# CHAPTER 10

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10.2 Strategic Highway Research Program (SHRP), Information Clearinghouse, July 22, 1994.

10.3 Strategic Highway Research Program (SHRP)

- Implementation Plan for SHRP Products, June 3, 1993.
- SHRP Products Implementation Plan, November 22, 1993.
- Asphalt Research Output and Implementation Program, September 1993.

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# CHAPTER 10

# STRATEGIC HIGHWAY RESEARCH PROGRAM

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*STATUS REPORT*

# Strategic Highway Research Program Product Implementation

December 1995

U.S. Department of Transportation
Federal Highway Administration

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# FOREWORD

The Strategic Highway Research Program (SHRP) was conceived and funded by State highway departments as a means of developing new technologies for designing and maintaining longer-lasting, safer roadways. During the 5-year program, experts in materials, construction, maintenance, traffic operations, and other areas focused on developing better ways of building and maintaining roads and bridges.

The research program ended in 1993. Since then, the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the Transportation Research Board (TRB) have been working with highway agencies and industry on the implementation of SHRP products. This Status Report, which is published periodically, summarizes the activities and projects currently under way for implementing the products of the Strategic Highway Research Program.

If you are familiar with the SHRP technologies and have followed the development of the implementation activities, the information in the Status Report gets right to the heart of the subject. However, if you are not quite so familiar with the subject, the Status Report may actually generate more questions. In those cases where the "bridge" is not complete, we encourage you to pick up the telephone and contact the chairman or secretary of the appropriate technical working group for additional information.

The strategic plan for SHRP implementation is described in the *Implementation Plan—SHRP Products* (June 1993, FHWA-SA-93-054). The plan describes the internal and external organizational structure, partners and partnerships, purposes, roles, and the implementation mechanisms and support functions that are used to accomplish the program. The plan provides the framework under which the partnerships function in developing the detailed product implementation plans.

FHWA provides several sources of information and assistance with SHRP products, including the following:

- Pooled-fund purchases of new test equipment.
- Test and evaluation projects.
- Training, equipment demonstrations, workshops, and exhibits.
- SHRP Information Clearinghouse, a computerized, on-line source of information on FHWA's SHRP implementation activities.
- *Focus*, a monthly newsletter reporting on State, Federal, and industry initiatives for implementing SHRP products.

## Technical Working Group Contacts

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### *Highway Operations*

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Jesse Story (Pavement and Winter Maintenance), Office of Engineering, 202-366-1552 (fax: 202-366-9981; email: jstory@intergate.dot.gov).

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### *Concrete and Structures*

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Assisting in the development of the overall strategy for SHRP implementation is the Transportation Research Board's SHRP Committee. The committee, composed of top-level managers from industry, State highway agencies, academia, and FHWA, provides oversight to the long-term pavement performance studies and serves as a sounding board for ideas for overcoming institutional barriers to SHRP implementation.

Each State and FHWA regional and division office has designated a SHRP implementation coordinator. So that these coordinators can benefit from each others' experiences, FHWA holds a coordinators meeting each January in Washington, D.C.

The technical working groups and their subgroups, known as expert task groups, are key players in shaping the scope, structure, and content of the SHRP implementation program.

The AASHTO Task Force on SHRP Implementation, chaired by Bobbie Templeton of the Texas Department of Transportation, provides coordination and guidance to States in implementing SHRP products.

With local governments responsible for more than 70 percent of our Nation's roads and streets, local highway organizations are prime candidates for implementing SHRP products. FHWA has contracted with Hibbs Highway Engineering Services to assist the Local Technical Assistance Program (LTAP) centers with the delivery of SHRP products to local governments. Toward that end, Hibbs provides the LTAP centers with news articles, technical materials, product exhibits, loaner equipment, and training packages geared to the needs of local highway agencies.

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***Long-Term Pavement Performance***

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## Overall Coordination

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To obtain a copy of the software program needed to access the SHRP Information Clearinghouse, contact Mark Bradley at Tonya (telephone: 202-289-8108; fax: 202-289-8107).

To be added to the *Focus* mailing list, contact Lisa Pope at Harrington-Hughes & Associates (telephone: 202-347-1448; fax 202-347-6938).

# Asphalt *UPDATE*

FHWA continues its outreach program to inform the highway community about the Superpave system, which was the primary product of the SHRP asphalt research program.

