansas	B-	40.3
Kentucky	C+	39.5
Louisiana	C-	56.1
Maine	C	41.6
Maryland	B	34.3
Massachusetts	C-	55.1
Michigan	C	41.1
Minnesota	B	40.8
Mississippi	D-	44.8
Missouri	D+	49.4
Montana	C	53.1
Nebraska	B-	33.1
Nevada	B-	51.8
New Hampshire	C	31.1
New Jersey	B	34.2
New Mexico	B+	61.7
New York	B-	35.6
North Carolina	B+	43.9
North Dakota	D	45.5
Ohio	B+	32.6
Oklahoma	C-	43.6
Oregon	B	43.9
Pennsylvania	B	46
Rhode Island	C	54.4
South Carolina	B-	38.7
South Dakota	C+	47.2
Tennessee	C-	47.5
Texas	C	60.5
Utah	B-	31.2
Vermont	D+	42.7
Virginia	C	43.1
Washington	C	51.5
West Virginia	C-	45.5
Wisconsin	C	45.6
Wyoming	D	55.1

—Associated Press

DOT Recommends Cuts for National Performance Review

DOT recently made 23 recommendations in the National Performance Review. Those recommendations represent a savings of $36.4 billion for fiscal years 1995 through 1999. FHWA recommended several ways to improve existing DOT resources, including:

- Automate administrative requirements for federal-aid highway projects. This would reduce the paperwork and staff time needed to complete forms and other requirements.
- Require the Office of Motor Carriers to improve program effectiveness and reduce travel cost by allowing regional managers to assign field staff to highly concentrated areas of motor carriers.
- Eliminate funding for highway demonstration projects by allowing projects to compete at the state level for the limited highway resources available and not be singled out for special treatment at the federal level.

—Women's Transportation Seminar (WTS)

USGS Produces Book on Aggregates and America's Future

Natural Aggregate: Building America's Future has recently been published by the U.S. Geological Survey (USGS) as part of its "Public Issues in Earth Science" series. The book, which is available free of charge from USGS, presents an overview of aggregates that outlines the dependence of society on them for uses such as construction and public works projects. "This book does an outstanding job in describing aggregates distribution and the issues of zoning, government relations, land use, reclamation, transportation, and infrastructure needs for the next decade," said Vincent P. Ahern Jr., president of the National Aggregates Association. Copies of the book can be ordered from the USGS Map Distribution, Box 25286, Building 810, Denver Federal Center, Denver, CO 80225.

—National Aggregates Association

The following new research studies reported by the Federal Highway Administration's (FHWA) Office of Research and Development are sponsored in whole or in part with federal highway funds. For further details on a particular study, please contact Richard Richter, (703) 285-2134.

NCP Category A—Highway Safety

A.3: Highway Safety Information Management

Title: Evaluation of Exposure Data Sources for Highway Safety Issues

Objective: The objectives are to: (1) identify and prioritize the current highway safety issues and their exposure data needs, (2) identify and review the existing exposure data sources, emerging exposure data sources, and innovative approaches for acquiring the exposure data, and (3) analyze a high-priority safety issue using traditional and non-traditional exposure data sources in innovative ways and/or newly identified data sources.
Contractor: University of Michigan
Expected Completion Date: December 1995
Estimated Cost: $321,605

A.5: Highway Safety Design Practices and Criteria

Title: Vehicle Dynamics Programs for Roadway and Roadside Studies

Objective: The objective is to obtain research directed at (1) developing vehicle dynamics model(s) (VDM) best suited to the FHWA on-going research program on the safety of roadside design elements, and (2) developing an appropriate computing environment, including data bases and links to other programs, required to utilize the VDM(s) in solving these problems. Two contracts were let for this purpose. In this contract, a computer symbolic multibody program, AUTOSIM, will be used to incorporate features of other vehicle dynamics programs into the vehicle dynamics codes to be developed for FHWA applications.
Contractor: University of Michigan
Expected Completion Date: August 1995
Estimated Cost: $373,319

Title: Vehicle Dynamics Programs for Roadway and Roadside Studies: STI

Objective: Same as previous study. This is one of two contracts let to meet this objective. In this contract, VDANL, a program that has been extensively validated for level surface applications, will be revised to serve FHWA applications.
Contractor: Systems Technology Inc.
Expected Completion Date: June 1995
Estimated Cost: $313,790

A study of human factors research on older drivers is being conducted.

