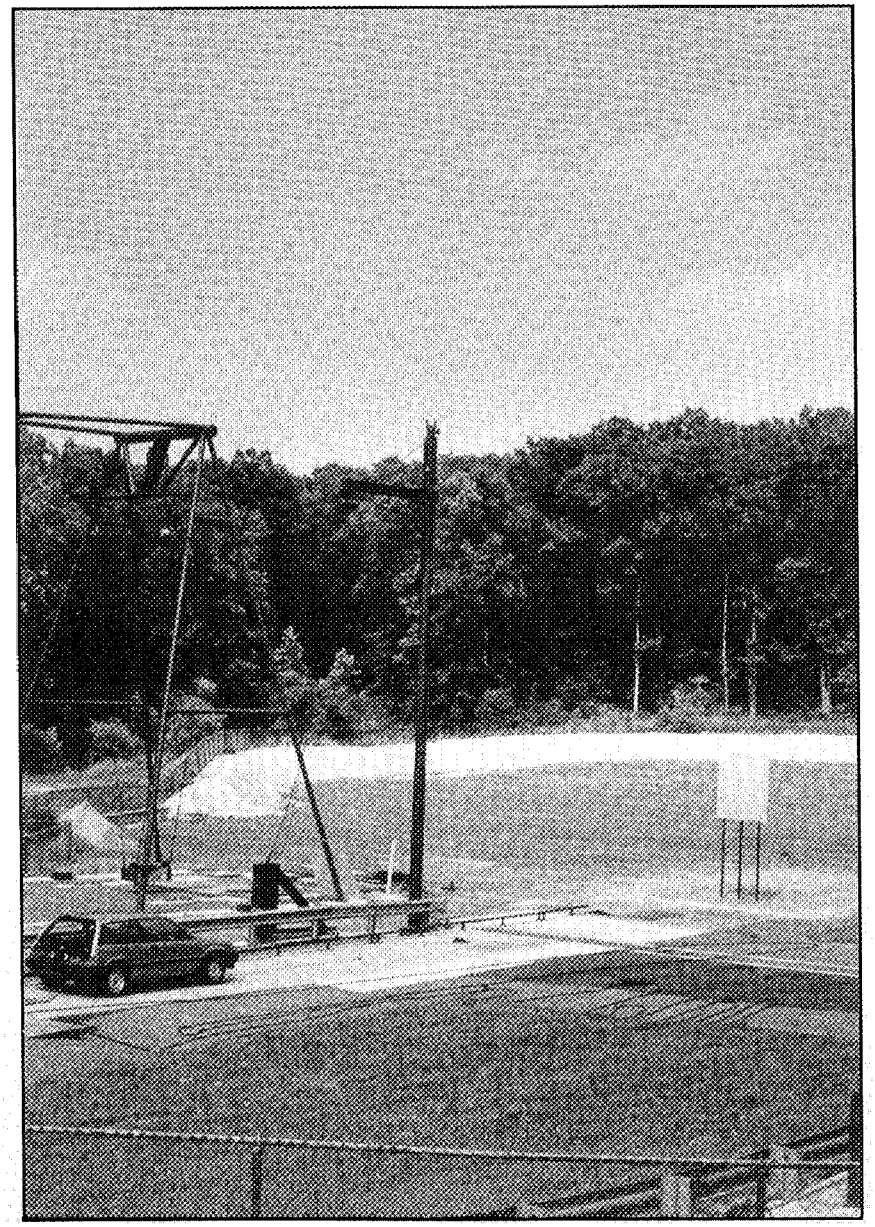
Research & Development

Achievements Report

1992



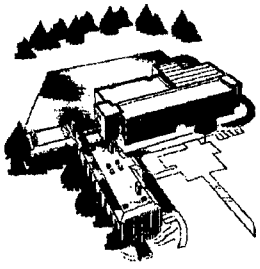
Research and Development
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101-2296

U.S. Department of Transportation
Federal Highway Administration

This 1992 report is the sixteenth in the series of annual achievements reports. It covers the period from October 1991 to September 1992.

While the supplies last, individual copies of the reports in the series are available without charge from the Federal Highway Administration, Research and Technology Report Center, HRD-11, 6300 Georgetown Pike, McLean, Virginia 22101-2296, (703) 285-2144.

Table of Contents



Turner-Fairbank Highway Research Center

FHWA Administrator
Thomas D. Larson

Associate Administrator for Research and Development
John A. Clements

Deputy Associate Administrator for Research and Development
Robert J. Betsold

Director, Office of Research and Development Operations and Support
Robert J. Kreklau

Managing Editor
Anne N. Barsanti

Statement of the Associate Administrator

Fiscal year 1992 was dedicated to meeting the challenges of FY 1991, which was a year of change and developing opportunities for the Federal Highway Administration's Office of Research and Development (R&D). Many challenges were created by the inherent diversity in the world of research and technology—diversity in "players," programs, policies, and priorities. In FY 1992, a major focus of the Office of R&D was the productive and progressive management of this diversity. This has entailed much internal and external coordination, cooperation, and development.

Program diversity is a feature of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, which became law on December 18, 1991. The ISTEA greatly increased funding and program responsibilities for FHWA's Research and Technology (R&T) Program. The Office of R&D made significant contributions to implementing the research and technology provisions of the ISTEA.

With the expanded funding for research and technology programs under the ISTEA, diversified funding mechanisms were initiated, such as the use of larger contracts, research consortia and cost sharing by industry, and new funding mechanisms such as grants and broad agency announcements.

We have further introduced diversity by vigorously pursuing new methods of collaboration. We have entered into research agreements or projects with almost a dozen Federal agencies, including the National Science Foundation, the National Institute on Standards and Technology, the Department of Energy, the Environmental Protection Agency, the Army Corps of Engineers, and the U.S. Geological Survey. We have emphasized our mutual interests in order to formulate bigger and better projects and results than either agency alone could have achieved.

We have also advanced the idea of a Highway Innovative Technology Evaluation Center (HITEC). In September 1992, the FHWA, in conjunction with many other organizations, developed an action plan to establish and operate this center.

We have become more involved in international activities in highway research. We have entered into cooperative research agreements with Japan, Sweden, and Saudi Arabia. We have increased our involvement in the Organisation for Economic Co-operation and Development (OECD) research activities, and have hosted—and been hosted by—our international peers in highway engineering. We boast loaned staff from Japan, China, Czechoslovakia, and Brazil, among others. Our staff has visited Europe to gain new ideas and South America to transfer technologies. Through the National Highway Institute, we have helped manage the new Pan American Institute of Highways, ensuring technology transfer throughout the Americas.

We have sought to reward and encourage engineering talent and innovation through grants and cooperative agreements. Through awards to undergraduates, graduates, historically black colleges and universities, and small businesses, we have tried to tap the "best and brightest"—particularly among underrepresented minorities. We are especially excited about the new Eisenhower Transportation Fellowship Program managed by the National Highway Institute.

Our research programs continue to expand into areas that are critical to the highway community. We made major contributions to intelligent vehicle-highway technology in FY 1992. We also initiated or expanded programs in seismic research, timber bridge research, and the use of recycled tires in asphalt pavements.

To ensure that our research remains cutting edge, an internal Office of Advanced Research was established. This unit is a basic research group—a previously non-existent aspect of the program—charged with identifying long-range problems and monitoring emerging technologies. Also, we are renovating our Fairbank Building, and are investing heavily in new, state-of-the-art technology for several of our labs.

Managerially, we implemented oversight mechanisms in program development and started an external Research and Technology Coordinating Committee to ensure that the highway research community is involved in establishing our research priorities. Working with the other FHWA R&T offices, we developed and published a 5-year strategic R&T plan.

Internally, we reorganized the National Highway Institute to better reflect its responsibilities under ISTEA. We also revamped the organization of the Intelligent Vehicle-Highway Systems Research Division to better match its priorities.

We successfully brought the Long-Term Pavement Performance Program (LTPP) under our wing, smoothly transitioning it out of the Strategic Highway Research Program organization. The transition was accomplished with no interruption in the critical LTPP research program.

We have enriched and diversified our staff through fellowship programs, Intergovernmental Personnel Act assignments, rotational assignments, and the Americans with Disabilities Act. These continuing actions provide new perspectives for our research program.

In all, FY 1992 has been an exciting and stimulating year during which we put into place many mechanisms, partnerships, and collaborations that will stand us in good stead in meeting the challenges of the future.

***Mr. Charles Miller** left the position of Associate Administrator for Research and Development on April 17, 1992, after 1 1/2 years. Mr. Miller became the State Highway Engineer in West Virginia. Among the accomplishments under his leadership were major contributions to the R&T provisions of the ISTEA, development of the FHWA's R&T Program, and establishment of an external R&T Coordinating Committee.*

***Mr. Robert J. Betsold**, Deputy Associate Administrator for Research and Development, served as the Acting Associate Administrator for the remainder of FY 92.*

***Mr. John A. Clements** assumed the responsibilities as Associate Administrator for Research and Development on December 1, 1992. Mr. Clements comes to the FHWA with a long history in transportation. He served as Commissioner of the New Hampshire Department of Transportation, President of the American Association of State Highway and Transportation Officials, Chairman of the Transportation Research Board's Executive Committee, President of the Highway Users Federation, and Vice President and Director of Highway Programs for Parsons Brinckerhoff Quade & Douglas, Inc.*

Operations

Mission

A recurring theme in the 1992 presidential campaign was the importance of improving and repairing our transportation infrastructure. Moreover, recent legislation—notably the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991—has mandated that the Nation's transportation networks be integrated, safe, and efficient. Together, these concerns point up the need for research and development in the transportation field, particularly with regard to the Nation's highways.

The Federal Highway Administration's (FHWA's) Associate Administrator for Research and Development oversees the federally supported research programs in the highway field, ensuring that available resources are used to find solutions to high-priority problems. This research is performed by, or under the auspices of, Office of Research and Development (R&D) personnel, working out of the Turner-Fairbank Highway Research Center (TFHRC), which is the Nation's primary highway transportation research facility.

See page 19 for a flowchart of the process by which research priorities are established. *[Research Highlights]*

Organization

The Office of R&D was reorganized to meet the challenges posed by the ISTEA. Much of the past year has been dedicated to ensuring the successful implementation and integration of this reorganization—particularly with regard to two new R&D elements: the Long-Term Pavement Performance Division and the Office of Advanced Research.

Commitment + Cooperation = Smooth Transition for LTPP

The Long-Term Pavement Performance Program is a 20-year research effort initiated and, for its first 5 years, managed by the Strategic Highway Research Program (SHRP). In FY 1992, continuation of the LTPP was given over to FHWA's Office of R&D, which initiated a year-long effort to ensure a seamless transition. Strong commitment and cooperation on the part of the SHRP and FHWA staffs, as well as among the States and contractors involved, made for a successful transition with no significant interruptions in ongoing research.

To facilitate the transition, six members of the LTPP Division were loaned to SHRP for periods ranging from a few weeks to more than a year. This gave SHRP additional staff to help wrap up its program responsibilities and enabled the FHWA staff to get up to speed before assuming day-to-day stewardship of the LTPP research.

There were two other important changes in the R&D organization:

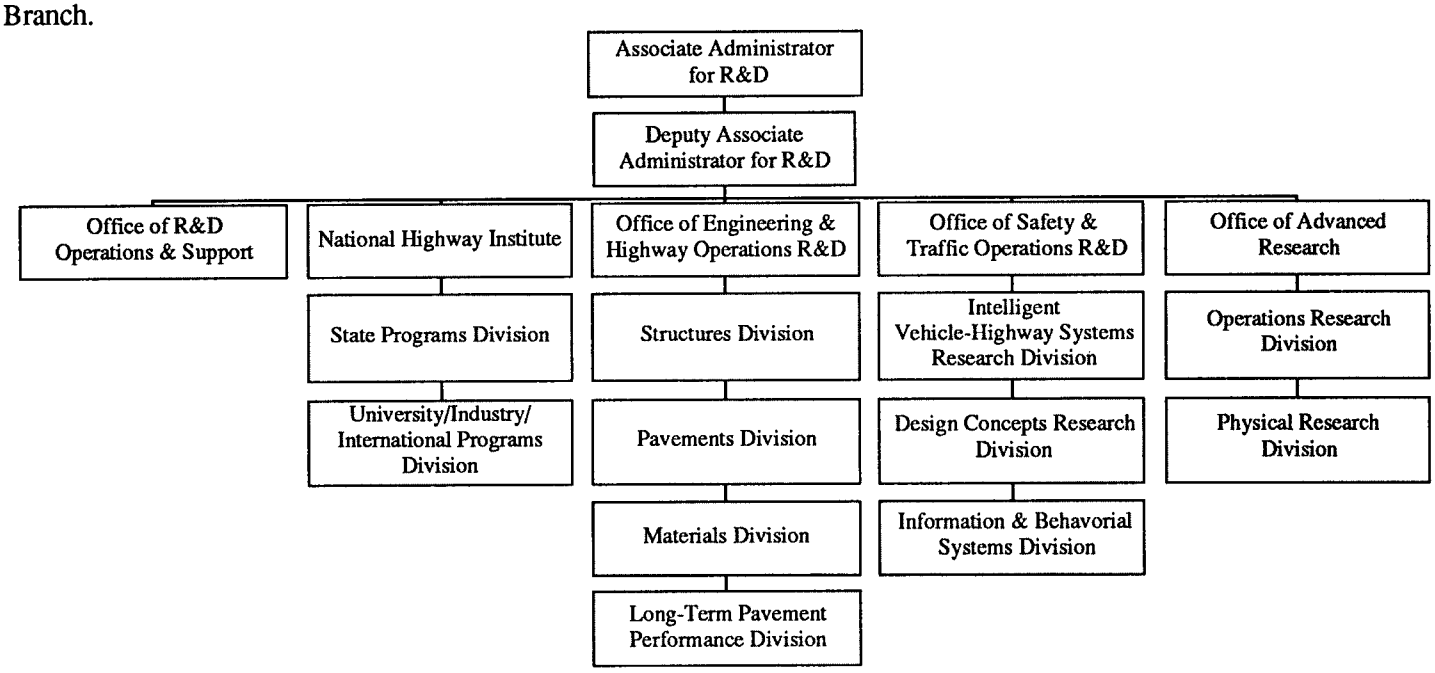
• **National Highway Institute.** To keep pace with changing times and changing emphasis areas, NHI's organizational structure and program responsibilities underwent a series of exciting transformations in 1992. As a result of its new program responsibilities under ISTEA, NHI was reorganized into two divisions—the State Programs Division and the University, Industry, and International Programs Division.