A new **brochure**, "The Superpave System: New Tools for Designing and Building More Durable Asphalt Pavements," provides an overview of the Superpave system and a list of resources for additional information. The brochure (Publication Number FHWA-SA-96-010) is available from FHWA's Reports Distribution Center (telephone: 703-285-2144, fax: 703-285-2919).

The Superpave system was also the theme of the October 1995 issue of the ***Asphalt Contractor***. FHWA provided several articles for the issue:

- User-Producer Groups Set the Stage for Superpave
- Team Refining Superpave Software
- States Move Forward on Superpave
- Superpave Straight Talk
- Superpave Travels a Rocky Road to Implementation

A new **videotape** on the Superpave volumetric mix design procedures, produced jointly by FHWA and the National Asphalt Pavement Association, will be available in January 1996.

Superpave was very much on the agenda of the recent annual meeting of the American Association of State Highway and Transportation Officials. Augmenting the many presentations and committee meetings on Superpave was FHWA's mobile Superpave laboratory, which was parked outside the meeting site to allow participants a hands-on look at the new test devices.

## Binder Test Equipment

Testing asphalt binders for conformance with the Superpave binder specification requires five principal pieces of equipment:

- Pressure aging vessel, to simulate in-service aging of the binder;
- Rotational viscometer, to determine the flow characteristics of the binder;
- Bending beam rheometer, to measure the binder's low-temperature stiffness;

### Superpave

The Superpave (Superior *Performing* Asphalt *Pave*ments) mix design and analysis system is a significant advancement in hot-mix asphalt pavement design. By taking into account climatic conditions and projected traffic loads, the system allows highway departments and contractors to create pavements that will better resist rutting and cracking and that will last longer.

State highway agencies, roadbuilders, suppliers, and others in the highway industry are in the process of acquiring and learning how to use the battery of new test equipment required for Superpave mixes. This section highlights the progress made by both States and industry in reaching the two target dates for Superpave implementation: adoption of the Superpave binder specification by 1997, and full-scale use of Superpave volumetric mix design by 2000.

Since 1992, FHWA has been providing technical assistance, support, and training in the use of the Superpave system. Those activities are expected to continue until 2000.

- Dynamic shear rheometer, to measure the binder's stiffness and phase angle at intermediate and high temperatures;
- Direct tension tester, to measure the low-temperature tensile and fracture properties.

All **States now have** the pressure aging vessel, rotational viscometer, bending beam rheometer, and dynamic shear rheometer. These devices were obtained through a pooled-fund purchase coordinated by FHWA.

In addition, FHWA has **loaned a full set** of the binder test equipment to each of the five regional asphalt user-producer groups. This equipment will be used both for training engineers and technicians and for testing asphalt binder samples provided by State departments of transportation and others.

The prototype for the third generation of the **direct tension tester**, the final piece of necessary binder equipment, is currently undergoing testing and evaluation at FHWA's Turner-Fairbank Highway Research Center (TFHRC). Once this evaluation is complete and necessary changes have been made, FHWA will purchase up to five additional units and loan them to the regional user-producer groups (UPGs) for ruggedness testing. The pooled-fund procurement for the States is expected to begin in late 1996.

## Superpave Volumetric Mix Design

The Superpave mix design system is based on volumetric proportioning of the asphalt and aggregate materials and laboratory compaction of trial mixes using the **Superpave gyratory compactor**. All 50 States, as well as Puerto Rico and the District of Columbia, have received the Superpave gyratory compactor as part of the pooled-fund purchase.

The Superpave system also includes mix analysis procedures for predicting how well a mix will perform in the field. These procedures are intended for mixes that will be placed in pavements with very high traffic volumes and loads. Two new, sophisticated pieces of laboratory equipment—the Superpave shear tester and the indirect tensile tester—provide the data needed for the performance models.

A prototype of the **Superpave shear tester** is currently being evaluated at the TFHRC and by the five Superpave regional centers (Alabama, Indiana, Pennsylvania, Nevada, and Texas). Because of the high cost and complexity of the device, highway agencies and contractors have expressed interest in a simplified version that would perform only the shear test (no ancillary tests) and would not require a pressure chamber. Once the evaluation of the full-scale Superpave shear tester is complete,

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FHWA will look into developing a simplified, less costly version.

The first-article **indirect tensile tester** was delivered to the TFHRC in July 1995. It is now undergoing testing and evaluation.