A.6: Human Factors for Highway Safety

Title: Synthesis of Human Factors Research on Older Drivers and Highway Safety

Objective: This is a review of all the research results completed under the older driver high-priority area and an investigation of other relevant research findings. The results will be synthesized into a format appropriate for inclusion in a handbook for use by highway designers. The research report will also specify how the findings can be used and what additional research is needed.
Contractor: Scientex
Expected Completion Date: September 1995
Estimated Cost: $282,723

NCP Category B—Traffic Operations/ Intelligent Vehicle-Highway Systems

B.3: Commercial Vehicle Operations

Title: Commercial Vehicle Fleet Management and Information Systems

Objective: The objective is to identify fleet management problems and needs that can be addressed through advanced technologies and that warrant public sector involvement. The feasibility of current and potential technologies to address fleet management needs will be assessed, and requirements will be developed as appropriate. Operations to be examined include: vehicle dispatch, routing, equipment tracking, driver scheduling, maintenance management, administration of interstate shipping, movement of urban goods, intermodal operations, and public services such as road maintenance, trash pickup, and fire and ambulance services.
Contractor: Cambridge Systematics
Expected Completion Date: June 1995
Estimated Cost: $405,461

B.4: Advanced Vehicle Control Systems

Title: Automated Highway System—Health Management

Objective: This study is one of 15 parallel analyses that will provide DOT and others in the IVHS community with a realistic range and AHS configurations and a better understanding of AHS applications, technology, design, deployment, operations, and practicality. These studies, called AHS Precursor Systems Analyses, are each of one-year duration so that the results will be available during the process of defining and evaluating alternative system concepts.
Contractor: Honeywell
Expected Completion Date: October 1994
Estimated Cost: $891,993

Title: Lateral and Longitudinal Control Analyses

Objective: This is one of the Precursor Systems Analyses, and it will define and analyze AHS requirements for lateral and longitudinal maneuverability on the AHS roadway to ensure system safety and operational efficiency.
Contractor: SRI International
Expected Completion Date: November 1994
Estimated Cost: $228,878

Title: Lateral and Longitudinal Control Analyses

Objective: This is one of the Precursor Systems Analyses.
Contractor: Martin Marietta Corporation
Expected Completion Date: October 1994
Estimated Cost: $313,404

Title: Precursor Systems Analyses of Automated Highway Systems (A-P)

Objective: This is one of the Precursor Systems Analyses.
Contractor: Delco Electronics Corporation
Expected Completion Date: October 1994
Estimated Cost: $3,009,712

Title: Precursor Systems Analyses of AHS (L)

Objective: This study covers urban and rural AHS analysis, AHS roadway deployment analysis, AHS entry/exit implementation, and preliminary cost/benefit factors analysis.
Contractor: University of California
Expected Completion Date: October 1994
Estimated Cost: $942,783

Title: Precursor Systems Analyses of AHS (F&O)

Objective: This study covers commercial and transit AHS analysis, the institutional issues that affect the deployment and operation of AHS systems, and societal issues and risks faced by the AHS program.
Contractor: BDM Federal Inc.
Expected Completion Date: October 1994
Estimated Cost: $499,658

Title: Precursor Systems Analyses of AHS (F)

Objective: This study covers urban and rural AHS comparison, automated check-in, automated check-out, lateral and longitudinal control analysis, malfunction management and analysis, commercial and transit AHS analysis, comparable systems analysis, AHS roadway deployment analysis, impact of AHS on surrounding non-AHS roadways, AHS entry/exit implementation, AHS roadway systems impact, AHS safety issues, institutional and societal aspects, and preliminary cost/benefit factors analysis.
Contractor: Calspan Corporation
Expected Completion Date: November 1994
Estimated Cost: $3,054,137

Title: Precursor Systems Analysis of Automated Construction, Maintenance, and Operational Requirements for AHS

Objective: This study covers the identification and analysis of urban and rural AHS roadway operational issues and risks for each of the representative system configurations.
Contractor: University of California
Expected Completion Date: July 1994
Estimated Cost: $144,038

Title: Automated Highway Systems (J)

Objective: This is one of the Precursor Systems Analyses.
Contractor: Raytheon
Expected Completion Date: October 1994
Estimated Cost: $1,789,994

Title: Automated Check-In

Objective: This is one of the Precursor Systems Analyses. This study will identify and analyze the requirements associated with ensuring that a vehicle and its operator are qualified and safe for entry onto the AHS roadway. Issues and risks will be identified and analyzed, and the implications for each of the representative system configurations will be discussed.
Contractor: Northrop Corporation
Expected Completion Date: August 1994
Estimated Cost: $208,368

Title: Activities D, E, & L for Automated Highway Systems

Objective: This is one of the Precursor Systems Analyses. This study covers lateral and longitudinal control analysis, malfunction management and analysis, and vehicle operational analysis.
Contractor: Rockwell International
Expected Completion Date: October 1994
Estimated Cost: $623,451

B.8: IVHS Research Centers of Excellence

Title: IVHS Research Centers of Excellence

Objective: The objective is to develop internationally recognized, university-based research centers that will aggressively develop and implement activities that advance the state of the art in Intelligent Vehicle-Highway Systems. Three universities were awarded multiyear contracts for up to $1 million per year each to establish and operate the centers.
Contractor: Texas Transportation Institute at Texas A&M University, Virginia Polytechnic Institute and State University, University of Michigan
Expected Completion Date: September 1997
Estimated Cost: $15,000,000