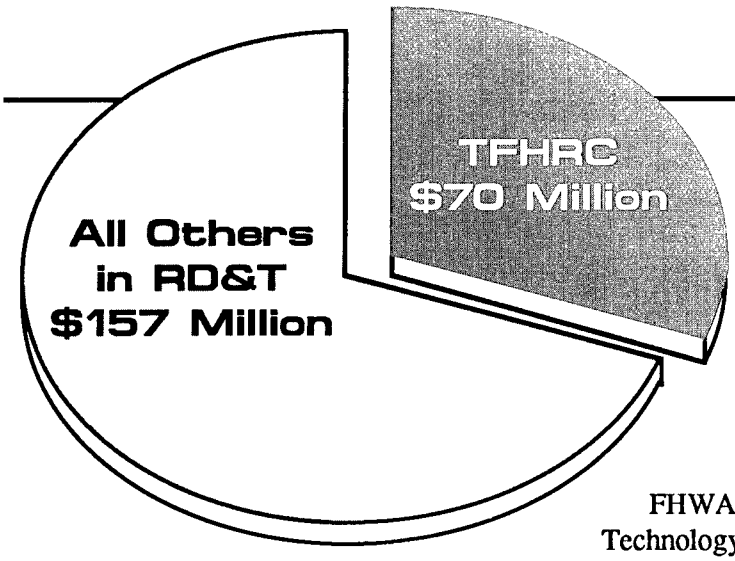
• **Intelligent Vehicle-Highway Systems Division.** Plans were set in motion in Fiscal Year (FY) 1992 to expand the IVHS Division at TFHRC. Three new branches were official as of October 1, 1992. They are the Traffic Systems Branch, the Electronic Systems Branch, and the Fleet and Rural Systems Branch.

Future Concepts: The Office of Advanced Research

R&D's new Advanced Research Office represents a highly qualified and unique resource for identifying long-range problems and monitoring emerging technologies. "Highly qualified" in that the team members collectively possess decades of experience in highway operations, implementation, pavements, materials, chemistry, expert systems, hydraulic research, metallurgy, and computer technologies. "Unique" in that few Federal entities have a basic research component dedicated to theoretical problem solving and analysis.

Currently, the Office has initiated and is administering active artificial intelligence and advanced technology circles. It is also putting together a program in advanced research to respond to needs expressed by the highway community and the Research and Technology Coordinating Committee.





The Budget

In FY 1992, FHWA's Research & Technology (R&T) Program received $227 million. Utilizing these Highway Trust Funds, the FHWA conducted or monitored nearly 2,000 studies which were performed by States, universities, contractors, and inhouse staff.

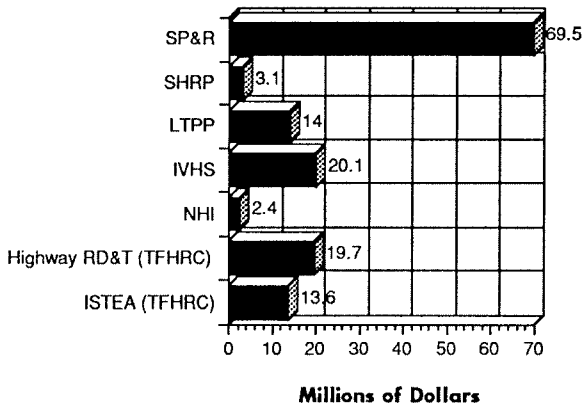
Of the original $227 million, the TFHRC directly managed about 30 percent, or $69.8 million. However, an additional $72.6 million was monitored by the TFHRC for the State Planning & Research (SP&R) and Strategic Highway Research (SHRP) programs, bringing the total TFHRC involvement up to $142.4 million.

The figure below itemizes the $142.4 million and shows how it was disbursed among the seven major research areas involved at the TFHRC.

Staff

Over 130 Federal employees work at the TFHRC; about 80 contract employees and 40 Graduate Research Fellows supplement the inhouse staff. Also, at any one time, there are six to eight visiting researchers on loan or on detail from various countries, universities, and agencies. Each of the senior professional employees—who are engineers, geologists, mathematicians, chemists, metallurgists, psychologists, etc.—coordinates or monitors about 50 research studies in his or her area of expertise.

Monies Controlled or Monitored by TFHRC



Many TFHRC staff are active participants on boards and committees of other transportation organizations including the Transportation Research Board (TRB) and the American Society for Testing and Materials (ASTM).

There is growing concern in the highway field including the R&D community about future shortages of trained personnel. The Office of R&D is attuned to this concern. To help attract new engineers to R&D, it restructured a portion of the Highway Engineering Training Program in FY 92 to allow new FHWA engineers to spend 2 weeks—rather than a single day, as previously—at the TFHRC. Each day, the trainees learned from and worked with experts from each R&D division to get hands-on experience in the different areas. It is hoped that this approach will cause new FHWA employees to become more interested in R&D and to request assignment in the Office.

Facilities

The Office of R&D is located in McLean, Virginia, at the TFHRC. The entire complex consists of 44 acres containing five Offices and over 40 labs and support facilities. In February 1992, plans were begun to renovate the Fairbank Building. This work will include new heating, air conditioning, and electrical systems as well as renovation of the laboratories. Actual renovation is scheduled to begin in the fall of 1993.

Where the Work Is Done

Almost 40 specialized laboratories—featuring the latest and best in highway-related technology and capabilities—are located at the TFHRC.

To ensure that TFHRC labs continue to provide peak performance and state-of-the-art technology, several upgrades were implemented in FY 1992, including:

• Creation of a National Crash Analysis Center by FHWA and the National Highway Traffic Safety Administration. This unique center—located on the Virginia campus of the George Washington University—is dedicated to advancing highway, vehicle, and biomechanics safety research issues.

• Installation of a programmable lifting mechanism designed to reduce unwanted dynamic loading and associated noise for the Accelerated Loading Facility (ALF) in the Pavement Testing Facility.

• Completion of first phase testing at the new FHWA Test Road Facility.

• Construction of a prototype dynamic truck actuator (DYNTRAC) to study the nature of dynamic forces on pavements induced by heavy trucks.

• Upgrading of equipment in the Bituminous Mixtures Laboratory including wheel track testers from France and Germany, three gyratory compactors, servo-hydraulic materials

The TFHRC Labs

- Aerodynamics Lab–Wind Tunnel
- Bituminous Mixtures Lab
- Chemistry Lab Complex
  - ❒ Chromatography Lab
  - ❒ Paint Lab
  - ❒ Scanning Electron Microscope Lab
  - ❒ Spectroscopy Lab
- Corrosion Lab
- Dynamic Truck Actuator–DYNTRAC
- Engineering Services Lab (Experimental Equipment Fab. Lab)
- Federal Outdoor Impact Lab–FOIL
- Geotechnical Laboratory Complex
  - ❒ Foundation Lab
  - ❒ Soils Mechanics Lab
- Highway Design Lab
- Highway Electronics Lab
- Highway Safety Information System–HSIS
- Highway Simulator Lab–HYSIM
- Human Factors Lab
- Hydraulics Lab
- Instrumented Test Road Metallurgy Lab
- Pavement Binders Lab
- Pavement Isothermat Testing System–PITS
- Pavement Performance Lab
- Pavement Testing Facility
  - ❒ Accelerated Loading Facility–ALF
- Petrographic Lab
- Photometric & Visibility Lab
- Portland Cement Laboratory Complex
  - ❒ Aggregate & Sample Preparation Lab
  - ❒ Concrete Analysis Lab
  - ❒ Concrete Curing/Maturity Lab
  - ❒ Concrete Test Lab
  - ❒ Plastic Concrete Lab
- Structures Lab
- Vehicle Preparation Lab

Awards

Several prestigious awards were bestowed upon R&D staff in recognition of recent accomplishments. Among these awards were the following:

- **American Society of Civil Engineers' 1991 James Laurie Prize:** Albert F. DiMillio, Materials Division

- **National Society of Professional Engineers/FHWA Engineer of the Year Award:** Thomas J. Pasko, Jr., Director, Office of Advanced Research

- **Illuminating Engineering Society of North America's Distinguished Service Award:** Richard N. Schwab, Information and Behavioral Systems Division

- **National Association of Corrosion Engineers 1992 Technical Achievement Award:** Dr. Yash Paul Virmani, Structures Division

- **TRB's Roy W. Crum Distinguished Service Award:** Lyle Saxton, Director, Office of Safety and Traffic Operations R&D

- **FHWA AASHTO Service Awards:** Howard Bissell, Information and Behavioral Systems Division; Paul Teng, Chief of Long-Term Pavement Performance Division; Charles Niessner, Acting Chief of Physical Research Division

- **FHWA Administrator's Award for Superior Achievement:** Ilene D. Payne, Director of Universities and Grants Programs, National Highway Institute

- **Office of R&D's Outstanding Technical Accomplishment of 1991:** "Evaluation of VOC-Compatible High Solids Coating Systems for Steel Bridges," coauthored by Dr. Shuang-Ling Chong and John Peart, Materials Division

- **Unusually Outstanding Award:** Ray Bonaquist, Pavements Division

testing equipment, a SHRP thermal stress restrained specimen test, a SHRP simple shear test, laser particle size analyzer, and a universal compression machine.

- Upgrading of equipment in the Chemistry Laboratory Complex and the Portland Cement Laboratory Complex.

- Purchase of a Reduced Instruction Set Computer workstation for use in bridge-related simulations.

- Completion of plans, specifications, and contract documents for an expanded Pavement Test Facility with 24 test sections.

Stewardship and Collaboration

The FHWA, through its Office of R&D, is taking the lead in a vital national enterprise—intermodal surface transportation research. The needs in this area are overwhelming. However, they are equaled by the awesome number of exciting ideas, thoughtful research plans, and top-notch researchers across the country.

The Office of R&D has been entrusted with the responsibility of matching needs and resources. It has been given a large budget, excellent staff, and a wide range of mechanisms by which to fulfill its duties.

It has also created a number of other mechanisms by which to exploit to the fullest the talent and information sources that exist here and abroad. This section describes some of the most innovative and successful of these mechanisms.

Fostering Innovation

Traditional solutions can be found in traditional ways. Innovation must be sought innovatively. The FHWA has taken advantage of numerous mechanisms to encourage innovation across the country in the area of highway research.

• **IDEA Program.** The FHWA recently entered into an agreement with the TRB to establish the IVHS IDEA—Innovations Deserving Exploratory Analysis—program. This program is directly modeled after the highly successful SHRP IDEA Program that was established and administered by the National Research Council. Under the IDEA Program, proposals will be solicited by the TRB for innovative concepts in the IVHS area. A panel of experts will select those proposals that merit funding for further development of the concept. Concepts that appear promising after the first stage will receive additional funding to develop prototype systems. Researchers will be expected to obtain matching funds from the private sector, especially for phase II funding. It is expected that this program will help individuals, small companies, and universities in developing emerging technologies and innovative concepts into viable IVHS systems.

• **Consortium Approach to Contracting.** Because of the complexity and magnitude of the IVHS program, it is believed that larger scale efforts will eliminate the delays that would be inherent in carrying out the work through a series of separate contracts. Therefore, FHWA is encouraging potential contractors to form consortia of public and private partners—including State and local highway agencies, private industry, and academia—in bidding on selected IVHS work. These partnerships should allow for multi-faceted, innovative solutions that take into account a variety of perspectives. In FY 1992, FHWA awarded such a contract to a consortium for a project on Real-Time Traffic Adaptive IVHS.

HITEC

In September 1992, the FHWA—in cooperation with American Association of State Highway and Transportation Officials (AASHTO), TRB, the Corps of Engineers, and the Civil Engineering Research Foundation—conducted a workshop on Implementing Innovative Highway Technology. The goal of the workshop was to develop an action plan to establish and operate a center for evaluating innovative highway technology.

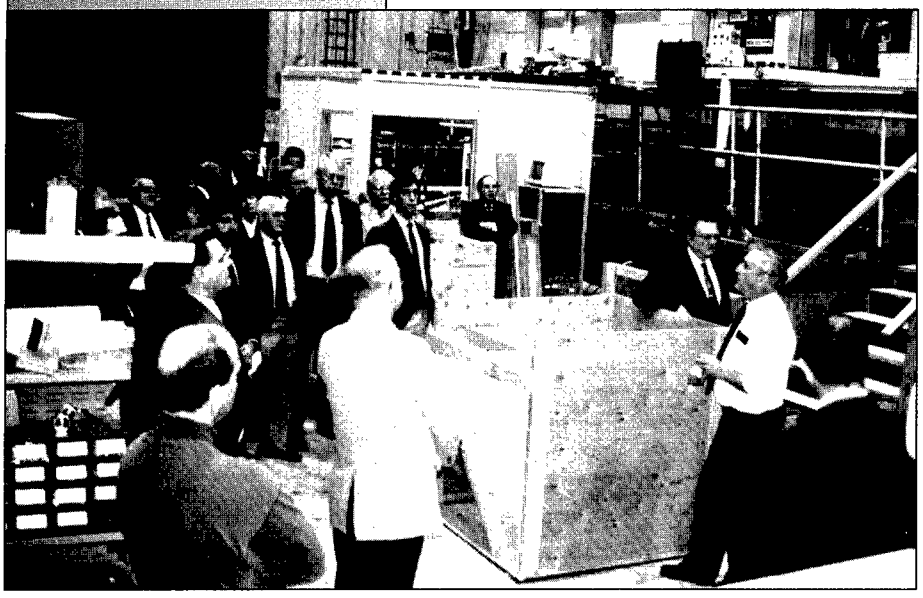
Over 120 representatives from the legal, financial, and insurance communities; small and large corporations; research agencies; State highway agencies; user groups; and Federal agencies participated in the workshop. Their consensus was that a national evaluation center could effectively expedite the implementation of innovative technology. To make such a center work, however:

- All parties (State and local highway agencies, private sector, universities, and Federal) must remain involved in and committed to the project.
- The center must establish its credibility.
- Criteria must be developed for screening and evaluating applications.

In November 1992, a cooperative agreement was signed with the Civil Engineering Research Foundation to establish and operate the Highway Innovative Technology Evaluation Center (HITEC). HITEC will be operational by mid to late 1993.

• **Cooperative R&D Agreements (CRADA).** In FY 1992, FHWA signed its first CRADA. A CRADA is a work arrangement in which private agency researchers use government laboratories to conduct a study. ENSCO, Inc., entered into a CRADA with FHWA to fabricate a reusable (bogie) test vehicle similar to that designed and used by the FHWA in crash testing. This technology was developed at the TFHRC.

• **SBIR Program.** The Small Business Innovation Research Program enables agencies to fund the development of innovative ideas or technology presented by small businesses. An FHWA SBIR awardee developed in FY 1992 an improved version of its all-digital loop test meter for testing inductive loops in the roadway, connecting cables, and detector electronics. The hand-held instrument uses digital signal processing techniques to make a broad range of electrical measurements. The instrument is in commercial production.



Opening Doors

Increasingly, FHWA promotes an open door policy at the TFHRC. Research results are not jealously guarded in an "ivory tower" atmosphere, but are openly shared. The TFHRC welcomes guests and visitors. It hosts numerous conferences, demonstrations, lectures, and tours. Examples of these activities follow.

• **American Concrete Institute.** As part of ACI's 1992 Spring Convention, a program for students was held at the TFHRC. The students competed in the 12th Annual ACI Concrete Cube Competition and toured some of the TFHRC facilities, including the Accelerated Loading Facility (ALF), the Structures Lab, and the Hydraulics Lab; they also were given a demonstration of nondestructive evaluation techniques for concrete.