## Training Programs

Since 1993, the **Asphalt Institute** has, under contract with FHWA, offered Superpave training courses and technical assistance to State departments of transportation, paving contractors, asphalt suppliers, and others. The Institute's National Asphalt Training Center, located in Lexington, Kentucky, has held sixteen 1-week courses in **binder testing**, drawing 290 participants. The center has also taught fourteen 1-week courses in mix design to 275 engineers and technicians.

FHWA recently awarded the Asphalt Institute a contract for the second phase of Superpave training. Over the next 3 years, the National Asphalt Training Center will provide additional laboratory training in the areas of **mix design and pavement performance prediction**. The center will also work with the Superpave regional centers to provide local on-site training, technical assistance, and workshops.

Two **training manuals** developed for the courses, *Superpave Performance-Graded Asphalt Binder Specification and Testing* (Publication No. SP-1) and *Superpave Level 1 Mix Design* (Publication No. SP-2), are available from the Asphalt Institute.

## Mobile Asphalt Laboratories

FHWA now has two mobile asphalt laboratories. The laboratories are staffed with skilled technicians who provide assistance and training in Superpave **volumetric mix design and quality control/quality assurance** at construction sites across the country. The mobile laboratories are each equipped with a Superpave gyratory compactor and are used to demonstrate the principles of Superpave volumetric mix design.

This year, the labs have provided assistance at a dozen job sites, including an extended evaluation at FHWA's new test track, WesTrack.

**For more information on training programs, contact the Asphalt Institute's National Asphalt Training Center:**
**Telephone: 606-288-4964**
**Fax: 606-288-4999**

## Superpave Software

The Superpave software and performance models are currently being refined in response to evaluations by FHWA and its contractors, as well as a select group of field testers.

The **first version** of the software will be demonstrated at

FHWA's technology fair of SHRP products, which will be held in conjunction with the Transportation Research Board annual meeting in Washington, D.C., in January 1996.

FHWA has contracted with the University of Maryland to refine and manage the software, particularly the performance models.

## Test Tracks

The Superpave system is currently being tested and validated through a variety of experimental projects. These include the new WesTrack facility, located at the Nevada Automotive Test Center. The track features 26 hot-mix asphalt pavement test sections. The performance of the various test sections will be evaluated against the Superpave performance prediction models.

FHWA is also collecting performance data, using two accelerated loading facility machines at the TFHRC, to validate the Superpave asphalt binder and mixture specifications.

## Regional Coordination and Training

The asphalt user-producer groups continue to play a key role in developing and facilitating the implementation of the Superpave system. They have outlined a sensible, well-planned strategy for adopting the Superpave system on a regional basis.

Superpave centers have been established in each of the five asphalt user-producer group regions. The centers, operated jointly by universities and State departments of transportation, will conduct a thorough and coordinated shakedown of the procedures used with the Superpave shear test and indirect tensile test. They will also provide training on a regional basis.

## New Logo Emphasizes Partnerships

To emphasize the partnerships involved in implementing the Superpave system, FHWA recently introduced a new Superpave logo. The logo shows the principal partners in the Superpave implementation program—namely, the American Association of State Highway and Transportation Officials, the highway industry, and FHWA. "Superpave 2000" signifies the target date for nationwide implementation of the Superpave mix design procedures.


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# Concrete and Structures *UPDATE*

Showcase workshops, conducted on a regional basis, are one of the principal means of conveying information about the SHRP products for improving construction and maintenance practices for concrete pavements and structures. Each workshop features hands-on training and classroom learning on a group of related SHRP products. In some cases, technical assistance and loaner equipment are available to State highway agencies. After each workshop, participants from State highway agencies, industry, and FHWA meet to discuss how the technologies can be implemented on a regional basis.

**Showcase workshops** are available or planned in the following six topic areas:

- Alkali-Silica Reactivity (ASR)
- Concrete Durability
- Assessment of the Physical Condition of Reinforced Concrete Structures
- Methodologies for Reinforced Concrete Removal, Repair, Protection, and Rehabilitation
- Electrochemical Chloride Extraction
- High-Performance Concrete for Bridges and High-Performance Rigid Pavements

The pilot **concrete durability** showcase workshop was held June 27-28, 1995, in Arlington, Virginia. Presented by Construction Technologies Laboratories (CTL), the course introduced participants to a number of devices and procedures for evaluating the durability of concrete. The workshop covered five main topics:

- Permeability
- Freeze-thaw resistance
- Quality control
- Nondestructive testing
- Expert systems

Techniques discussed included the impact-echo method for measuring concrete thickness and locating defects, the microwave oven drying method for determining water content, and the hydraulic fracture test. FHWA will begin holding concrete durability workshops on a regional basis in April 1996.