NCP Category E—Materials and Operations

E.2: Cement and Concrete

Title: Fast-Track Paving: Concrete Temperature Control and Traffic Opening Criteria for Bonded Concrete Overlays

Objective: This study will evaluate existing information on the control of concrete temperature during curing for portland cement concrete pavement construction and also on monitoring of bond and bond-strength criteria for the opening to traffic of newly constructed bonded concrete overlays. The study will also develop guidelines in these two areas.
Contractor: Transtec Inc.
Expected Completion Date: March 1996
Estimated Cost: $498,712

NCP Category H—R&D Management and Coordination

H.6: Other

Title: Ruggedness Testing in Accordance with ASTM Standard Practice C1067-87 on the SHRP Binder Specification Tests

Objective: This is a screening program that detects the sources of variation in a test method.
Contractor: Pennsylvania Transportation Institute
Expected Completion Date: March 1994
Estimated Cost: $22,000

The following are brief descriptions of selected publications recently published by the Federal Highway Administration, Office of Research and Development (R&D). The Office of Engineering and Highway Operations R&D includes the Structures Division, Pavements Division, Materials Division, and Long-Term Pavement Performance Division. The Office of Safety and Traffic Operations R&D includes the Intelligent Vehicle-Highway Systems Research Division, Design Concepts Research Division, and Information and Behavioral Systems Division. All publications are available from the National Technical Information Service (NTIS). In some cases, limited copies of publications are available from the R&T Report Center.

When ordering from NTIS, include the PB number (or publication number) and the publication title. Address requests to:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Requests for items available from the R&T Report Center should be addressed to:

Federal Highway Administration
R&T Report Center, HRD-11
6300 Georgetown Pike
McLean, Virginia 22101-2296
Telephone: (703) 285-2144

Blowup of a Concrete Pavement Adjoining a Rigid Structure.

Publication No. FHWA-RD-90-11.

by Office of Engineering and Highway Operations R&D

The main cause of concrete pavement blowups are axial compression forces induced into the pavement by a rise in temperature and moisture. Previous analyses were based on the notion that blowups are caused by lift-off buckling of the pavement. The cases analyzed were: (1) continuously reinforced concrete pavement and (2) concrete pavement weakened by a traverse joint or crack. This report is an analysis of another case—a long continuously reinforced concrete pavement adjoining a rigid structure like a bridge abutment. The analysis is similar to the ones described above. The resulting formulation is non-linear. The obtained results are evaluated numerically and are compared with those of a long continuously reinforced pavement to show the effect of the rigid structure on the pavement response.

The NTIS number for this publication is PB93-227924; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

The Assessment of Concrete Pavement Blowups—A User Manual.

Publication No. FHWA-RD-91-056.

by Office of Engineering and Highway Operations R&D

This manual is based on the analyses of pavement blowups presented in 1984 and in 1989. It may be divided into three parts. The first part reviews briefly the various early attempts to clarify the blowup phenomenon and describes the blowup mechanism, the adopted criterion of the "safe temperature increase," and the outline of the analytical methodology on which this manual is based. The second part contains the analytical expressions for the solutions of three problems shown, the description of the steps for the numerical evaluation as well as a list of the used pavement parameters, and the graphical presentation of the obtained results. Part three contains a discussion of the practical implications of the presented results for concrete pavement design as well as for assessing pavement blowups after years of service, a presentation of a number of specific examples, and suggestions for full-scale tests for the determination of the identified pavement parameters.

The NTIS number for this publication is PB94-109287; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

Design, Construction, and Quality Control Guidelines for Stress-Laminated Timber Bridge Decks.

Publication No. FHWA-RD-91-120.

by Office of Engineering and Highway Operations R&D

Under the U.S. National Timber Bridge Initiative Program, sponsored by Congress in 1989 and administered by the United States Department of Agriculture, Forest Service, approximately 130 modern timber bridges are currently in service in 41 participating states. Most of these bridges use stress-lamination technology. Considerable research on stress-lamination technology has been completed and has provided design, construction, and inspection guidelines for timber bridge decks. Guidelines for the design of stress-laminated timber decks have been published by AASHTO, but they do not provide comprehensive information on materials, construction, and inspection. Therefore, this document presents: (1) background information on timber bridge materials and quality control, (2) a comprehensive step-by-step design procedure based on the 1991 AASHTO Guide Specification, and (3) guidelines for construction, field monitoring, inspection, and maintenance procedures. Potential fabrication problems are discussed, and an inspection checklist is included. This publication is part of a collection of three booklets for the study "Education and Technology Transfer," under the Timber Bridge Research Program. The other two booklets are: FHWA-RD-92-044, Corrosion Protection of Steel Hardware Used in Modern Timber Bridges, and FHWA-RD-93-024, Timber Substructures for Bridge Applications.