• **Research, Engineering, and Standards Committee of National Ready Mixed Concrete Association.** The FHWA gave presentations on FHWA 2000, ISTEA, National Quality Initiative, and performance-related specifications for portland cement concrete (PCC). Participants were given a tour of TFHRC facilities, concentrating mostly on the labs that are investigating PCC or concrete structures.

• **Research, Operations, and Engineering Committee of the National Aggregates Association.** Presentations were made by FHWA on research under ISTEA, LTPP, aggregate

base courses, and aggregate-related standards activity in the ASTM. A tour was given of the TFHRC, particularly the Bituminous Mixtures Lab.

• **American Trucking Association Executive Council.** This group met at the TFHRC in April for an R&D orientation and tour of the ALF and the Truck Shaker Laboratory.

• **Mathematical Modeling of Rigid Pavements.** A 2-day workshop on this topic was held at the TFHRC in February. It was the first in a series of three workshops focusing on issues pertaining to mechanistic pavement analysis and design. This first workshop brought together about 20 Federal, State, and private sector experts in pavement modeling to assess methods used to estimate the impact of today's heavy vehicles on rigid pavements.

• **Research and Technology Coordinating Committee.** The RTCC met at TFHRC in October 1991 for one of their three-per-year scheduled meetings. FHWA Administrator Thomas D. Larson and the Associate Administrators met with the RTCC to discuss the FHWA R&T Program. The meeting also included a tour of several of the laboratories.

• **SHRP Product Implementation Working Group Meetings.** These meetings brought TFHRC, SHRP, and FHWA operations personnel together to plan for implementation of early LTPP research products.

Opening Doors Internationally

International research in highway issues is a stimulating resource for FHWA researchers.

There are several means by which FHWA opens its doors internationally: through visitors to the TFHRC; through visiting staff, guest researchers, visiting experts, etc.; through international collaborations and joint sponsorship of programs, projects, and conferences; and by sending staff to other countries. By keeping the TFHRC and its staff visible in the international community, FHWA generates interest in its work, which in turn fosters further interaction and information exchange.

• **Visitors.** The TFHRC has over 250 overseas visitors a year. The Russian First Deputy of Transport and General Director of the Federal Highway Department Nikolai I. Golovanov toured the TFHRC. The Japanese Society of Civil Engineers, the China Road Data Bank, the Jordanian Ministry of Public Works, and the International Road Federation Fellows were among the major international delegations that

LTPP International Technology Transfer

The FHWA has continued the tradition established by SHRP of strong international participation in LTPP research. Exchanging information on pavement performance, monitoring, and construction practices with international partners allows LTPP to benefit from their experiences–both positive and negative–and strengthens the LTPP research program.

LTPP International Coordinators. As part of the transition from SHRP to FHWA, LTPP coordinators have been established in 30 countries. These coordinators are the principal contacts for information concerning the LTPP program and are focal points for establishing LTPP experiments and activities in their countries.

International Pavement Information Management Systems. To date, seven countries have received a copy of the LTPP information management system for pavement performance data collection in participating countries.

International Loan Staff Program. The LTPP continues to provide learning opportunities and free exchange of information to the international community through its loan staff program. Currently, Mr. Keizo Kamiya of Japan is completing a 2-year loan staff assignment with the LTPP Division. In addition, SHRP-loaned staff from Australia, the United Kingdom, Finland, Slovenia, and Romania interact with LTPP staff intermittently keeping their countries up to date on progress and developments in the LTPP research.

visited the TFHRC for technical discussion and information exchange.

• **Guest Researchers.** During the year, the TFHRC has been host for visiting research professors and loaned staff from Argentina, Brazil, China, Colombia, Costa Rica, Japan, and Uruguay. The length of stay varies, but is normally 1 year. Through these exchanges:

—Highway safety techniques are being shared with Brazil.

—A report is being developed on the similarities and differences in U.S. and Japanese maintenance philosophy and practices.

—Corrosion protection system technology is being transferred to Czechoslovakia.

—Studies are being conducted by Chinese researchers on transferring technology in geotechnology areas.

• **Cooperative Research Agreements.** The FHWA signed cooperative research agreements with Japan, Sweden, and Saudi Arabia in FY 1992.

• **North American Research Forum.** FHWA hosted this forum at the TFHRC which brought together, for the first time ever, the heads of the government research and development agencies for Canada, Mexico, and the United States. These leaders shared their common concerns and goals.

• **Organisation for Economic Co-operation and Development.** FHWA staff participated in several OECD initiatives in FY 1992. These included attending a strategic planning meeting for OECD's Highway Research Program Symposium; representing the FHWA in the FORCE project, which involves the validation and calibration of mathematical pavement models; representing FHWA in OECD's expert systems group; participating in OECD's Second Seminar on Technology Transfer and Adaptability in Developing Countries and Economies in Transition; and representing the FHWA in the group reporting on "Modification of Road User Attitudes." During FY 1992, one staff member returned to the

TFHRC at the completion of a 2-year assignment to the OECD Transport Research Project in Paris.

• **European Study Tours.** A TFHRC staff member joined 20 other U.S. public and private sector highway and pavement experts on the 1992 U.S. Tour of European Concrete Highways. The results of the trip are being disseminated and may have significant impacts on future U.S. design, contracting, and construction practices.

• **Technical Assistance in Venezuela.** A team of U.S. traffic engineering experts, including a TFHRC staff member, assisted Venezuela in ongoing efforts to enhance its surface transportation system by offering seminars on the state of the art in traffic engineering in the United States.

• **FHWA-NSF Geotechnical Workshops.** A TFHRC staff member made presentations at Geotechnical Workshops cosponsored by the FHWA and the National Science Foundation (NSF) in Brazil, China, and France.

• **International Scanning Tour.** A TFHRC staff member participated in this FHWA-sponsored tour that was designed to collect advanced technology data on soil nailing in Germany, France, and England, which are leaders in the application of soil nailing.

The Pan American Institute of Highways is another major international initiative undertaken by FHWA. It is discussed on page 40. *[NHI section]*

Opening Doors Among Agencies

It is easy for a bureaucracy to become highly compartmentalized and for exciting ideas, projects, and activities to fall between the cracks or not be sufficiently maximized because the initiating agency does not have a full complement of resources to dedicate to the effort.

Cooperation is the key. And the Federal Government has taken steps to ensure that technology is shared, budgets are pooled, and resources are maximized. Projects that cut across agency boundaries are encouraged, since it is felt that the blending of multiple perspectives will create a greater project.

FHWA fully supports this position. In FY 1992, it signed agreements to initiate research in areas of mutual interest with several agencies. It also participated in Department of Transportation (DOT)-wide activities to ensure the effective solutions that come from an intermodal perspective. Highlights of these activities follow.

• **Engineering Research Agreement With the National Science Foundation.** FHWA signed an agreement in June with NSF to promote the advancement of engineering research and provide for the transfer of technology between FHWA, NSF, and industry. The agencies will sponsor research in areas of mutual interest with respect to highway safety, design,

The Federal Government has taken steps to ensure that technology is shared, budgets are pooled, and resources are maximized... Projects that cut across agency boundaries are encouraged... FHWA is a partner in many interagency research projects.

TFHRC is involved in more than 70 interagency projects.

structures, pavements, materials, etc. For example, the two agencies plan to establish sites for U.S. National Geotechnical Experimentation. These sites will be open to geotechnical research institutes for use in evaluating, developing, and improving laboratory and in situ tests.

• **Research Agreement With the National Institute of Standards and Technology.** In July, FHWA signed an agreement with NIST's Building and Fire Research Laboratory (BFRL) to promote cooperative research on advanced construction technology, seismic engineering, and applications of advanced materials to enhance the performance of highway structures, including bridges and pavements. Specific interagency agreements between BFRL and FHWA will be developed to define specific undertakings.

• **Interagency Agreement with the NIST–Calibration of Marshall Compaction Hammers.** An interagency agreement was finalized with the NIST to develop a practical testing apparatus that can be used to calibrate mechanical hammers used in the Marshall asphalt mix design.

For more information on this project, see page 26. *[Pavements section]*

• **Interagency Agreement with the NIST–Application of Machine Vision Technology.** In March, the FHWA IVHS Research Division signed an Interagency Agreement with the Robot Systems Division of NIST to conduct research in application of machine vision technology, originally developed for the Defense Department, to highway automation. This research was cost-shared between FHWA and NIST.

• **FHWA-Army Corps of Engineers R&D Coordination Workshop.** This workshop was held to enhance the agencies' coordination of research in areas of mutual interest and to identify potential projects for future cooperative research.

• **Q-500.** FHWA and the Federal Emergency Management Agency cooperated with the U.S. Geological Survey to develop a practical procedure for estimating the 500-year flood.

For more information on this project, see page 24. *[Scour sidebar]*

• **Interagency Agreement with Sandia National Laboratories.** The purpose of this agreement, conducted through the Department of Energy, is to initiate research on the potential applica-tion of IVHS technologies to the problem of commercial vehicle safety.

For more information on this project, see page 36. *[Moving Goods Efficiently]*

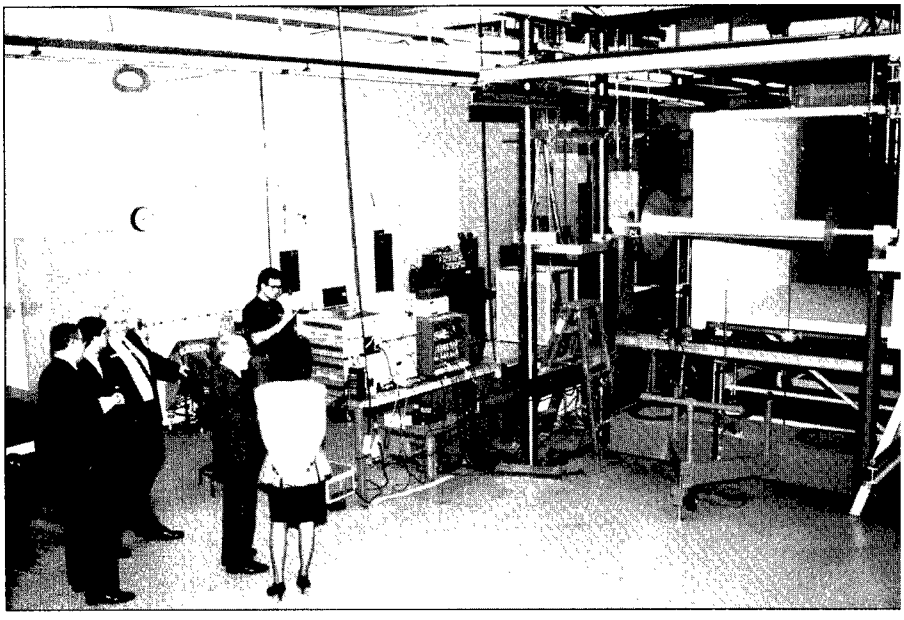
• **FHWA-EPA Project.** FHWA and the Environmental Protection Agency (EPA) are cooperating on a joint project to use recycled material in highway construction, focusing on the evaluation of crumb rubber modifier in asphalt pavements.

For more information on this project, see page 25. *[Pavements section]*

• **Commerce Science and Technology Fellowship Program.** FHWA staffer Stephen Forster was chosen as 1 of 12 participants in this executive branch program. The program's purpose is to enhance mid-level scientists' and engineers' understanding of the roles and policies of science and technology in the Federal Government and in U.S. industry and economics. This selection entailed a 9-month assignment for Dr. Forster in the Department of Commerce, Office of Technology Commercialization, and was the third consecutive year in which R&D had a fellow in the program.

• **Interagency Task Group on Infrastructure/Construction.** The Director of FHWA's Office of Advanced Research chairs this task group of the Committee on Materials which ultimately reports—through the committee structure—to the Science Advisor to the President. The task group is composed of representatives from 16 agencies. The representatives have met every 2 months for the past year to detail research needs in the infrastructure materials areas, with special emphasis on high-performance concrete and steel. The task group is detailing research needs, defining budgets, and identifying an interagency cooperative approach to carrying out the program.

• **Staff Exchange Program with the New Mexico Alliance for Transportation Research.** In September, a TFHRC staff researcher spent 4 days with the New Mexico Alliance for Transportation Research to kick off a staff exchange program designed to build a strong technical bond between FHWA and the Alliance and to develop a basis for meaningful research and development in transportation with benefits for both organizations. A representative of the Alliance visited TFHRC for a week in October. The Alliance is a unique, cooperative venture coordinating the research capabilities of Los Alamos National Laboratory, Sandia National Laboratory, the University of New Mexico, New Mexico State University, and the New Mexico State Highway and Transportation Department.



Intergovernmental Personnel Act Agreements

IPA's allow agencies to supplement their inhouse staff with people from universities and other State and Federal agencies. The special talents and perspectives of these outside experts create a mutually beneficial situation. They lend their specialized expertise to the host agency, and upon their return they bring back insights and ideas to their home agency . The FHWA made frequent and varied use of IPA's in FY 1992.

In FY 1992, the University-Industry-International Programs Divison of the NHI, used this mechanism under its Visiting Staff Program to initiate several specialized studies, primarily involving alternative training delivery mechanisms.

Lonnie Cowherd from the Minnesota Department of Transportation is on detail with FHWA to work on new training techniques and approaches for NHI. His work will assist NHI in implementing a teaching program via satellite.

Dr. Ian Flood, Professor of Civil Engineering from the University of Maryland, has had an IPA appointment as a visiting professor for three summers. This past summer, Dr. Flood worked on various aspects of his neural network program, helped FHWA staff apply his radial Gaussian Neural Network Program to various highway applications, and conducted a series of miniseminars for the TFHRC staff.

Tapping the "Best and Brightest"

FHWA participates in numerous programs to gain the benefit of top national experts in specialized highway concerns. To ensure the future supply of such experts, the agency also sponsors several fellowship and grant programs. Key 1992 achievements in attracting the "best and brightest" to FHWA research include the following:

• **National Research Council Research Associateships.** The TFHRC is now able to offer Postdoctoral Research Associateships in the areas of asphalt chemistry and corrosion behavior of generic and proprietary devices including electrochemical approaches. These associateships are being offered through the NRC program, which has historically provided competitive postdoctoral research opportunities at major Federal research labs.

Dr. Jerry Wekezer from the University of Alaska taught a graduate course while visiting the TFHRC. An expert in finite element analysis, Dr. Wekezer's class topic was advanced mathematics for research. The semester-long class consisted of 30 Federal employees. Dr. Wekezer also did a 1-day followup class on the PRISM computer program and has developed a PRISM training course and user manual for NHI.

Drs. Nicholas J. Carino and William C. Stone, research engineers with the BFRL, were on detail to TFHRC for 3 months. Dr. Carino worked in the Office of Advanced Research to develop plans for a research program in high-performance materials. Dr. Stone worked with the Structures Division on research in the seismic performance of bridge structures.