Eight **ASR showcase workshops** were held in 1995. These

More than 40 products were developed under SHRP's concrete and structures program. These products can be classified under the broad categories of bridge condition assessment, bridge protection and rehabilitation, concrete durability, high-performance concrete, and alkali-silica reactivity. Many of these products can be applied to both pavements and bridges. The focus now is on refining the products and, through such means as showcase workshops, introducing them to the State highway departments and highway contractors.

## Showcase Workshops

*Alkali-Silica Reactivity*

The 3-day workshop features several SHRP products for detecting alkali-silica reactivity (ASR) in concrete in the field and in the laboratory. Includes hands-on training in identifying ASR. Target audience: materials engineers in highway departments and industry.

Next workshop: Montreal, Quebec, April 16-18, 1996.

Contact: Roger Surdahl, 202-366-1563 (fax: 202-366-9981; e-mail: rsurdahl @intergate.dot.gov).

*Concrete Durability*

Covers freeze-thaw durability, concrete permeability, and nondestructive testing of concrete. Target audience: materials and research engineers and technicians.

Schedule: Workshops will commence in April 1996.

Contact: Gary Crawford, 202-366-1286 (fax: 202-366-7909; e-mail: gcrawford @intergate.dot.gov).

*Assessment of the Physical Condition of Reinforced Concrete Structures*

Features corrosion detection devices, radar units, and rapid chloride test kits and emphasizes using these devices to evaluate bare and covered bridges. Target audience: bridge and construction engineers and technicians.

Schedule: The pilot showcase is tentatively scheduled for March 1996.

Contact: Donald Jackson, 202-366-6770 (fax: 202-366-7909; e-mail: djackson @intergate.dot.gov).

workshops are designed to give participants hands-on training in identifying and mitigating the effects of ASR-induced deterioration in portland cement concrete. The next workshop is scheduled for April 1996 in Montreal, Quebec.

Pilot workshops for the showcases on assessing the **physical condition of concrete structures** and **repairing, protecting, and rehabilitating concrete structures** will be held in spring 1996. The two showcases will run back-to-back during the same week, to make it possible for more engineers and technicians to attend.

Two ground-penetrating radar units for bridge deck evaluations have been ordered for use in both the workshops and field corrosion activities. The equipment is due to be delivered in the spring of 1996.

Three pilot **electrochemical chloride extraction** (ECE) projects have been installed: a bridge deck in Arlington, Virginia, and bridge columns and piers in Charlottesville, Virginia, and Sioux City, South Dakota. ECE is a promising technique for removing chloride ions from reinforced concrete structures, thus slowing deterioration. The pilot projects are designed to provide more information on the results of the ECE process, including how long a treatment can be expected to last and under what conditions ECE treatment is advised.

Open houses held at the pilot projects attracted a diverse group of attendees from State and Federal governments, private industry, and academia.

The pilot workshop on ECE was held in Arlington, Virginia, in July 1995. A field trip to the Arlington bridge project was included as part of the workshop.

## Equipment Evaluations

Field evaluations of the **impact-echo device** are under way. The devices have been loaned to the highway departments in Wisconsin, New York, Iowa, California, South Dakota, Missouri, Virginia, Texas, Mississippi, West Virginia, New Jersey, Nevada, North Carolina, Massachusetts, and Pennsylvania, as well as the University of Washington and the University of Texas. In addition, Kansas, South Dakota, Indiana, and the University of Louisville have each purchased the equipment.

Initial evaluation reports of the device have been turned in by Missouri, Wisconsin, West Virginia, and Virginia. Users have reported difficulties in taking measurements and interpreting data with the device and have recommended additional research and development. The biggest problem they encountered was measuring the pavement thickness within the desired accuracy of ±5 mm; results to date have been in the range of ±13 mm. To

address this problem, FHWA has begun testing a new production unit that allows users to measure pavement thickness more accurately (±4 mm).