The NTIS number for this publication is PB94-108768; the cost is $19.50 for a paper copy or $9 for the report on microfiche.

Michael Ritter, U.S. Forest Service

The Piney Creek Bridge is a stress-laminated timber bridge in Richland Center, Wisc.

Corrosion Protection of Steel Hardware Used in Modern Timber Bridges.

Publication No. FHWA-RD-92-044.

by Office of Engineering and Highway Operations R&D

Corrosion of steel components and connectors used in timber bridges can cause structural damage and failure. The steel hardware is usually exposed to corrosive environments, and therefore, inadequate corrosion protection and favorable conditions for galvanic reactions can promote the onset of corrosion and lead to unexpected failures. In particular, the steel-stressing system and special connectors used in modern timber bridges, such as stress-laminated and glue-laminated systems, must be adequately protected against corrosion and inspected frequently. The objectives of this booklet are: (1) to familiarize the bridge engineer with the steel components and fasteners used in timber bridges that may corrode and with the types of corrosion that may occur on those components, and (2) to recommend corrosion prevention measures (galvanizing and epoxy coating) applied to the steel components and to provide inspection guidelines for quality control and inservice maintenance of these components. A simple explanation of the corrosion mechanism and its causes is presented, followed by a detailed discussion of the quality control and inspection of galvanized and epoxy-coated steel articles. The inspector is alerted to potential corrosion treatment problems (e.g., hydrogen embrittlement) that must be avoided. Checklists are provided for quality control of treated steel articles and inservice maintenance of steel components in timber bridges. This publication is part of a set of three booklets for the study "Education and Technology Transfer," under the Timber Bridge Research Program. The other two booklets are: FHWA-RD-91-120, Design, Construction, and Quality Control Guidelines for Stress-Laminated Timber Bridge Decks, and FHWA-RD-93-024, Timber Substructures for Bridge Applications.

The NTIS number for this publication is PB94-109154; the cost is $19.50 for a paper copy or $9 for the report on microfiche.

Drilled Shafts for Bridge Foundations.

Publication No. FHWA-RD-92-004.

by Office of Engineering and Highway Operations R&D

This study examined drilled shafts for bridge foundations in soil and water environments where, historically, engineers have been reluctant to specify the use of drilled shafts because of their concern for possible undetected construction defects. The major objectives of this study were to evaluate existing nondestructive testing techniques for identifying defects and/or results of adverse downhole conditions that impact the load settlement behavior and to develop a pilot acceptance criteria for drilled shafts containing defects. The study included the construction of a total of 20 drilled shafts with and without defects for different soil sites located in California and Texas. The shafts were constructed using different techniques: dry construction and wet construction using water, controlled bentonite slurry, and controlled polymer slurry. Five instrumented shafts were statically load-tested, and all shafts were dynamically load-tested to correlate with static results. All shafts were tested nondestructively using both surface reflection and direct transmission techniques, and the results are summarized and evaluated in the report. The pilot, allowable defect criteria consider the design basis, the ratio of design stress to a maximum code allowable, the type of stress, the level of quality control, and the risk tolerance.

The NTIS number for this publication is PB94-114550; the cost is $44.50 for a paper copy or $17.50 for the report on microfiche.

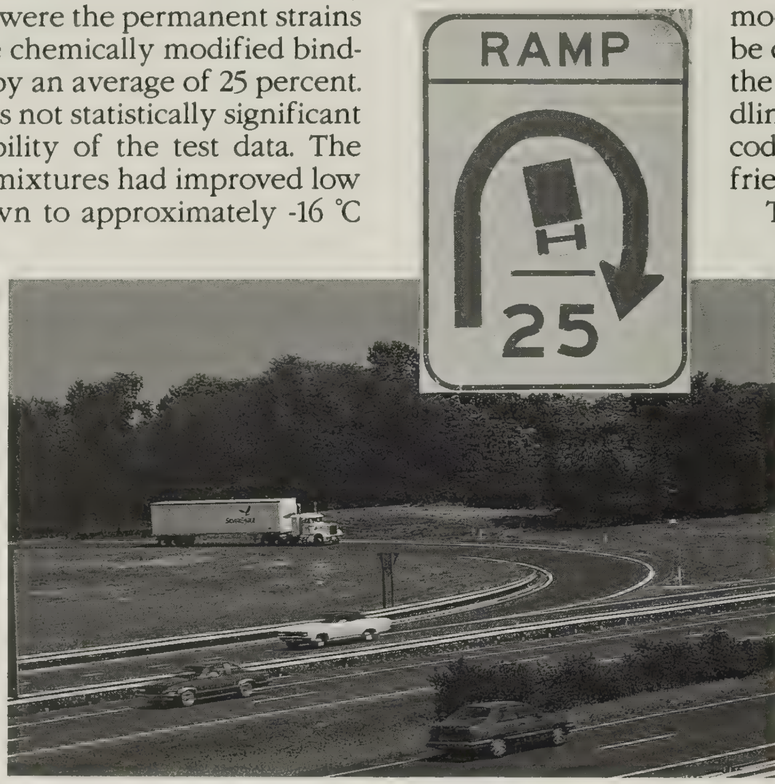
Asphalt Mixtures Containing Chemically Modified Binders.