Dr. Walaa Mogawer of the University of Massachusetts-Dartmouth was contracted to complete an assignment in the Pavements Division. He assisted in a study to determine what mechanical tests could be used to measure the susceptibility of stone mastic asphalt to permanent deformation.

• **Eisenhower Transportation Fellowship Program—Faculty Fellows.** Professor Dah-Yinn Lee of Iowa State University was the first visiting professor funded under this new fellowship program. He is working on asphalt-related studies in the Pavements Division at the TFHRC.

For more information on the Eisenhower Fellowship Program, see page 38. *[NHI section]*

• **Discretionary Grants for Safety Research.** Grants were awarded to five schools—Tennessee State University, Vanderbilt University, Pennsylvania State University, University of Michigan, and Texas A&M—in order to (1) broaden existing highway safety research at U.S. colleges and universities, and (2) encourage U.S. citizens to seek advanced degrees in highway safety-related areas. Students will present their findings at the TFHRC or at the TRB Annual Meeting.

• **FHWA Academic Study Program.** Joe Bared was selected by FHWA's Office of Personnel and Training as one of this year's recipients. Through this graduate study program, he will be attending the University of Maryland until June 1993.

Research Highlights

The Office of R&D designs, performs, and monitors over 62 percent of all Federal Highway Administration research efforts. Research priorities are set by an intricate process of external input and internal decisionmaking, which is explained below and illustrated by the chart on page 19.

FHWA interacts formally with several advisory committees and informally with other external organizations to obtain information for the R&T Program. To strengthen the outreach of FHWA's R&T Program, an external communications and coordination mechanism has been established.

The first tier of this mechanism is the RTCC. This committee consists of State and local transportation officials, as well as representatives from private industry and academia. The function of this committee is to ensure that all highway R&T bodies, highway users, associated interest groups, and other highway R&T interests have input to the national agenda of R&T needs and programs. This information ensures that FHWA's R&T Program addresses the critical national issues in highway transportation.

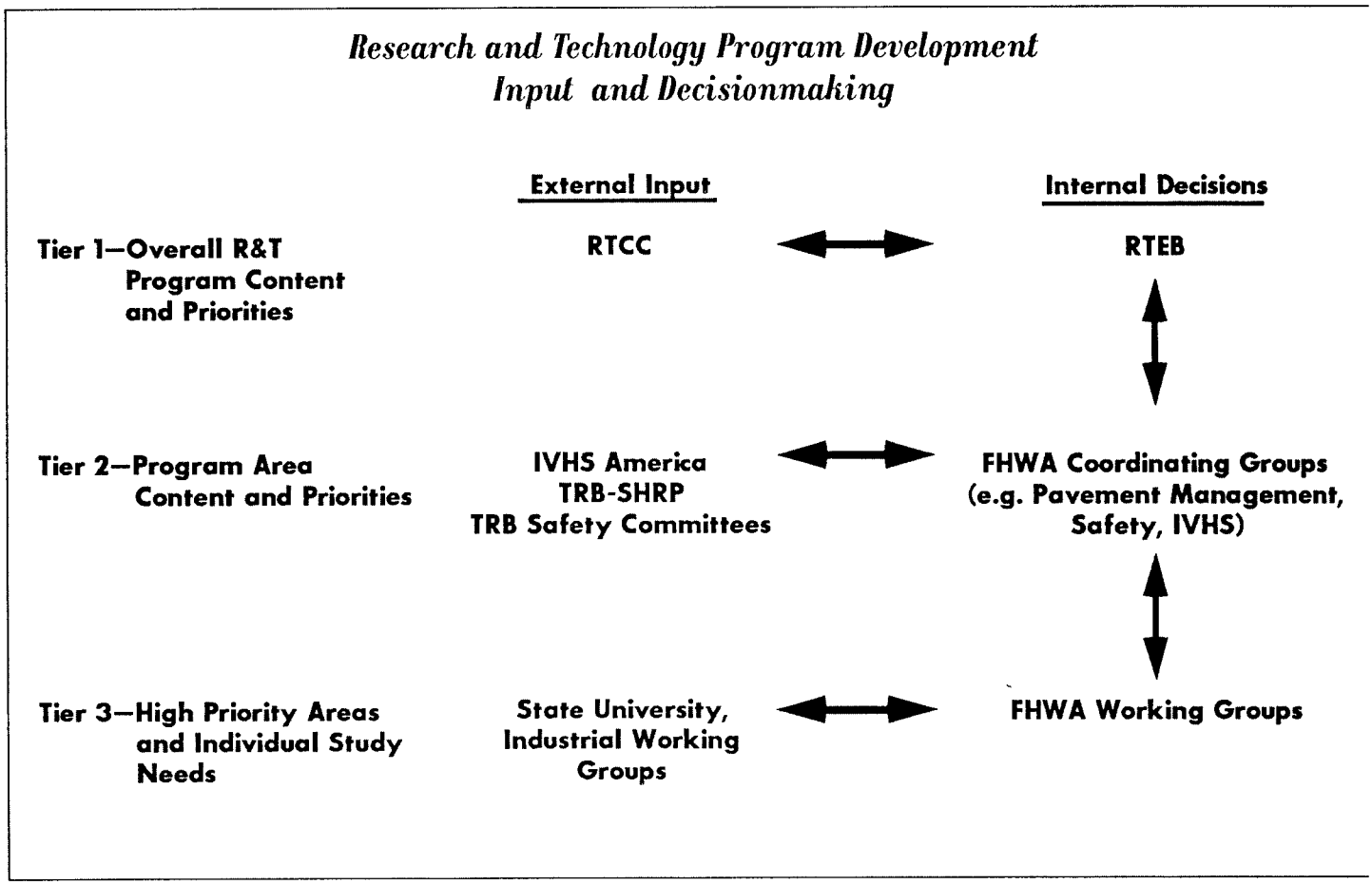
Existing groups such as the Intelligent Vehicle-Highway Society of America and the Motor Carrier Advisory Committee are second tier committees, and they provide information on R&T activities in specific areas, monitor research progress, and recommend applications of research findings. Other second tier program committees and third tier technical working groups are established as needed.

Internally, the R&T Executive Board, whose membership includes the FHWA executive director and associate administrators, provides policy guidance, and approves major program activities. This board interacts with the external RTCC. Internal R&T coordinating groups and technical working groups are responsible for the actual R&T Program development activities. The FHWA coordinates with internal groups such as the DOT R&D Council and the DOT IVHS Coordination Committee.

Most of the FHWA research is managed by the TFHRC in McLean, Virginia. In FY 1992, the Office of R&D staff worked on approximately 225 projects. Highlights of this work follow.

Relieving Traffic Congestion

Over the last few years, demand for the use of the Nation's transportation facilities has increased at a much faster rate than can be provided by current systems. This additional demand has resulted in major increases in traffic congestion. Because it is neither possible nor desirable to construct sufficient new facilities to satisfy current and future travel demand while also preserving the environment, the FHWA is pursuing the development and implementation of Intelligent Vehicle-Highway Systems (IVHS).



Advanced Traffic Management Systems (ATMS)

• **Evaluating Freeway Improvement Alternatives With CORFLO.** CORFLO, an integrated traffic simulation system for freeway corridors, was used in Columbus, Ohio, to evaluate a lane addition proposed to alleviate rush hour congestion. Based on the city's traffic data, FHWA calibrated and executed the model and analyzed the results. In addition to tabular reports, a set of three-dimensional color graphics (showing, e.g., speed profiles along the corridor) were generated. According to the simulation results, it was found that the lane addition merely shifted the existing traffic bottleneck to a location farther downstream. Viewing the results, the FHWA recommended additional features to the corridor — including a combination of demand management, capacity expansion, and ramp metering—which will improve the traffic flow of the entire corridor.

With the data collected from the CORFLO experiment, Ohio engineers will now reevaluate their freeway design plans and consider the additional features recommended by the FHWA.

• **Freeway Simulation Model.** FHWA studied ways to expand the capacity—in both directions—of the Theodore Roosevelt Bridge, which connects

The main goal of the IVHS program, which will carry the FHWA into the 21st century, is to develop and implement state-of-the-art vehicle-highway management techniques and control systems that will effectively reduce congestion by optimizing the use of existing infrastructures.

Washington, DC., and Northern Virginia. The researchers used INTRAS, a freeway simulation model developed by R&D to analyze alternative approaches. Based on the simulation results, the FHWA's recommendation to replace the existing median on the bridge with a reversible lane was adopted. With this improvement, the traffic speeds on the Theodore Roosevelt Bridge have increased, as predicted, from 16 mi/h (26 km/h) to 33 mi/h (53 km/h) during peak hours.

The FHWA is now completing the development of an improved freeway simulation model, FRESIM, which will eventually replace INTRAS.

• **Loop Detector Test Instrument.** Through the FHWA's SBIR Program, a new digital loop test instrument has been developed to test new loop detector systems, to identify faulty loop detector systems, and to assist with preventive maintenance. The instrument is portable and has a measurement accuracy of 0.02 percent. The manufacturer has completed prototype development, and the instrument is now in production.

More recently, the TFHRC had modifications installed in their four instruments to download information into a laptop computer or printer. This will allow for onsite information retrieval. The modified instruments will be available by January 1993.

• **TRAFEdit.** TRAFEdit is a new data entry program developed by FHWA to allow the users of the TRAF models to create and modify their data files more efficiently, thus encouraging the use of TRAF models. The two models currently involved in TRAFEdit are NETSIM, which involves the network of signalized intersections, and CORFLO, which deals with highway corridors. A new TRAF model, FRESIM, which involves freeway simulation, will be released in April 1993.

• **Improved User Interface.** FHWA researchers used point and click technology to create a user interface for an expert system program being developed to design signal timing at isolated intersections. The effort was undertaken to investigate the applicability of this technology for traffic operations software. This interface enables the user to input data five times faster while dramatically reducing errors.

• **Development of TRAF-NETSIM.** TRAF-NETSIM is a simulation model for analyzing traffic control strategies and geometric configurations for grid networks. In FY 1992, Version 3.1 of this model was completed, and the model and its graphics post-processor were released to the public. This model generates standard measures of effectiveness, such as travel time and delay, for use in comparative analysis of alternative traffic control strategies. The new model overcomes most of the deficiencies of earlier versions and executes the program at a much faster rate.

Advanced Traveler Information Systems (ATIS)

• **Laboratory Assessment of the Potential Traffic Benefits of Invehicle Navigation and Information Systems.** One of the first studies comparing the effectiveness of different types of invehicle navigation systems of the type contemplated for use in IVHS has been completed. The study was intended to assess, using FHWA's CORFLO traffic simulation model, the effects on traffic of drivers' reactions to various kinds of navigation and traffic information and routing directions supplied by different in-vehicle navigation and information systems. These systems were a static map, a dynamic map, route guidance, and an advanced system that included a display of a recommended route and auditory instructions. The study showed that both the route guidance and the advanced system resulted in the greatest improvements in network performance.

• **Evaluation of Pathfinder Operational Test.** The evaluation of the Pathfinder operational test in Los Angeles was completed and overall results are positive. Results from this test provided a significant contribution to the design and evaluation of other, similar systems. A final report will be available in spring 1993.

• **Orlando TravTek.** The operational test design and installation of Orlando TravTek was completed, and evaluation is under way. One hundred Oldsmobile Toronados were equipped with systems to provide navigation assistance, real-time traffic information, route selection, and other information to tourists and business travelers in the Orlando area. Data collection will be completed by spring 1993. To date, participants, particularly from those drivers with route guidance capability, report a favorable impression of TravTek.

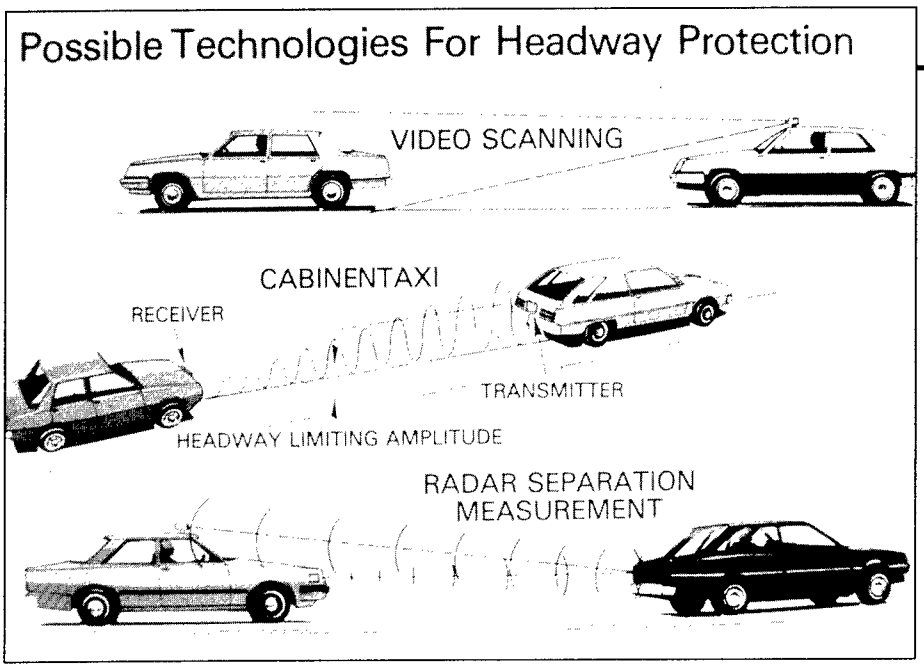
• **Use of Commercial FM for Traffic Data.** A focus group meeting of the FM/Subsidiary Communications Authority (SCA) was held to discuss the use of the subcarrier of the commercial FM broadcast band to transmit digital traffic information for IVHS communications. The meeting resulted in a project being initiated to develop and test a prototype FM/SCA system. The analysis and preliminary design phase of this study has been completed.

Commercial Vehicle Operations (CVO)

• **System Requirements for Invehicle Information and Management Systems.** This effort reviewed state-of-the-art invehicle information and management systems (i.e., onboard computers), determined the information exchange and performance requirements for such systems, and then developed general system requirements for these systems to meet future needs.

IVHS will provide an increased level of safety, mobility, driver convenience, and environmental quality for both rural and urban areas.

An element of ATIS is quantification of driver behavior—how people select routes, react to highway incidents, and select their mode of travel.



• **Institutional Barriers and Opportunities for IVHS on Commercial Vehicle Operations.** This study identified the most promising applications of IVHS technology for commercial vehicles. It then determined the various institutional barriers to full implementation of these applications, using Iowa as a case study site. Institutional barriers, in general, are various laws, regulations, standard practices, and organizational structures. For example, if a paper copy of the vehicle registration must by law be carried in the vehicle, then an electronic tag that allows a computer to check whether a vehicle is legally registered is of little value. Also, a trucker cannot get credentials electronically if regulations require the owner to sign a form or pay in cash.