Five small **hydraulic fracture test chambers** have been purchased for round-robin testing. The units have been sent to Kentucky, Iowa, Missouri, North Dakota, and Maryland.

Additional **air permeability test devices** have also been purchased, bringing the total available for loans to five. To date, the equipment has been loaned to Florida, New Jersey, Nevada, Arkansas, Missouri, the University of Nebraska, the Virginia Transportation Research Council, and South Dakota.

## High-Performance Concrete

Officials from FHWA and the American Association of State Highway and Transportation Officials, together with representatives from private contractors and consulting agencies, recently toured the Northumberland Strait Crossing Project in Prince Edward Island, Canada. They met with Canadian officials and had an opportunity for a first-hand look at the bridge that is being built with high-performance concrete (HPC).

The first **HPC for bridges showcase workshop** will be held March 25-27, 1996, in Houston, Texas. It will cover the advantages and disadvantages of high-performance concrete, mix proportioning, structural design considerations, and evaluation of bridge component performance.

There are currently five **HPC bridge projects** being constructed in four States: Texas (2 bridges), Virginia, Nebraska, and New Hampshire. The projects are funded jointly by the Office of Technology Applications, the Office of Engineering R&D, the Office of Advanced Research, and the participating States. In addition, 10 States (California, Georgia, Iowa, Massachusetts, Minnesota, New York, Ohio, Pennsylvania, Texas, and Washington) have pooled a portion of their research funds to help finance two of the projects. projects. Seven more HPC for bridges projects have been proposed by Georgia, Colorado, Ohio, Washington, North Carolina, Nevada, and Indiana.

FHWA is making arrangements to host an **international HPC conference** in 1997.

Members of the expert task group (ETG) on **high-performance rigid pavements** (HPRP) held their first meeting in April 1995. As a result of their discussions, FHWA, through its regional offices, has invited State highway agencies to submit proposals for modifying or developing concrete paving projects to incorporate high-performance features.

*Methodologies for Reinforced Concrete Removal, Repair, Protection, and Rehabilitation*

The workshop features a variety of SHRP and non-SHRP products (including software, specifications, test procedures, and reference documents). Target audience: bridge and construction engineers and technicians.

Schedule: The pilot workshop is tentatively scheduled for March 1996.

Contact: Donald Jackson, 202-366-6770 (fax: 202-366-7909; e-mail: djackson @intergate.dot.gov).

*Electrochemical Chloride Extraction*

Demonstration projects in Delaware and Maryland will provide the basis for discussion in the workshops. Target audience: bridge and construction engineers and technicians.

Scheduled for Wilmington, Delaware, summer 1996, and Baltimore, Maryland, fall 1996.

Contact: Donald Jackson, 202-366-6770 (fax: 202-366-7909; e-mail: djackson @intergate.dot.gov).

*High-Performance Concrete for Bridges*

This workshop covers mix proportioning, structural design considerations, and advantages and disadvantages of high-performance concrete (HPC). Target audience: materials, bridge, and design engineers, as well as concrete inspectors.

Contact: Terry Halkyard, 202-366-6765 (fax: 202-366-7909; email: thalkyard@ intergate.dot.gov).

# Highway Operations UPDATE

The SHRP highway operations program developed a wide range of test methods, design guides, and products addressing such areas as pavement repair, preventive pavement maintenance, snow and ice control, and work zone safety. Some of these products are undergoing further evaluation and refinement. Others, such as most of the work zone safety devices, have been readily adopted by State highway agencies.

Showcase workshops will be used to introduce many of these products on a regional basis.

### Workshop Contacts

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*Innovative Pavement Maintenance*
Contact: Patrick Bauer, 202-366-1554 (fax: 202-366-998); email: pbauer @intergate.dot.gov).

## Pavement Preventive Maintenance

More than 100 persons attended the May 1995 pilot **showcase workshop** on pavement preventive maintenance, held in Denver, Colorado. Designed for pavement, construction, and maintenance engineers, the workshop covered preventive treatments for both hot-mix asphalt and portland cement concrete pavements.

Regional workshops are tentatively scheduled to begin in early 1996. Workshop leaders will explain and demonstrate promising treatments that have been found to extend pavement service life. Test and evaluation plans for preventive maintenance treatments will be developed, and technical assistance will be provided to those State highway agencies participating in the evaluations.