Publication No. FHWA-RD-92-101.

by Office of Engineering and Highway Operations R&D

The properties of a mixture containing an AC-20 control asphalt binder were compared to mixtures where the binder was modified with either: (1) 1.5 percent chromium trioxide (CrO_3), (2) 6.0 percent maleic anhydride (MAH), or (3) 0.75 percent furfural. Penetration and viscosity data of binders recovered from the four mixtures indicated that the three chemically modified binders should be stiffer at high pavement temperatures and softer at low pavement temperatures compared to the AC-20 control asphalt after mixing and compaction. The primary measurements for evaluating the susceptibility to rutting were the permanent strains from a creep test. The three chemically modified binders decreased these strains by an average of 25 percent. However, this difference was not statistically significant because of the high variability of the test data. The three chemically modified mixtures had improved low temperature properties down to approximately -16 °C (3.2 °F) based on diametral test results. All four mixtures had equivalent test results below this temperature. The MAH-modified mixture passed both engineering tests used to evaluate moisture susceptibility. The CrO_3, furfural, and AC-20 control mixtures each failed at least one of the tests. The AC-20 control mixture had a high amount of visual stripping, while all three modified mixtures showed no visual stripping. It was concluded that the poor engineering test results shown by the CrO_3- and furfural-modified mixtures were related to a loss of cohession rather than a loss of adhesion. When the data for the three modified mixtures were compared to each other, very few differences were found in any of their test properties.

The NTIS number for this publication is PB93-227700; the cost is $19.50 for a paper copy or $9 for the report on microfiche.



Despite the use of warning signs, truck rollover on curved exit ramps is still a significant problem.

Vehicle Impact Simulation Technology Advancement (VISTA): Planning Document.

Publication No. FHWA-RD-92-111.

by Office of Safety and Traffic Operations R&D

The VISTA Planning Document provides details on the development of a powerful, versatile, user-friendly vehicle impact/handling simulation model. The model uses the general-purpose finite element codes, DYNA3D/NIKE3D, developed by the Lawrence Livermore National Laboratory. A three-part program is discussed. Part I is a demonstration phase and is planned to take one and one-half (1 1/2) years. During this phase, both the vehicle handling (real-time and NIKE3D) and the vehicle impact (DYNA3D) computer code enhancements will be executed and validated against experimental test data using a developed vehicle model, roadside safety structure mode, and terrain mode. Part II expands the work of Part I. All vehicle handling and vehicle impact/crash code developments work will be completed. All vehicle models, roadside safety structure models, and terrain models will be developed. Part III completes the validation of the vehicle handling and vehicle impact/crash code developments and the user-friendly, man-machine interface.

The NTIS number for this publication is PB94-113628; the cost is $19.50 for a paper copy or $9 for the report on microfiche.

Feasibility of an Automatic Truck Warning System.

Publication No. FHWA-RD-93-039.

by Office of Safety and Traffic Operations R&D

One type of truck accident that occurs on curved exit ramps at interchanges is truck rollover. A truck will overturn if the lateral acceleration imposed upon it as it travels around a curve of a certain radius and superelevation is greater than allowable for a given level of load. Also, there is a speed at which rollover will occur. This report deals with an automatic warning system to prevent truck rollover. Within the study, three different options were identified and evaluated for feasibility. Of the three, the option selected for further definition and cost-effectiveness analyses was an inroad detection/warning system. The system consists of two detection stations upstream of the curve with the combined ability to detect truck speed, weight, and height threshold. The warning system is a combination of a static warning sign and a fiber-optic warning message sign that would be activated if the controller determined that the truck would be operating at the rollover threshold speed or faster by the time it reached the point of curvature. This report provides the details of the design, its costs, and its cost-effectiveness. Also, design plans and specifications were prepared for three installations on the Capital Beltway in Maryland and Virginia.

The NTIS number for this publication is PB94-112075; the cost is $19.50 for a paper copy or $9 for the report on microfiche.

Minimum Retroreflectivity Requirements for Traffic Signs: Summary Report.