Advanced Vehicle Control Systems (AVCS)

• **AVCS Research in Platooning for Highway Automation.** This activity was supported as part of an ongoing effort of the California Partners for Advanced Transit in Highways (PATH) program to develop technology to support high-speed platooning. In platooning, strings of vehicles follow each other closely, using electronic sensing and communications, to increase highway capacity and safety. In FY 92, efforts were focused on determining achievable performance in vehicle-follower longitudinal control. These efforts included characterization of the performance of vehicle-to-vehicle sensors, vehicle-to-vehicle communications systems, and braking actuation systems, as well as extensive on-road testing.

• **Advanced (Vision-Based) Vehicle Control Systems.** This study demonstrated the application of machine vision technology to automated driving, specifically the task of automatically steering a vehicle along a road. The technology was originally developed for the Department of Defense's unmanned ground vehicle program. Machine vision technology— whose use in autonomous vehicle systems has the potential for greatly reducing infrastructure requirements—consists of the processing of video images in real time with high-speed computing systems to extract relevant information from the image and make decisions. In this case, the painted road edge lines are detected and steering commands are calculated and performed. The research was performed cooperatively with the NIST and resulted in a vehicle following a well-marked road, using autonomous lateral control (steering) based on machine vision. Additional efforts will further refine this technology.

Maintaining the Infrastructure

The effects of an aging and deteriorating highway system are becoming more severe and more pervasive. Deteriorating facilities serving beyond their original design lives, and catastrophic structural failures, congestion, and accompanying reductions in safety and service are all too commonly associated with the U.S. infrastructure. In the recent presidential campaign, all the leading candidates pledged to improve the infrastructure, citing it as a key component of the country's productivity and economic well being. In FY 1992, the FHWA continued to emphasize development of the tools and materials to rebuild, strengthen, and preserve the U.S. highway system.

Structures

• **Fatigue Cracking on Interstate Highway Bridge.** The FHWA helped investigate the cause of fatigue cracking on the I-64 bridge that spans the Maury River near Lexington, VA. The case presented a unique problem in that there was some question of whether the structural behavior of the delta frame was correctly predicted by normal analysis techniques. The FHWA installed instrumentation and determined that out-of-plane bending was causing the cracking. An innovative retrofit was designed whereby diaphragms and bracing were removed from the structure. The case demonstrated FHWA's immediate availability to help States work on specific problems.

• **Improved Grouts for Bonded Tendons in Post-Tensioned Bridge Structures.** The adequacy of grout is highly significant in protecting the tendons and applying the prestressing force to resist live loads. This study, completed in FY 1992, developed generic grout mixes that will provide long-term corrosion protection to prestressing tendons and strands. It also developed accelerated corrosion test methods to test the corrosion resistance of new mixes. This study will encourage the development of better grouts, leading to greatly improved corrosion resistance for prestressing tendons and stay cables.

• **Model Bridge Study.** This 8-year study, completed in FY 1992 and cosponsored by FHWA and the American Iron and Steel Institute, evaluated the behavior of a scale model—40 percent the size of a full-scale bridge—of a two-span continuous plate girder bridge. The data indicate that finite element analysis is a very plausible method for computing elastic wheel load girder distribution factors.

Scour Studies

Several scour-related studies were undertaken in FY 1992 aimed at helping avoid catastrophic bridge collapses caused by scour.

- **Strategies for Managing Unknown Bridge Foundations.** Foundation depth is a critical parameter when conducting scour evaluations; however, plans and information on depth and type are not available for many bridges. The report and results from this research provide a strategy for setting priorities and dealing with the risk of not knowing as well as general guidance for determining foundation type and depth of bridges over water.

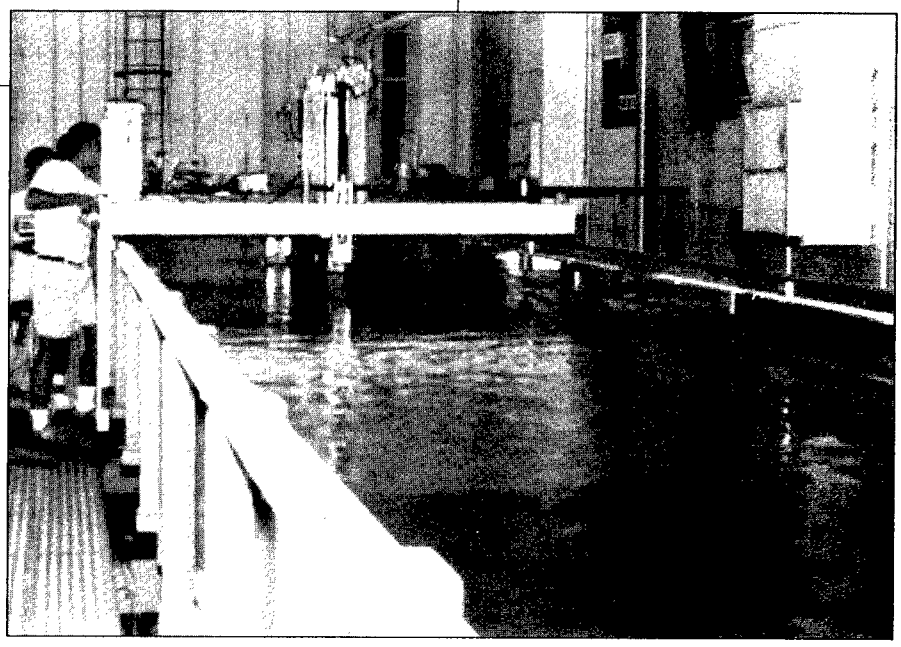
- **Numerical Two-Dimensional Model of Scour Processes.** This project updated a version of a two-dimensional finite element surface water modeling system. Future versions of the model are being developed to include algorithms for scour and sediment transport, alluvial fan flow, and a three-dimensional flow module.

- **Stability of Rock Riprap to Protect Bridge Abutments.** Two laboratory projects developed procedures for sizing riprap to protect bridge abutments located on the floodplain from scour. A design procedure has been prepared for incorporation into FHWA's Hydraulic Engineering Circular (HEC) 18.

- **Alternative Measures for Protecting Bridge Piers From Scour.** This project investigated the use of grout-filled bags, articulated mattresses, and concrete tetrapods to protect against scour at piers.

- **Seismic and Radar Scour Instrumentation.** Using geophysical techniques, methods were developed to detect the interfaces of refilled scour holes.

- **Q-500.** With the Federal Emergency Management Administration and the U.S. Geological Survey, FHWA developed a practical procedure for estimating the 500-year flood for use in assessing bridges for scour vulnerability.



The alternate load factor design method may be able to save 25 to 30 percent of the cost of steel materials and fabrication.

• **Bridge Temporary Works Research Program.** This program was established following the collapse of the Route 198 bridge over the Baltimore-Washington Parkway in 1989. Study outcomes include guidelines and specifications for the design and construction of falsework and formwork used to support bridges as they are being built. These reports will be used by State highway agencies to build safer structures, so collapses like that of Route 198—where nine workmen and five commuters were injured—do not occur.

• **Storm Water Collection and Drainage System Model Tests.** Over 600 physical scale model simulations of a range of pipe, pipe junctions, and manhole combinations were conducted in the Hydraulics Laboratory to represent the free-surface/not-full flow condition used to design storm drains. The results of these simulations have been incorporated into the hydraulic energy grade line routine used to analyze a storm drain system for steady peak flow conditions; they are also slated for inclusion in the storm drain routines of HYDRAIN, FHWA's drainage design software package. Additional laboratory simulations were conducted by a graduate research fellow to evaluate the accuracy of the routines for a network of storm drains. That study showed that the pressure flow routine in HYDRAIN will be significantly improved by incorporating the new junction loss equations.

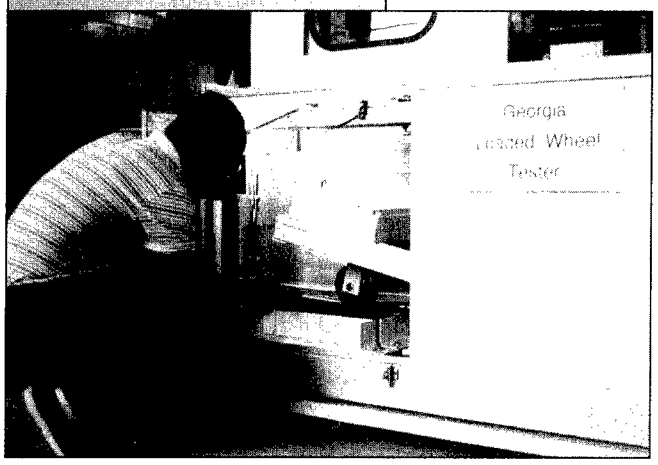
Pavements

• **Recycled Materials in Highway Construction.** This congressionally mandated study—a joint effort between the FHWA and the EPA—is looking at several issues related to the use of recycled paving materials in highway construction. The study's first phase is assessing and summarizing existing information about performance capabilities, health and environmental issues, and the recycling potential of these products. A report will be provided to Congress in June 1993. Phase 2 will be a longer term followup effort to examine some of the unresolved issues identified in the phase 1 report. This portion of the work will focus on an evaluation of various asphalt paving materials containing scrap tire rubber.

• **Validation of SHRP Asphalt Specifications.** An experimental design for using the Pavement Testing Facility to validate proposed SHRP binder specifications was developed. This study will evaluate the effect of asphalt binder on pavement performance in terms of fatigue, permanent deformation, and moisture damage. The study will begin after the PTF improvements are completed and all key issues concerning the binder specifications are resolved.

• **Stone Mastic Asphalt (SMA) Mixtures.** SMA mixtures are used in Europe to decrease the amount of rutting in pavement surface courses. Following a 1990 European Asphalt Study Tour, it was recommended that the FHWA evaluate, promote, and transfer the technology in the United States. Based on these recommendations, a report titled "Stone Mastic Asphalt Mixture Design" was prepared and distributed. Also, two staff studies were initiated to develop mixture performance tests and evaluate various mix stabilizing additives. Final reports for these studies will be issued by the end of 1993.

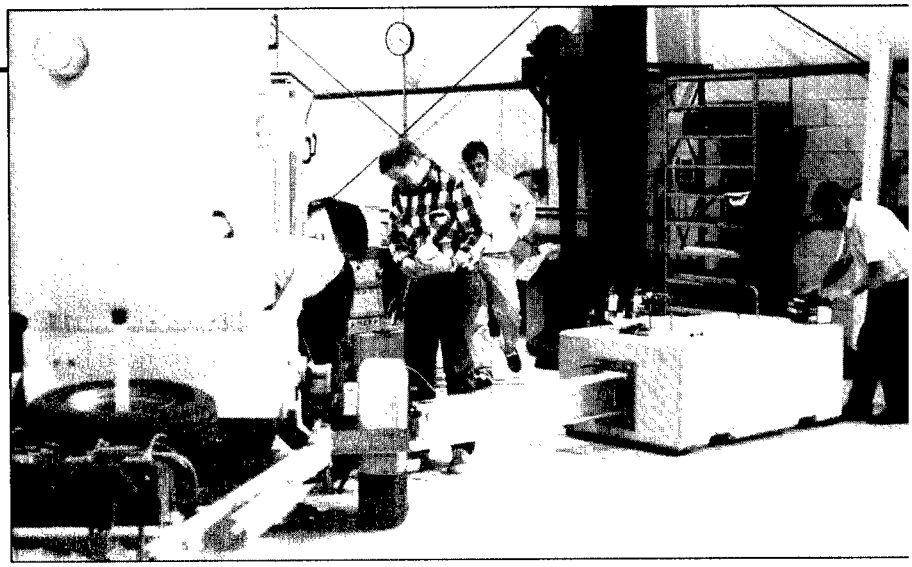
• **Calibration of Marshall Compaction Hammers.** An interagency agreement was finalized with the NIST to develop a practical testing apparatus that can be used to calibrate mechanical hammers used in the Marshall asphalt mix design. This apparatus will help improve the consistency of mix design results, which, in turn, should lead to improved pavement performance. A working model of the testing device and a recommended calibration procedure will be available by the end of 1993.



• **Life-Cycle Cost Models.** A project was initiated to develop a data base that will provide inputs to various life-cycle cost pavement models. This data base should expand the potential of these models and make them more useful for Federal research studies, congressional inquiries, and State pavement programming activities. The data base should be completed by mid-1994.

• **Rock and Mineral Identification.** The R&D guidebook, *Rock and Mineral Identification for Engineers*, was written to enable engineers to make preliminary identification of rocks and minerals in construction aggregate and to provide background information on the engineering properties of various rock types. In addition to use in the NHI Materials Course, this guide is receiving wide distribution to the field.

• **Portland Cement Concrete Pavements.** A series of comprehensive studies was conducted to investigate the design, performance, and rehabilitation of standard and experimental portland cement concrete (PCC) pavements. Theoretical modeling was closely tied to field performance data in order to arrive at realistic evaluations of potential performance of various design/ rehabilitative features. The results of these studies will contribute to improved design/rehab procedures for rigid pavements. Also, a study was conducted on joint sawing practices and early loading of new concrete pavements. Information gained from the study is being used to develop a handbook on these subjects to be distributed to the field by the Office of Technology Applications.



• **Bituminous Mixtures Studies.** A series of studies conducted in the bituminous mixtures lab have made these significant contributions to the state-of-the-practice: methylene chloride was shown to be an acceptable solvent in the Abson recovery method, and guidelines were developed for required use of the supplemental specific gravity procedure. Evaluations were conducted on asphalt-aggregate stripping tests, the performance of sulfur - extended asphalt pavements and the effect of inclusion of deicer chemicals. The effect of chemical modifiers on asphalt mixtures performance continues to be studied.

• **New Pavement Evaluation Equipment.** Recently developed pavement evaluation equipment includes: PRORUT, a van-mounted system for simulation measuring longitudinal profile and rut depth; a van instrumented to measure macrotexture at highway speeds; and ROSAN, a tester for estimating high-speed skid resistance from measurements taken at walking speed.

• **New Concrete Evaluation Tools.** Several new concrete evaluation tools have recently been developed. These include an automated device for measuring the thermal coefficient of expansion of concrete specimens (resulting from an inhouse staff study) and an updated automated image-analysis-based system for the investigation of the air void system in hardened concrete.