## Innovative Pavement Maintenance

The pilot showcase workshop on innovative pavement effectiveness was held in August 1995 in Washington, D.C. The workshop covered the **four maintenance areas** studied under SHRP:

- pothole repair in asphalt concrete pavements,
- crack sealing and filling in asphalt concrete pavements,
- spall repair in portland cement concrete pavements, and
- joint resealing in portland cement concrete pavements.

The workshop was divided into six sessions. The first two sessions were aimed at upper management and emphasized the importance of pavement maintenance to a sound pavement management strategy. The other sessions were geared for maintenance engineers and provided more detailed information.

Regional workshops are scheduled to begin early in 1996.

## Snow and Ice Technology

FHWA recently wrapped up its 2-year **anti-icing test and evaluation project** (T&E Project 28). The study, which consisted of extensive field testing of various anti-icing technologies, culminated in a symposium in Estes Park, Colorado, in October

1995. The symposium drew more than 200 maintenance engineers and managers from State and local highway agencies, academia, consultants, suppliers, and manufacturers. The 15 State highway agencies that participated in the study reported the strategies they used and the benefits they gained. The contractor for the project, the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL), summarized the overall findings and described the methodologies used in the study.

Based on data collected in the study, CRREL has developed a **guidance manual** for anti-icing operations under a variety of storm conditions. Highway agencies will be able to use the manual to develop their own localized anti-icing strategies. A draft of the manual was distributed at the Colorado symposium, and a final version is expected in early 1996.

Beginning in 1996, FHWA will conduct a series of 2-day **regional workshops** to showcase the snow and ice technologies. In addition to anti-icing strategies and technologies, the workshops will cover

- methods for evaluating chemical deicers,
- ice disbonding,
- road weather information systems,
- customized weather prediction,
- snow drift control,
- snowplow cutting edge,
- snowplow design, and
- snowplow scoop.

FHWA is currently seeking participants for five **test and evaluation projects:**

- Anti-icing—to evaluate how well spreader equipment distributes a finely graded salt prewetted with a liquid chemical.
- Road weather information systems—to determine the integration and interoperability between systems from different vendors and to establish a standard protocol.
- Road weather information systems—to test and evaluate snow and ice control management systems that are based on road weather information systems.
- Cutting edge—to evaluate a plow blade coated with a high cobalt grade of tungsten carbide to resist wear from shock.
- Plow design—to evaluate a plow that combines the SHRP-developed cutting edge, snowplow scoop, and moldboard design.

### Snow and Ice Test and Evaluation Project

To solicit interest in the snow and ice test and evaluation projects, FHWA has distributed a brochure, *Better Snow and Ice Control Using State-of-the-Art Technologies: An Invitation to Test and Evaluation and Winter Workshops.*

For a copy of the brochure, which includes a response card to indicate interest, contact Salim Nassif at FHWA (telephone: 202-366-1557; fax: 202-366-9981; email: snassif@intergate dot.gov).

## Work Zone Safety Devices

Since 1992, the SHRP work zone safety devices have been displayed at 41 major events, including such recent ones as the Texas Municipal League 1995 Convention and the 1995 annual meeting of the American Association of State Highway and Transportation Officials. Each FHWA region and most Local Technical Assistance Program (LTAP) centers have received a full set of the safety devices, allowing the devices to be shown at many regional and local events. To make it easier for the regions and LTAP centers to demonstrate the SHRP products to local and State highway agencies, FHWA has provided utility trailers that can easily store and transport the entire complement of work zone safety devices.

FHWA is encouraging highway agencies to try out the products in actual field applications. Technical assistance and funding support have been provided to participating States.

*Availability of Devices*

Seven work zone safety devices are now commercially available.*

Five companies currently manufacture **intrusion alarms**. The Safety Line Infrared Alarm (ASTI Transportation Systems, Newark, Delaware) consists of an infrared transmission unit housed in a traffic cone; the alarm unit is housed in a second cone. It provides both longitudinal and transverse detection.

The Safety Sentinel Microwave Alarm (Traffic Management Systems Corporation, St. Louis, Missouri) is a two-unit system housed in plastic drums. Solar cells are mounted on top of the drums to recharge the batteries as needed. The system uses a microwave beam to provide longitudinal detection. It also includes a drone radar transmitter that sets off radar detectors in vehicles within 600 meters of the unit, helping to slow approaching traffic.