Publication No. FHWA-RD-93-152.

by Office of Safety and Traffic Operations R&D

Currently, national guidelines regarding the nighttime visibility of signs are limited to the stipulation in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) that all warning and regulatory signs be illuminated or reflectorized to show the same color and shape by day or night. There are no objective measures that can be used to determine when a sign has reached the end of its service life and needs to be replaced. This study seeks to fill that need by establishing minimum retroreflectivity requirements for traffic signs. Given the wide range of visual, cognitive, and psychomotor capabilities of the driving population and the complexity of the relationships between driver, vehicle, sign, and roadway, a mathematical modeling approach was selected. The model determines the distance at which a driver needs to see a sign, uses this distance to determine the luminance required, and then calculates the coefficient of retroreflection at standard measurement angles. This model is called Computer Analysis of Retroreflectance of Traffic Signs (CARTS). The CARTS model was executed for each sign in the MUTCD at various vehicle speeds, sign sizes, and sign placements. The results are summarized and presented in a format that can be implemented by practitioners. Retroreflectivity values are given for yellow and orange warning signs, white-on-red regulatory signs, white regulatory signs, and white-on-green guide signs.

The NTIS number of this publication is PB94-111945; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

TECHNOLOGY APPLICATIONS

The following are brief descriptions of selected items that have been completed recently by state and federal highway units in cooperation with the Office of Technology Applications and the Office of Research and Development, Federal Highway Administration. Some items by others are included when they are of special interest to highway agencies. All publications are available from the National Technical Information Service (NTIS). In some cases, limited copies of publications are available from the R&T Report Center.

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6300 Georgetown Pike
McLean, Virginia 22101-2296
Telephone: (703) 285-2144

Urban Traffic Seminar Report of Proceedings.

Publication No. FHWA-SA-91-009.

by Office of Technology Applications

This document reports on the proceedings of a seminar, hosted by the Federal Highway Administration (FHWA) on September 25-26, 1990, on how to improve the transfer of traffic technology within the urban sector. The participants were experts from state and local agencies, universities, professional associations, and private consulting services. The objectives of the seminar were to introduce participants to technology transfer programs offered by FHWA, identify training programs offered by universities and others, and generate new ideas on how to improve the technology transfer process.

The NTIS number for this publication is PB93-217198; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

COM624P—Laterally Loaded Pile Analysis Program for the Microcomputer, Version 2.0.

Publication No. FHWA-SA-91-048.

by Office of Technology Applications

The computer program, COM624P, has been developed for use in the analysis of stresses and deflection of piles or drilled shafts under lateral loads. The program is especially written for highway engineers who wish to run the analysis on microcomputers. The technology on which the program is based is the widely used p-y curve method. The program solves the equations giving pile deflection, rotation, bending moment, and shear by using iterative procedures because of the nonlinear response of the soil. The program provides a user-friendly/menu-driven input and a graphics output in a microcomputer environment. The version of COM624P for the microcomputer was developed in 1989. Several new features were included in the program, such as: generation of p-y curves for rock, capability of analysis of piles in sloping ground, improved solution for multilayered soils, and a variety of boundary conditions at the pile head for selection. The current version of COM624P (version 2.0) includes more improvements, and a subroutine has been added to compute the ultimate bending capacity and the flexural rigidity of piles. The user documentation provides detailed information to enable the user to employ the program conveniently and effectively. The documentation consists of three parts: Part I, Users Guide; Part II, Engineering Background; and Part III, Systems Maintenance.

The NTIS number for this publication is PB94-108305; the cost is $61 for a paper copy or $19.50 for the report on microfiche.

Design of Bridge Deck Drainage, Hydraulic Engineering Circular 21.

Publication No. FHWA-SA-92-010.

by Office of Technology Applications

The manual provides guidelines and procedures for designing bridge deck drainage systems. Should the design process indicate a drainage system is needed, utilization of the most hydraulically efficient and maintenance-free system is emphasized. The manual also stresses the advantages of designing to minimize the complexity of bridge deck drainage systems. Integration of practical drainage details into overall structural design is presented. For the user's convenience, all design graphs and nomographs appear in an appendix. The manual is a compendium of bridge drainage design guidance. It includes design theory, step-by-step design procedures, and illustrative examples. Drainage system design is approached from the viewpoints of hydraulic capacity, traffic safety, structural integrity, practical maintenance, and architectural aesthetics. System hardware components, such as inlets, pipes, and downspouts, are described. Guidance for selecting a design gutter spread and flood frequency are provided. System details and existing computer models are discussed.

The NTIS number for this publication is PB94-109584; the cost is $27 for a paper copy or $12.50 for the report on microfiche.

An Evaluation of Granular Overlays in Washington State.

Publication No. FHWA-SA-92-042.

by Office of Technology Applications

Granular overlays have been used by the Washington State Department of Transportation (WSDOT) for about 30 years. Since the mid-1980s and along with the full implementation of WSDOT Pavement Management System (WSPMS), WSDOT has been examining the performance of granular overlays. WSDOT believes that the performance of this rehabilitation treatment is better than one might reasonably expect. Although WSDOT occasionally required the preexisting surfacing (often several bituminous surface treatment (BST) layers) be scarified prior to placement of the crushed rock layer, this practice is not supported by this research.