Status of the Long-Term Pavement Performance Program

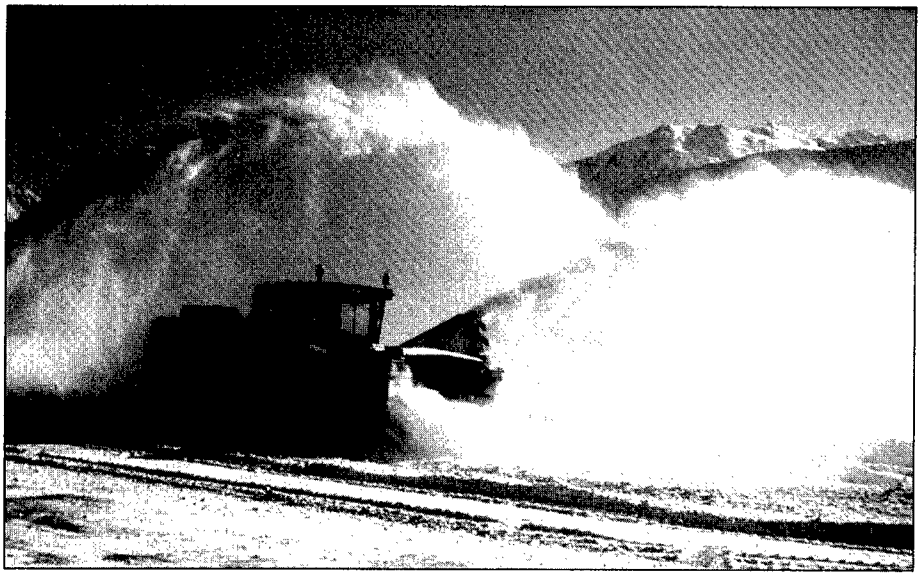
The LTPP program is a 20-year research effort aimed at improving highway engineers' ability to design, build, and manage pavements in a cost-effective fashion. The mechanism for achieving these ends is the LTPP data base, which documents the design and performance of some 2,000 pavement test sections in North America. These sections are either part of LTPP's **general pavement studies (GPS)**, which involve existing pavements, or **specific pavement studies (SPS)**, which involve pavement structures specially constructed to provide information on the efficacy of specific design features.

In FY 1992, continuation of LTPP—a Strategic Highway Research Program effort—was entrusted to the Office of R&D. As part of the transition, six multiyear, multimillion dollar research contracts were awarded—four for data collection and coordination with State partners; one for technical support in planning, managing, and assessing

LTPP research; and one to collect high-resolution pavement distress photographs. Highlights of LTPP Division activities since the transition include the following.

• **Performance Monitoring.** Deflection testing, profile measurement, collection of pavement distress records, etc., continued for the GPS and SPS test sections, as did entry of the resulting data into the national Pavement Performance Data Base.

• **Seasonal Monitoring Program.** The selection of instrumentation for the seasonal monitoring sites was finalized, and procurement of instrumentation began. In this long-awaited program, selected test sections will be instrumented for temperature and moisture and monitored on a monthly basis in order to evaluate seasonal effects. Full project implementation will begin in spring 1993.



• **SPS.** Recruitment of SPS projects continued with the establishment of an incentive program to reimburse highway agencies for some of the expenditures associated with the experiments.

• **Profiling Demonstration.** A demonstration was conducted to help decide on devices to be used in future LTPP profile measurement activities.

• **Pavement Distress Identification Accreditation Workshop.** Thirteen participants successfully completed a 5-day accreditation workshop to perform pavement distress surveys on LTPP experimental sections. This training will help ensure the consistency and reliability of distress data entered in the Pavement Performance Data Base.

Materials

• **Snow and Ice Control.** A congressionally mandated study comparing the full costs of using rock salt versus calcium magnesium acetate (CMA) for highway deicing was completed in FY 1992. Full deicer costs include the initial material cost; storage, application, and handling costs; the cost of corrosion to vehicles and structures; and health factors. Although CMA deicer itself costs significantly more than rock salt per ton and about 50 percent more CMA than salt is required to achieve the same deicing effects, the differences in full costs are much less because CMA is a benign material that does not cause pollution or corrosion. In FY 1993, a large-scale effort will be initiated to find ways to reduce CMA's production costs.

• **Chemically Modified Asphalts.** Staff researchers explored the chemical and engineering properties of several potential polymer modifiers developed to improve conventional asphalt binders. The chemically modified asphalts—especially furfural-modified asphalt—yield better performance over the temperature ranges encountered in pavements, are less prone to stripping away from aggregate in the presence of moisture, and are cost effective.

• **Asphalt Laboratory Waste Disposal.** Guidelines were developed for the States to use in determining how to reduce and dispose of hazardous wastes, particularly used solvents from asphalt extraction tests.

• **Development of Performance-Related Specifications (PRS) for Asphalt Concrete Pavement Construction.** Laboratory relationships were established between several materials and construction variables and fundamental response variables such as resilient modulus and indirect tensile strength. These results were combined with American Association of State Highway and Transportation Officials' (AASHTO's) Design Guide relationships in a conceptual version of PRS for asphalt concrete. An accelerated field test of pavement sections conforming and nonconforming to materials and construction specifications is scheduled for 1993.

• **Design to Reduce Exhaust Emission Impacts to Hospital Over a Highway.** A New York City hospital's decision to use the air rights over busy East Side Drive as the site for a major building addition posed potential highway pollution impacts for the hospital and for area pedestrians. Although the architect and engineers had proposed solutions that included large exhaust fans ventilating through five 11-story chimneys, FHWA staff provided simpler, more cost-effective solutions; pollutant dispersal would be achieved by appropriate placement of vertical walls and platform extensions.

FHWA staff provided simpler, more cost-effective solutions.

• **Evaluation of Test Methods Used to Quantify Sand Shape and Texture.** A paper was presented on this FY 1991 study at the TRB Annual Meeting in January 1992. It described testing done to determine whether and how sand type affects mixture performance in terms of rutting susceptibility. Additional testing is being conducted.

• **Rapid Method for Measuring Chloride Permeability of Concrete.** Ten years after this method was originally developed under an FHWA-sponsored research effort, it was adopted by ASTM (in December 1991) as the new "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration." The test is widely used as a laboratory tool by materials

After this method was originally developed under an FHWA-sponsored research effort, it was adopted by ASTM as the new (standard).

An Invaluable Resource: The Highway Safety Information System

FHWA's Highway Safety Information System (HSIS) combines accident, roadway design, and traffic volume data from Illinois, Maine, Minnesota, Michigan, and Utah for the years 1985 through 1991. These States were selected for inclusion in the HSIS based on the quality of their data, the range of data collected, and the ability to combine the data for location-based analyses. HSIS data are used by FHWA staff, research contractors, and university researchers to investigate current highway safety issues and to evaluate the effectiveness of safety countermeasures.

Several improvements were made to the HSIS in FY 1992. Notably, besides adding the 1990 and 1991 data of the five States, files containing more detailed information on vehicle size and weight characteristics, roadway cross-section data for two-lane rural roads, and interchange design characteristics were added. Major studies completed in 1992 using the HSIS include the relationship of median design and accidents, the characteristics of commercial bus accidents, the effectiveness of current guardrail designs for utility vehicles and vans, and the magnitude of passing accidents on two-lane rural roads. Also, 13 new analysis efforts were initiated.

researchers and by producers of concrete additives such as latex and silica fume. It allows chloride permeability to be measured in 6 hours, replacing the previous standard in which sodium chloride solutions were pooled on the surface of concrete samples for 90 days after which core testing determined how much salt had permeated the concrete.

• **Lead Paint Debris Containment, Treatment, and Disposal.** Protecting workers and the general public from lead is forcing increasingly stringent requirements on contractors and agencies during paint removal from highway structures. Guidelines were assembled for the removal, containment, stabilization, and disposal of lead-containing paints. Design and ventilation criteria for containment structures are included in these guidelines.

• **Powder Coatings as Replacement for Lead Paint.** With paints containing lead compounds or based on solvents containing volatile organic compounds under severe environmental constraints, alternative coating systems are being sought. Electrostatically applied powder coatings are one such alternative, and the best performing coatings have been identified in accelerated corrosion and other test series.

• **Coatings Tolerant of Minimal Surface Preparation.** Another way to minimize lead exposures during lead paint removal is to remove as little of the original paint as possible and to use coatings that tolerate little surface preparation. Moisture-cured polyurethane and nontoxic alkyd systems that perform well over hand- or power tool-cleaned surfaces have been identified.

• **Chemistry of Asphalt and Asphalt-Aggregate Mixes Symposium.** The FHWA organized and chaired this 2-day symposium as part of the 204th American Chemical Society annual meeting. A primary motivation for this symposium was to spread SHRP asphalt-related research results throughout the scientific community. Presentations were made on the new SHRP microstructure model of asphalt from chemical, rheological, and asphalt-aggregate interaction perspectives.

Improving Highway Safety

The United States, with a motor vehicle fatality rate of 1.9 per 100 million vehicle miles (161 million km) of travel, has the safest highways in the world. Nevertheless, by 2000, the projected number of annual highway fatalities will be over 50,000. R&D's highway safety program focuses on reducing accidents and the fatality rate through advanced technology and behavioral research.

Safety Data

• **New Technologies for Accident Data Collection.** A research study evaluated the accident data collection process and identified new technologies for automating it. Laptop and pen-based

computers, identification technologies, form readers, and Global Positioning System receivers are among the new technologies that were identified as having great potential for reducing the cost of accident data collection and improving data quality. A 1993 following contract will conduct a field evaluation of the most promising technologies.

• **Systemwide Accident Analysis Procedure.** A new statistical procedure was developed to assess widespread geographic effects resulting from the use of safety treatments. Step-by-step guidelines were also developed on how to use the procedure to evaluate highway safety studies. The guidelines discuss adequate sample sizes, identifying and correcting regression-to-the-mean problems, and using computerized data analysis procedures.

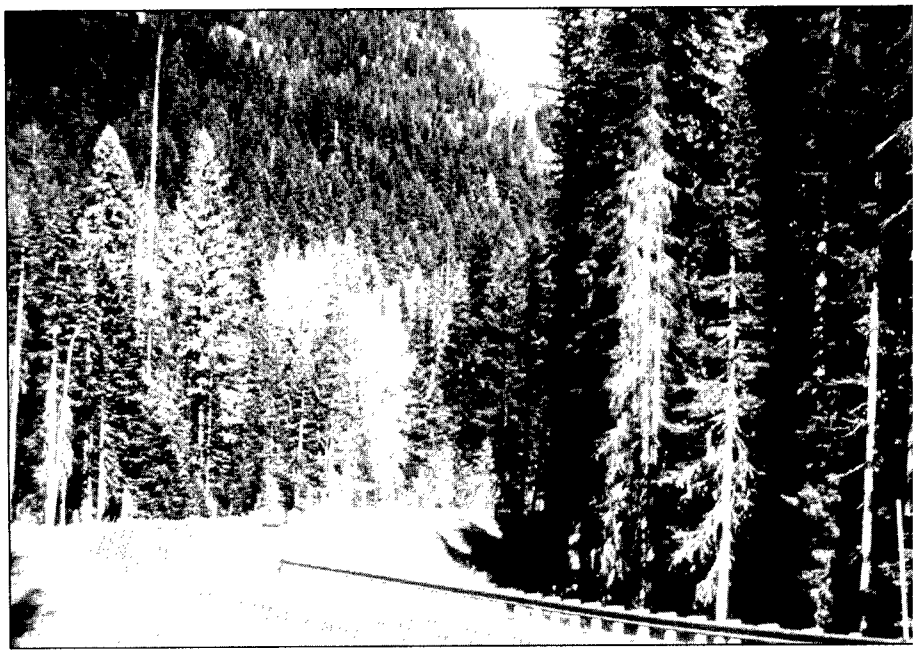
Human Factors

• **Human Factors Research Topics Prioritized.** In April, the TRB held a conference on Human Factors Research Priorities in Highway Safety. The conference's purpose was to develop a national research program addressing driver-related problems in highway safety. Priorities were identified in three major areas: traffic control devices, highway design, and highway capacity and operations. The conference findings are being used to extend the existing high priority older driver human factors research program into additional priority areas such as younger driver safety and driver performance.

• **Human Factors Research Key Priority in IVHS.** In 1992, three distinct but interrelated projects were undertaken to examine the human factors issues associated with four major IVHS areas. The research will be conducted over the next 3 years and will culminate in human factor design guidelines to be used by IVHS designers.

Geometric and Roadside Design

• **Safer Roadside Barriers.** Research into safer roadside barriers has resulted in some new designs. A retrofit bridge rail has been developed that makes it possible to leave old bridge rails in place on historic bridges. Full-scale tests have shown that guardrail/curb combinations can cause vehicles to vault the guardrail. W-beam guardrails have been stiffened by bolting an extra W-beam rail to the



backs of the posts or by adding a C6 x 8.2 channel rub rail. These measures strengthen and stiffen the guardrail, helping to reduce the guardrail deflection that can cause vaulting problems. These stiffer guardrail/curb combinations have passed full-scale crash tests. New composite and recycled materials have been identified for possible use in safety hardware.

• **Safety Effectiveness of Highway Design Features.** Based on a critical review of the literature, the FHWA has documented the most probable relationships between geometric design elements and safety. The areas covered include alignment, cross section, access control, intersections, interchanges, and pedestrians and bicyclists. In a parallel effort, the TRB Committee on Geometric Design is proposing a synthesis of existing practices in similar areas.

• **Testing of Small and Large Sign Supports.** Twenty-seven States are jointly funding and participating in a research study underway at the TFHRC's Federal Outdoor Impact Laboratory (FOIL). This study involves crash testing several State-designed large and small roadside signs and associated support systems for compliance with the AASHTO Standard Specification for Highway Sign, Luminaires, and Traffic Signals (1985) as modified by FHWA. The testing is being conducted to ensure that the roadside signs are "impact safe" or "crashworthy" for occupants of errant, out-of-control, colliding motor vehicles.

• **Composite and Recycled Materials for Roadside Safety Devices.** A 1-day workshop was held on this topic in FY 1992 at the TFHRC. Presentations included a discussion of recent low-temperature materials tests, work done on guardrail blockouts made of recycled tires, and Florida's recycling efforts in response to legislative mandates. Participants also witnessed a full-scale crash test of a guardrail with posts and blockouts made of Rivenite—a mixture of sawdust and recycled mixed plastics.

• **Composite Materials in Transportation Structures.** The FHWA is studying new structural applications for fiber-reinforced composite materials subjected to dynamic loadings. Under a cooperative agreement with Catholic University of America, staff research engineers and graduate research fellows are working at the TFHRC toward the development of roadside safety structures composed partly or entirely of glass fiber-reinforced polymers. Examples of such structures include roadside barriers, crash cushions, signs, and roadway lighting supports. These structures perform specific transportation functions and, at the same time, must be "safe" or

"crashworthy" to vehicle occupants when hit by errant, out-of-control motor vehicles. Efforts to date have focused on a basic understanding of the impact behavior of glass fiber composite materials when subjected to dynamic loadings. Two papers on this subject, including one presented at an international conference, have been published so far, and work on a third is in its initial stages.

• **Computer Simulations for Vehicle Crash and Handling Models.** A planning document has been developed that identifies future upgrading projects to improve FHWA's computer simulations for vehicle crash and handling models. These projects will use state-of-the-art programs and computational tools to update programs that were mostly developed in the late 1970's. It is anticipated that this work will center on and involve improvements to the finite element codes DYNA3D (for crash impact) and NIKE3D (for vehicle handling)—codes originally developed by the Lawrence Livermore National Laboratory (LLNL) over the past 30 years. FHWA, National Highway Traffic Safety Administration (NHTSA), and the TRB Computer Simulation Subcommittee are jointly participating in this effort, which is led by the LLNL.