This study examined granular overlays by using three different techniques. First, previous research on the behavior of confined crushed rock layers was studied. Through these studies, information was sought concerning the stiffness that has been found in crushed rock layers, what can be done to improve the crushed rock layer, and the problems that have been encountered in working with confined, crushed rock layers. Next, the usable life of the granular overlay was compared with that of other types of pavement resurfacing, including asphalt concrete overlays and BST. Finally, the granular overlays were tested to determine their properties and to measure the effect of different designs on their performance.

The NTIS number for this publication is PB93-210102; the cost is $27 for a paper copy or $12.50 for the report on microfiche.

Crumb Rubber Modifier Workshop Notes.

Publication No. FHWA-SA-93-011.

by Office of Technology Applications

FHWA, the asphalt paving industry, academia, technology transfer centers, and state highway agencies developed a two-day workshop on crumb rubber modifier (CRM) technology. Experts in asphalt paving and CRM technology prepared this document to support the workshop. Workshops were held in February and March of 1993 at seven locations across the country. More than 1400 engineers, contractors, and interested individuals attended the workshops.

This document is a comprehensive overview of the design procedures and construction practices for CRM technology. The CRM technology encompasses any use of scrap tire rubber in asphalt paving materials. The workshop notes begin with an overview of national and state legislation. The production of CRM material is described in detail and the history/description of individual technologies are discussed. The majority of the document focuses on cost factors, guidelines for specifications, pavement applications, binder design, mixture design, and construction practices.

The NTIS number for this publication is PB93-217297; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

Guidelines for Evaluating Fluorescent Strong Yellow-Green Crossing Signs.

Publication No. FHWA-SA-93-035.

by Office of Technology Applications

This manual was prepared to assist states and local highway agencies in conducting field studies to determine the effects of fluorescent strong yellow-green crossing signs on motorist behavior at crossings for pedestrians, bicyclists, and school children. These guidelines were developed to use existing personnel and equipment with a modest time expenditure. A before-and-after study with comparative site experimental design is recommended for the effectiveness evaluation. Field data collection using two observers and readily available, inexpensive equipment is suggested.

The NTIS number for this publication is PB93-219053; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

Traffic Models Overview Handbook.

Publication No. FHWA-SA-93-050.

by Office of Technology Applications

This handbook provides an overview of a number of traffic models used to optimize traffic signal timing mainly for arterials and networks and to evaluate traffic operations and geometric design plans for intersections, arterials, urban street networks, and freeways. These simulation models encompass both macroscopic and microscopic models, including PASSER II, TRANSYT-7F, TRAF-NETSIM, CORFLO (NETFLO 1 and 2 and FREFLO), FRESIM, ROADSIM, PASSER III, MAXBAND, SOAP, TIMACS, and FREQ. The purpose of the handbook is to provide transportation professionals with information so that they may decide if a particular traffic model would be suitable for their applications and how much effort and resources would be required to apply the model effectively.

The NTIS number for this publication is PB94-111879; the cost is $52 for a paper copy or $19.50 for the report on microfiche.

Ice Detection and Highway Weather Information Systems —Summary Report Test and Evaluation Project 011.

Publication No. FHWA-SA-93-053.

by Office of Technology Applications

During the past 20 years, a number of state highway agencies have installed ice detection and highway weather information systems. Their evaluations have addressed the performance of the system equipment—not its usefulness, effects on highway safety, and cost-savings aspects. This project was initiated in 1988 with the objective of documenting the usefulness of ice detection and highway weather information systems in maintaining highway safety during winter weather and reducing salt or winter chemical and personnel needs for snow and ice control. A total of eight cooperating agencies participated and evaluated their systems over the winter of 1989-90. Participants' experiences during this evaluation showed that proactive use of ice detection and highway information systems to aid in planning winter maintenance operations can reduce personnel, material, and equipment needs; reduce the potential for accidents due to icing conditions; and reduce the amount of corrosive or environmentally harmful chemicals used for snow/ice control.

The NTIS number for this publication is PB93-228088; the cost is $17.50 for a paper copy or $9 for the report on microfiche.

Demonstration Project No. 93: Traffic Control Equipment and Software, Participant's Notebook.

Publication No. FHWA-SA-93-061.

by Office of Technology Applications

This Participant's Notebook was developed as a training and reference aid for the Traffic Signal Equipment and Software Workshop. The notebook is organized to reflect the material presented in each of the two-day sessions. The workshop is designed to provide participants (traffic signal systems engineers and technicians) with information and an opportunity to discuss and operate examples of the state-of-the-art traffic signal technology and equipment on the market today. The notebook covers the role and impact of traffic control systems, the resources and maintenance requirements for traffic control systems, the concept of the National Electrical Manufacturers Association's standards and the Model 170 traffic signal controller unit specifications, controller input and output devices—i.e., detectors, time switches, time base coordinators, conflict monitors, flashers, isolators, load switches, test equipment, uninterruptible power supply, suppression device, communication techniques, closed-loop systems, centralized signal systems, and signal timing software—and emerging traffic control and Intelligent Vehicle-Highway Systems technologies. This notebook also supplements the hands-on demonstration portion of the workshop, in which participants learn to operate 25 interactive technologies supplied by traffic equipment manufacturers and systems software firms.