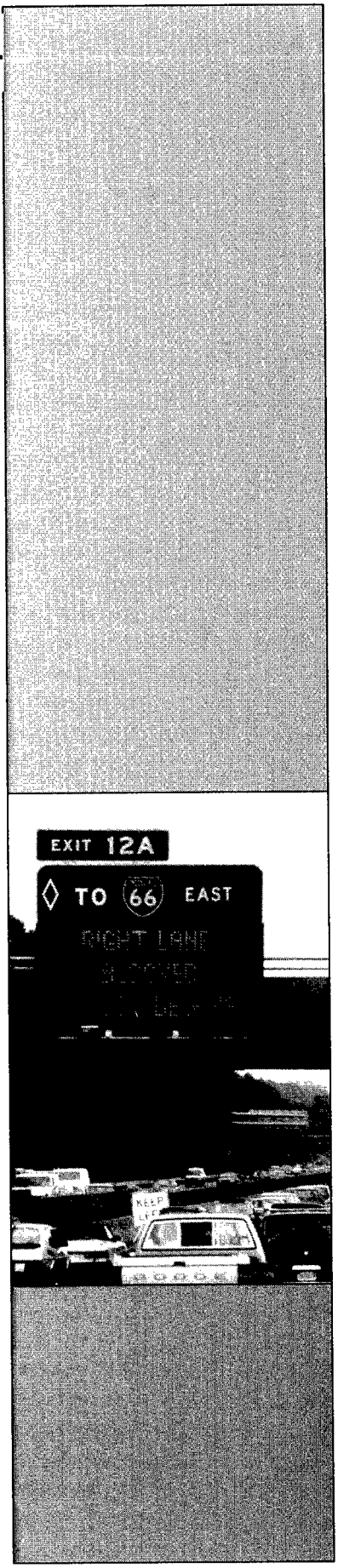
• **Crush Characteristics of Subcompact Automobiles.** Four cars, weighing from 704 kg (1,550 lb) to 817 kg (1,800 lb), were crash-tested at the FOIL to generate data on their frontal impact crush characteristics. The California Department of Transportation is using the data to design a crushable front end for a reusable bogie crash test vehicle currently under development.

• **Minicar Safety.** Although minicars—those weighing less than 680 kg (1,500 lb)—have not yet appeared in the United States in significant numbers, they are prevalent in Europe and Japan. A literature review suggests that the U.S. market potential for minicars is high. Current geometric standards should be adequate to accommodate them. However, the design of some roadside objects, such as guardrails and ditches, may need to be modified to reduce their injury potential.

Traffic Control Devices and Operations

• **Changeable Message Signs.** This study identifies problems in visibility of changeable message signs related to sign size, letter height, stroke width, spacings, letter style, text and background, orientation to the sun, and visibility surround complexity. A second study is developing and testing standard word and symbol messages to be used on changeable message signs for condition-responsive, traffic control, and hazard warnings for use on streets and highways.

• **Environmental Sensor Systems.** This project is examining whether condition-responsive traffic control systems can adequately measure data on reduced visibility conditions (heavy rain, blowing snow, dense fog, and dust storms), pavement conditions (wet and icy), and cross winds. The study will



Research to develop or improve traffic control devices helps to ensure highway safety by enhancing the orderly and predictable movement of all traffic, motorized and nonmotorized, throughout the national transportation system.

specify functional requirements for developing new devices where existing sensor systems are found to be inadequate. If a new system looks promising, a prototype may be developed under this project.

• **Setting Advisory Speeds for Curved Roads.** This Graduate Research Fellowship project evaluated criteria in the *Traffic Control Devices Handbook* for setting advisory speeds for curved roads. The research findings revealed that States are not applying the criteria uniformly; it also found that the criteria do not adequately represent actual traffic speeds around curves.

• **Mobile Sign Retroreflectometer.** A prototype mobile system, the Traffic Sign Evaluator, has been developed to evaluate the nighttime appearance of traffic signs during daylight conditions. During FY 1992, the system was evaluated by the R&D staff and the Michigan Department of Transportation, and several problems were identified and corrected. Further field evaluations are planned for early FY 1993.

• **Pavement Marking Retroreflectometer.** Refinements continue on a prototype mobile pavement marking evaluation system that uses a scanning laser to measure inservice markings under daylight conditions. Field tests have reported good agreement between measurements made by the system and actual nighttime visual observations. The system provides useful information on the replacement status of pavement markings. The first commercial unit, called the LaserLux, was delivered by the developer in late September.

• **New Roadway Lighting Standard.** The Illuminating Engineering Society of North America recently proposed the use of small target visibility as a standard in designing roadway lighting. The FHWA is currently conducting a study to determine if the new design procedure predicts accident probability better than the existing system; this study will be completed by July 1994.

• **Fluorescent Pigments in Traffic Control Devices.** Fluorescent pigments can increase the conspicuity of traffic control devices under daylight condition; however, they have a very short service life. FHWA is conducting research to determine if stable, long-life, and economical fluorescent pigments are available for use in traffic control applications, and—if so—how they should be used.

• **Effects of Stripe Length in Work Zones on Driver Performance.** Two separate studies evaluated the effects of the stripe length used for nonpermanent pavement markings on drivers. One study, conducted as a Graduate Research Fellowship project, used HYSIM, FHWA's highway driving simulator; the other took field measurements from vehicles traveling over a newly paved highway. The slight variations found by the studies in driver speed, lateral placement, distance from lane line, etc., were not statistically significant. Consequently, no reason was found to change the 1.22-m (4-ft) stripe required by the *Manual on Uniform Traffic Control Devices.*

Moving Goods Efficiently

Most of the FHWA's research and technology projects involving commercial vehicles and their movement of goods are spearheaded by the Office of Motor Carriers. Notably, R&D sponsors investigations into the effects of trucks on highway pavement. Additionally, R&D projects are examining potential applications of advanced technologies to increase truck safety and efficiency.

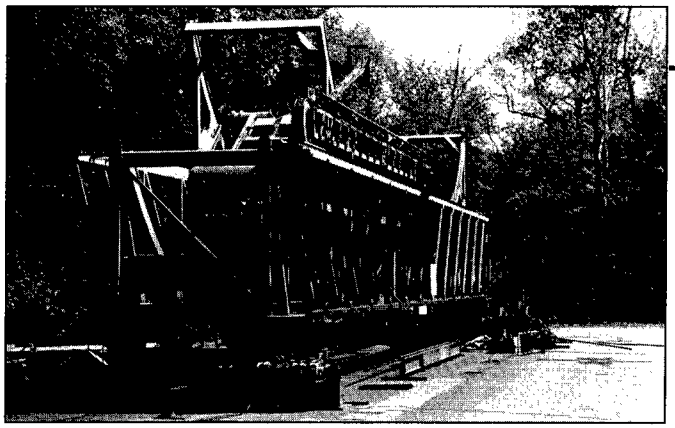
Truck-Pavement Interaction

• **Load Equivalence Workshops.** A February 1992 workshop, "Mathematical Modeling of Rigid Pavements," was the first in a series of load equivalence workshops to be held as part of the Truck-Pavement Interaction research program. About 20 experts from around the country exchanged information on the state of the art in rigid pavement analysis.

• **Truck-Pavement Interactions.** In FY 1992, R&D staff shared information on goals, applications, and findings from the ongoing Truck-Pavement Interaction research program. For example, presentations were made at the Third International Heavy Vehicle Weights and Dimensions symposium and at Ohio University.

• **Weigh-in-Motion Experiments.** R&D sponsored a series of experiments at a Kentucky truck weigh site to determine the effects of shear forces exerted on pavements by heavy truck axles during braking and acceleration. The project's final report analyzed the pavement-damaging effects attributable to changes in axle load levels and fifth wheel locations.

• **Wide-Based Single Tire Research.** Wide-based single tires offer truckers increased productivity through reduced fuel consumption, and these tires have also been shown to enhance rollover stability in some cases. However, highway officials fear that the tires can cause increased damage to pavements. In fact, several Western States are considering regulations to limit wide-based single tire loadings to 204 kg (450 lb) per inch of gross tire width. For a typical 385 mm (15 in) wide-based single, this would reduce the allowable tandem load by 21 percent and the allowable single load by 30 percent.



Using the PTF and the ALF, the FHWA conducted a major research effort to study pavement damage caused by wide-based single tires. The findings support the load limits that have been proposed. For the same load and tire pressure, the wide-based single tire that is most comparable to the most common dual radial tires caused significantly more damage to the conventional flexible pavements tested at the facilities. R&D researchers have publicized their results at several national and international forums.

Other Truck-Related Studies

• **Load Prediction and Structural Response.** Contracted by the FHWA, the University of Colorado completed this study in FY 1992. The university monitored truck traffic on freeway bridges to determine critical load patterns. For the first time ever, weigh-in-motion data was collected on three-lane directional bridges. The TFHRC will use the results of this study to improve the design specs for structures that will allow the highway community to build safer and more cost-effective bridges.

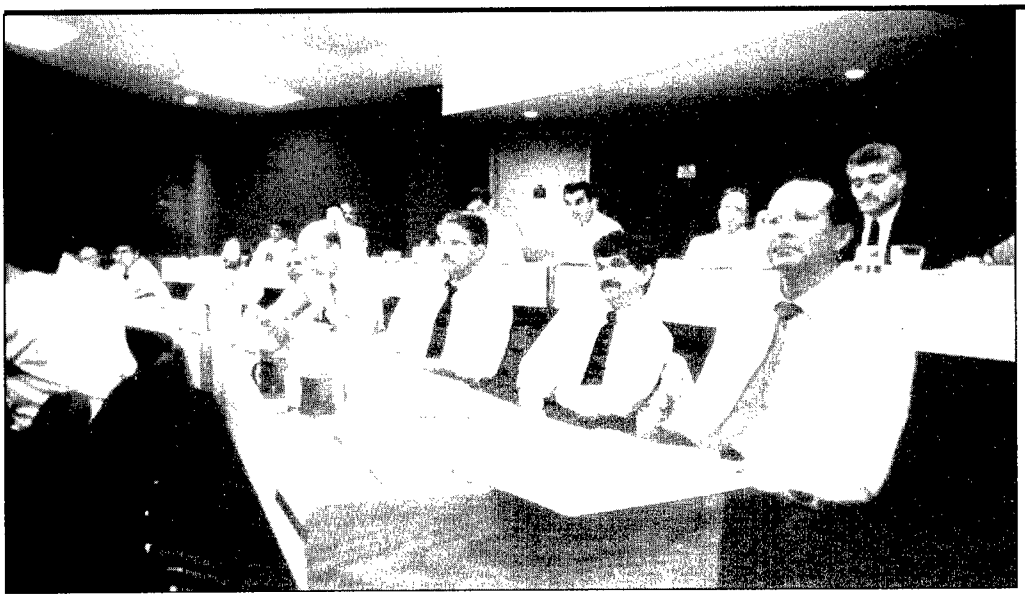
• **IVHS Technologies and Truck Safety.** Through an interagency agreement between the FHWA and the Department of Energy, researchers at Sandia National Laboratories are exploring the feasibility of applying IVHS technologies to automate the truck inspection process, improve the safety of transporting hazardous materials, and provide truck-specific warning information at hazardous locations. Concepts that are potentially viable will be developed under this agreement or elsewhere into prototypes for testing.

• **Feasibility of a Truck Warning System.** This study determined the feasibility of installing a truck warning system on three Capital Beltway ramps in Maryland and Virginia. Prototype systems were designed for the ramps. The systems contain detectors to measure the speed, weight, and height of approaching vehicles. An algorithm then determines if a truck is traveling too fast for the ramp curve. If so, a fiber optic blank-out sign displays the message "Trucks reduce speed."

With the feasibility study completed, the Maryland State Highway Administration and the Virginia DOT will install the three ramp systems by spring of 1993 to improve highway truck safety.

Opening a Dialogue With the Trucking Industry

The issue of wide-based single tires is still unresolved; it may, however, have helped open the lines of communication between the trucking industry and the highway community. To this end, members of R&D's Pavements Division continue to participate in meetings and conferences with the U.S. trucking industry, presenting research findings and discussing concerns. By working together, the industry and highway engineers may prevent situations like the wide-based tire controversy. An example is the meeting initiated by the Motor Vehicle Manufacturing Association and the Highway Users Federation and held at TFHRC to discuss common interface issues.



NHI Training

For the FHWA's technical training arm, the NHI, FY 1992 was a busy, successful year.

• Passage of the ISTEA legislation and the President's National Transportation Policy challenged NHI to meet the training needs of the entire transportation community, rather than being limited to its original target audience of the FHWA and State and local highway agencies.

• The NHI was reorganized to better align its structure with its program responsibilities.

For more information on the NHI reorganization, see page 5. *[Organization section]*

• At the TFHRC and around the country, the NHI offered 462 course sessions; these were attended by more than 14,300 students. The number of NHI course presentations in FY 1992 represented almost a 10-percent increase over the previous year's offerings.

New and Revised NHI Courses

The NHI 1992 course catalog includes descriptions of 95 different courses. During FY 1992, NHI updated the curriculum material for several of these; also, several new courses were developed with input from FHWA technical experts and contractors. These new courses, listed below, incorporate state-of-the-art technology and present the latest and best information available on their respective topics:

• Practical Conflict Management: Skills to Resolve Highway/Wetland Issues (#14231).

• HYDRAIN: Integrated Drainage Design Computer System (#13057).

• Application of Geographic Information Systems for Transportation (#15129).

• Corridor Preservation for Technical Staff (#15130).

• 1990 Census Transportation Planning Package Applications (#15131).

• On the Road to Equality: Women in Highway Construction (#36119).

• Marketing Highway Technology (#42015).

• Materials Control and Acceptance - Quality Assurance (#13442).

• TRAF-NETSIM Training Course (#13356).

The NHI has proposed 30 new courses for development in FY 1993.

Many of these new courses reflect FY1992 FHWA research achievements—e.g., the HYDRAIN course (see page 25) and the TRAF-NETSIM course (see page 20). *[See Structures section and ATMS section]*

Looking to the Future

These courses are expected to result in an overall saving of training dollars, more uniform training, and—ultimately—higher quality (results).

• **Serving the Private Sector.** ISTEA expanded NHI's mission to include the development and delivery of training programs for employees of private sector organizations involved in highway transportation. Consequently, NHI staff members are serving on two joint AASHTO-FHWA-industry task forces to coordinate the development of new courses on asphalt and portland cement concrete pavement placement. These courses are expected to result in an overall saving of training dollars, more uniform training, and—ultimately—higher quality pavements.

• **Meeting Training Needs.** The NHI has proposed 30 new courses for development in FY 1993. To ensure that these courses will meet field training needs—and to obtain States' comments on new course choices, content, audience, delivery method, etc.—the Institute convened a panel of State training representatives to review and comment on course development priorities. The NHI plans to expand and rotate panel membership in future years.

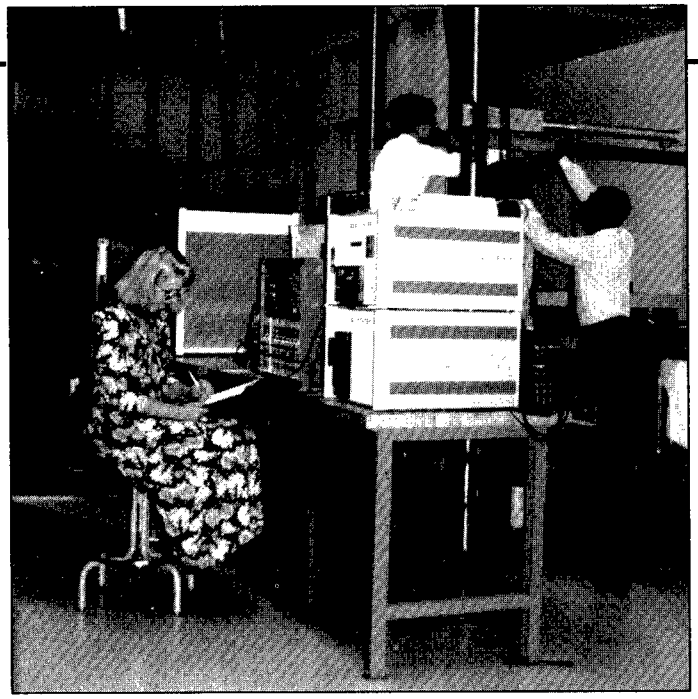
• **Exploiting Technology.** Electronic technologies can reach larger audiences than can traditional classroom training. Under its Visiting Staff Program, the NHI this year initiated special studies to examine field acceptance of electronic classrooms, the viability of expert systems and videodisc technology in basic training and skills upgrading, and the role of satellite-transmitted training programs for the highway community.

Other Activities

Eisenhower Transportation Fellowship Program

In 1992, the NHI was delegated responsibility for administering this new, congressionally mandated, fellowship program for the entire DOT. The program's four components are designed to upgrade the educational level of the U.S. transportation community by awarding research grants as follows:

• **Faculty Fellows.** This component provides fellowships to top transportation researchers in academia. Recipients are given the opportunity to pursue and upgrade their research in a



DOT facility. The first such award was made this past year to Professor Dah-Yinn Lee of Iowa State University. Dr. Lee is a world-renowned expert on asphaltic materials, and is providing his expertise to the FHWA Pavements Division during his year-long fellowship.

• **Eisenhower Historically Black Colleges and Universities (HBCU) Fellowships.** These fellowships target students at the Nation's historically black colleges and universities. Starting up in FY 1992, this program encourages promising students to pursue careers in the transportation field. The FHWA HBCU Task Force has currently selected nine colleges to be recipients of a $50,000 fellowship. Each school will administer its own program and make student selections.

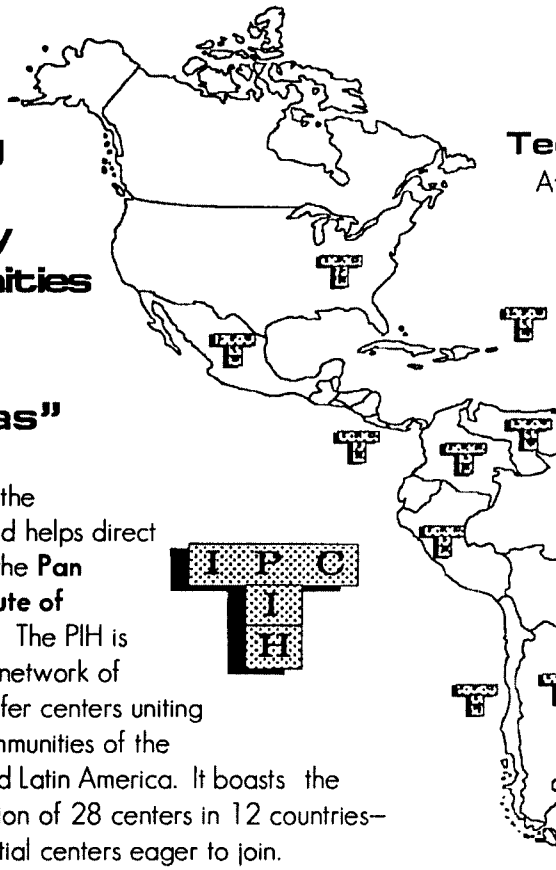
For FY 1992, the NHI disbursed $24,000 to eight of the nine schools to cover initial program start-up costs. Because South Carolina State had previously developed a mechanism to start up the program, it was the only school of the nine that was able to have the program in place by the end of FY 1992 and thus received $4,000 in start-up costs and an additional $93,000 for 17 fellowships and one faculty advisor. All schools are expected to have the program in place by FY 1993.

• **Grants for Research Fellowships.** This component provides fellowships to undergraduate and graduate students, who are nominated for participation by their universities. Awards are based on the quality of the research proposals made by the nominees. Fellows receive a stipend and tuition support, as well as course credit for their project. In 1992, nearly $1 million was awarded for 27 students to perform 27 projects. The students came from 17 different universities.

• **Graduate Fellowships.** These fellowships are intended for transportation professionals and students who plan to enter the profession upon graduation. Fellows will receive full tuition, fees and a stipend to cover a 24-(master's degree students) or 36-month period (doctoral degree students).

Given its recency, the Eisenhower Program was not fully operational in FY 1992. Grants were awarded in some categories, and brochures and program announcements were developed and distributed. FY 1993 funding for the program will be $2 million, which is expected to cover 150 fellows.

Pan American Institute of Highways



"Serving the Highway Communities of the Americas"

The NHI houses the headquarters and helps direct the activities of the **Pan American Institute of Highways** (PIH). The PIH is an international network of technology transfer centers uniting the highway communities of the United States and Latin America. It boasts the active participation of 28 centers in 12 countries–with more potential centers eager to join.

PIH Annual Meeting

Representatives of these centers, the World Bank, the International Road Federation, the Permanent International Association for Road Congresses, the Institute of Transportation Engineers, and some 40 other organizations met this past summer in Mexico at the first annual PIH meeting. Participants learned about each others' technology transfer activities, and made plans for the coming year.

Technology Transfer

At the annual meeting, the PIH advisory committee suggested that a course catalog would be a tremendous aid in fostering technology exchange. As a result, the first PIH course catalog was prepared in FY 1992 and published in October 1992. It includes over 100 courses from 17 centers in 10 countries, and, more importantly there is a firm commitment from all of the centers to share these courses, professors, and materials.

Over the past year, courses have been presented in Argentina, Bolivia, Chile, Columbia, Costa Rica, Honduras, Mexico, Peru, Uruguay, and Venzuela.

Loaned Staff Program

Member centers are encouraged to loan professionals to other PIH centers. During FY 1992, NHI hosted three loaned staff in its office as well as having three other visiting staff in the Safety office, Eastern Federal Lands Division and Arizona State University. At the end of their assignments, these professionals will return to their countries as experts in their fields. The program has been remarkably successful to date.

Publications 1992

Office of Safety and Traffic Operations R&D

Intelligent Vehicle-Highway Systems Research Division

RD-91-075 INFORM Evaluation, Volume I: Technical Report, PB92-177260/AS, A08

RD-91-076 INFORM Evaluation, Volume II: Executive Summary, PB92-177757, A03

Design Concepts Research Division

RD-90-021 Cost-Effective Geometric Improvements for Safety Upgrading of Horizontal Curves

RD-91-042 Ramp Signing for Trucks, PB92-204254, A06

RD-91-044 Safety Effectiveness of Highway Design Features, Volume I: Access Control

RD-91-045 Safety Effectiveness of Highway Design Features, Volume II: Alignment

RD-91-046 Safety Effectiveness of Highway Design Features, Volume III: Cross Sections

RD-91-047 Safety Effectiveness of Highway Design Features, Volume IV: Interchanges

RD-91-048 Safety Effectiveness of Highway Design Features, Volume V: Intersections

RD-91-049 Safety Effectiveness of Highway Design Features, Volume VI: Pedestrians and Bicyclists

RD-91-065 Evaluation of Improvements to Breakaway Cable Terminal

RD-91-088 Side Impact Crash Testing: Thirty MPH Side Impact of a Dodge Colt and an ESV Luminaire Support, PB92-174846, A03

RD-92-032 Side Impact Crash Testing: Thirty MPH Side Impact of a Honda Civic and an ESV Luminaire Support, Test Number 91S003, PB92-185206, A03

RD-92-033 Side Impact Crash Testing: Twenty MPH Side Impact of a Plymouth Colt and an Ameron Slipbase Luminaire Support, Test Number 91S004, PB92-185214, A03

RD-92-034 Side Impact Crash Testing: Forty MPH Side Impact of a Dodge Colt and an ESV Luminaire Support, Test Number 91S005, PB92-185222, A03

RD-92-035 Side Impact Crash Testing: Twenty MPH Side Impact of a Dodge Colt and a Slipbase Luminaire Support, PB92-185230, A01

RD-92-036 Side Impact Crash Testing: Forty MPH Side Impact of a Dodge Colt and an Ameron Slipbase Luminaire Support, Test Number 91S007, PB92-185248, A01

RD-92-047 Side Impact Crash Testing of a Honda Civic SI and a Breakaway Cable Terminal, PB92-174838, A03

RD-92-048 Side Impact Crash Testing of a Honda Civic SI and a Breakaway Cable Terminal, PB92-177211/AS, A03

RD-92-051 Side Impact Crash Testing: Thirty MPH Side Impact of a Honda Civic SI and a Modified Eccentric Loader Breakaway Cable Terminal, PB92-174853, A03

RD-92-052 Side Impact Crash Testing: Thirty MPH Side Impact of a Honda Civic and a Modified Eccentric Loader Terminal Enhanced for a Side Impact (MELT-SI), PB92-177203/AS, A03

RD-92-053 Side Impact Crash Testing: Twenty MPH Frontal Impact of a Volkswagen Rabbit and an ESV Luminaire Support, PB92-174861, A03

Information and Behavioral Systems Division

RD-90-101 Service Life of Retroreflective Traffic Signs, PB92-162163, A06

RD-91-078 Study Designs for Passing Sight Distance Requirements, PB92-205525, A02

RD-92-007 Non-Permanent Pavement Markings in Work Zones, PB92-185172, A07

RD-92-049A Systemwide Methodology for Evaluating Highway Safety Studies

Office of Engineering and Highway Operations R&D

Structures Division

RD-90-065 Model Bridge Study, Volume I: Summary Report, PB93-124030, A08

HI-92-043 Minimum Allocation

Calculation Example

HI-92-044 Highway Program Financing—Agenda

HI-92-045 Federal-Aid Highway Program Categories With New Authorizations Available

HI-92-046 Hazardous Waste: Impacts on Highway Project Development—Case Studies

HI-92-047 DOT and Related Agencies Appropriations Act, 1992—Public Law 102-143

HI-92-048 Highway Program Financing; Selected Course Visuals

HI-92-049 1990 Census Transportation Planning Package Application: Participant Workbook

HI-92-050 Vessel Collision Design of Highway Bridges: Participant Notebook

HI-92-051 Dwight David Eisenhower Transportation Fellowship Program: 1993 Graduate Fellowship Announcement

HI-92-053 Research Program Management: Participant Notebook

Office of R&D

Operations and Support

RD-91-040 Turner-Fairbank Highway Research Center—Expertise and Facilities to Advance Transportation Technology into the 21st Century

RD-91-081 Nationally Coordinated Program of Highway Research, Development, and Technology, Annual Progress Report, FY 1991

RD-91-098 Research and Development Annual Report 1991

RD-92-005 FHWA 2000 Consensus Team Report on the Development of FHWA's Vision, Mission, Values, and Goals

RD-92-009 Research & Technology Transporter, October 1991

RD-92-010 Research & Technology Transporter, November 1991

RD-92-011 Research & Technology Transporter, December 1991

RD-92-012 Research & Technology Transporter, January 1992

RD-92-013 Research & Technology Transporter, February 1992

RD-92-014 Research & Technology Transporter, March 1992

RD-92-015 Research & Technology Transporter, April 1992

RD-92-016 Research & Technology

Transporter, May 1992

RD-92-017 Research & Technology Transporter, June 1992

RD-92-018 Research & Technology Transporter, July 1992

RD-92-019 Research & Technology Transporter, August 1992

RD-92-020 Research & Technology Transporter, September 1992

RD-92-023 Public Roads, A Journal of Highway Research and Development, Volume 55, Number 3, December 1991

RD-92-024 Public Roads, A Journal of Highway Research and Development, Volume 55, Number 4, March 1992

RD-92-025 Public Roads, A Journal of Highway Research and Development, Volume 56, Number 1, June 1992

RD-92-026 Public Roads, A Journal of Highway Research and Development, Volume 56, Number 2, September 1992

RD-92-038 TFHRC WAN/LAN Systems Administrator Manual

RD-92-039 TFHRC Local Area Network User Guide

RD-92-050 SI (Modern Metric) Conversion Factors

RD-92-076 Turner-Fairbank Highway Research Center Directory, July 1992

RD-92-081 Research and Technology Program 1993-1997

List of Acronyms

ACI	American Concrete Institute
AASHTO	American Association of State Highway and Transportation Officials
ALF	Accelerated Loading Facility
ASTM	American Society for Testing and Materials
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVCS	Automatic Vehicle Control Systems
BFRL	NIST's Building and Fire Research Laboratory
CMA	Calcium Magnesium Acetate
CRADA	Cooperative Research and Development Agreement
CORFLO	(An integrated traffic simulations system)
CVO	Commercial Vehicle Operations
DOT	Department of Transportation
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FOIL	Federal Outdoor Impact Laboratory
FRESIM	Freeway Simulation Model
GPS	General Pavement Studies
HBCU	Historically Black Colleges and Universities
HITEC	Highway Innovative Technology Evaluation Center
HSIS	Highway Safety Information System
HYDRAIN	(FHWA's drainage design software package)
HYSIM	Highway Driving Simulator
IDEA	Innovations Deserving Exploratory Analysis
INTRAS	(a freeway simulation model)
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
IVHS	Intelligent Vehicle-Highway Systems
LLNL	Lawrence Livermore National Laboratory
LTPP	Long-Term Pavement Performance Program
NETSIM	Network of Signalized Intersections Simulation
NHI	National Highway Institute
NHTSA	National Highway Traffic Safety Administration
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
OECD	Organisation for Economic Co -operation and Development
PATH	(California) Partners for Advanced Transit in Highways
PCC	Portland Cement Concrete
PIH	Pan American Institute of Highways
PRS	Performance-Related Specifications
PTF	Pavement Testing Facility
R&D	Research and Development
R&T	Research and Technology
RTCC	Research and Technology Coordinating Committee
SBIR	Small Business Innovation Research Program
SCA	Subsidiary Communications Authority
SHRP	Strategic Highway Research Program
SMA	Stone Mastic Asphalt
SP&R	State Planning and Research Program
SPS	Specific Pavement Studies
TFHRC	Turner-Fairbank Highway Research Center
TRAFEdit	(an interactive data entry program)
TRAF-NETSIM	(simulation model for analyzing traffic control strategies and geometric configuration for grid networks)
TRB	Transportation Research Board

Publication No. FHWA-RD-93-019
HRD-10/12-92(6M)EW