The NTIS number for this publication is PB94-106978; the cost is $36.50 for a paper copy or $17.50 for the report on microfiche.

Construction Quality Management for Managers (Demonstration Project 89). Publication No. FHWA-SA-93-071.
by Office of Technology Applications

This student workbook accompanies presentation of the two-day workshop, "Construction Quality Management for Managers," sponsored under FHWA Demonstration Project 89, "Quality Management." This workshop was developed as an overview for managers from federal, state, and local governments and from private industry on the concepts of quality control/quality assurance. Topics discussed included a top management module, implementation, statistical concepts, elements of a quality assurance program, and specifications overview. Much of the material contained in this workbook is also presented in the National Highway Institute course, "Materials Control and Acceptance-Quality Assurance" (NHI Course 13442).

The NTIS number for this publication is PB94-108834; the cost is $27 for a paper copy or $17.50 for the report on microfiche.

INSTRUCTIONS TO AUTHORS

Background

Public Roads is soliciting articles and input in the form of feature articles, technical articles, information for the "Along the Road" department, reader feedback, and suggestions concerning story ideas to be developed. Feature articles should deal with surface transportation issues and topics in the following general categories: significant technological advancements and innovations, important activities and achievements, specific program areas, and general interest subjects. Technical articles should describe technical issues/developments or new research that makes a significant contribution to the body of knowledge.

Before you spend a great deal of time developing and writing an article, call or write the editor to discuss the concept and scope of the article. You can call editor Bob Bryant at (703) 285-2443 or managing editor Anne Barsanti at (703) 285-2102. The address is provided below.

The new *Public Roads* attempts to communicate through a balance of text and visual elements—photographs, charts, graphs, and other illustrations. An appropriate number of high quality photographs and/or illustrations with proper captions is an indispensable part of an article. Lack of photographs or other visual elements in sufficient quantity or quality may be rationale for rejecting an article.

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Provide a hard copy and a copy on 3.5-inch computer disk using IBM-compatible WordPerfect.

Type the manuscript using one space between sentences and double line spacing with at least 25-mm (1-in) margins on 216- by 279-mm (8.5- by 11-in) paper. Excluding visual elements, one magazine page equals about three pages of manuscript.

Measurements should be expressed in metric units followed immediately, when appropriate, by English units in parentheses. For figures and tables, the English equivalent units are placed in the legend.

If the article has been previously published or presented publicly, provide the following information on the title page: the publication or forum in which the information has been presented, the audience (approximate circulation/size and general make-up), and the date of publication/presentation.

Number each page manually in the lower right corner.

Avoid trademarks and brand names in the text unless it is directly related to the object of the article. The magazine neither endorses nor wants to appear to be endorsing specific products or manufacturers.

Provide a list of all photographs, tables, figures, and other illustrations with a complete caption for each.

Cite all tables and figures in the text in the same sequence as the tables and figures appear. Do not substantially repeat in the text information that is clearly represented in the table or figure. Place all references and footnotes at the end of the sentence after the final punctuation.

Follow the reference format used for the articles in this issue.

Submit a brief biography of the author(s) with the manuscript. Include the author's present position and responsibilities and previous positions relevant to the subject of the article.

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Submit the complete manuscript/illustration package to:

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Manuscripts submitted by authors employed by federal, state, or local governmental agencies must include a letter of transmittal from the author's supervisor, endorsing the publication of the article.

Manuscripts by authors within the Department of Transportation must be endorsed by the applicable office director.

Montana Department of Transportation

The new bridge spanning the Yellowstone River northwest of Pine Creek, Mont., was designed to harmonize with the surrounding natural beauty. Additionally, sharp curves in the approach roadway at both ends of the bridge were eliminated by skewing the new bridge 35° to the flow; the old bridge crossed the river at about 90° to the flow. Traffic consists primarily of local residents, tourists visiting Yellowstone National Park, and recreational fishermen fishing the Yellowstone River.

U.S. Department
of Transportation

Federal Highway Administration

400 Seventh St., SW.
Washington, DC 20590

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in this issue

The National Highway System

Applied Research and Technology: New Guidelines for Accelerating the Use of Innovative Technology by the Highway Industry

Highway Innovative Technology Evaluation Center

Modeling of Geotextiles and Other Membranes in the Prevention of Reflection Cracking in Asphaltic Resurfacing

HYSIM: the Next Best Thing to Being on the Road

FHWA's Implementation Plan for SHRP Products

Environmental Research: Helping Highways Improve the Quality of Life

Looking for a Few Good IDEAs

The National Quality Initiative