The Model 10 two-unit intrusion alarm (Safe Lite System, Newtown, Pennsylvania) runs on rechargeable batteries and uses a radio communications linkage between the units. A pneumatic tube laid on the pavement is used to detect intruding vehicles and provides transverse detection at the lane closure.

The intrusion alarm manufactured by the Columbia Safety Sign Company (Woodland, Washington) also uses a pneumatic tube to detect intruding vehicles.

The Watchdog (Kenco International, Ligonier, Pennsylvania) consists of a series of pneumatic hoses hard-wired to the alarm unit.

*The U.S. Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

### Work Zone Safety Brochure

Highway work zones are dangerous places. The need to perform critical road repairs often conflicts with the need to maintain traffic flow, leading to increased potential for work zone accidents. The SHRP work zone safety devices were designed to address these opposing needs.

The SHRP work zone safety devices are described and portrayed in an FHWA brochure, *Innovative Devices for Safer Work Zones*. The brochure covers the flashing stop/slow paddle, portable rumble strip, portable all-terrain sign and stand, direction indicator barricade, opposing traffic lane divider, intrusion alarm, remotely driven vehicle, portable crash cushion, truck-mounted attenuator for salt-spreaders, and queue detector.

The brochure also includes a listing of the SHRP work zone safety device contacts in each of the FHWA regions.

To request a copy of the brochure, contact Jacques Jenkins at 202-366-8025 (fax 202-366-7909; email: jjenkins@intergate.dot.gov).

Impact Recovery Systems (San Antonio, Texas), Flexstake, Inc. (Ft. Meyers, Florida), and Flasher Handling Corporation (Depew, New York) currently manufacture the **opposing traffic lane divider**. All three products feature a similar two-arrow face design, with the main difference between the three being the support systems for returning the divider to an upright position when hit.

Three companies currently manufacture devices that meet the basic criteria for SHRP's **direction indicator barricade**. The product from WLI Industries, Inc., (Villa Park, Illinois) has a horizontal arrow on a type II barricade, while Flasher Handling Corporation (Depew, New York) and Carsonite, Inc. (Carson City, Nevada) place the sign panels on a support with a weighted base. The device's primary objective is to provide guidance during lane closures. Currently, the barricade is still considered experimental and thus requires permission from FHWA for use.

Poly Enterprise (Monrovia, California) has produced a molded version of the **portable rumble strip** using virgin and recycled plastic in place of the neoprene laminated version developed by SHRP. The rumble strip works best under low speed traffic conditions; under high traffic speeds or heavy truck volume, the strip is subject to rotation and movement.

The original SHRP-designed **flashing stop/slow paddle** is currently being produced by a Canadian firm, Detronics, and distributed by Graham-Migletz, Inc. (Independence, Missouri). In addition, Columbia Safety Sign Corporation (Woodland, Washington), Action West (Kelso, Washington), A/C Enterprise (Vancouver, Washington), Medifax, Inc. (La Center, Washington), and Brittney Safety Sign (Copper Country Safety Sales, Phoenix, Arizona) are each manufacturing a paddle that is based on the SHRP concept but that uses strobe lights or bulbs rather than high-intensity halogen bulbs.

Napoleon Fabricators, Inc. (Napoleon, Ohio) and AdraCorp. (Huntsville, Alabama) both manufacture the **portable all-terrain sign and stand**. AdraCorp's product is a tripod version that weighs just over 3 kilograms (7 pounds).

The **queue detector**, which consists of a transmitter, receiver, and electronics module, is available from ASTI Transportation Systems (New Castle, Delaware). The detector alerts drivers to stopped or slow traffic ahead, giving them more time to react and prevent accidents.

### *Still Under Development*

The portable crash cushion is currently being modified so that it uses a small trailer for more maneuverability in loading and unloading. Three trailer units are currently being manufactured for testing and evaluation by State highway agencies.

### MUTCD Approval

The revised Part VI of the *Manual on Uniform Traffic Control Devices* includes three of SHRP's work zone safety devices.

Section 6E-4 includes a discussion of stop/slow paddles and approves the use of SHRP's flashing stop/slow paddle.

SHRP's portable rumble strip meets the specifications set forth in Section 6F-8d, which describes allowable types of rumble strips and their proper application.

Section 6F-8g covers opposing traffic lane dividers, which are used as center lane dividers to separate opposing traffic on a two-lane two-way operation.

# Long-Term Pavement Performance *UPDATE*

Designed to give States the information and products they need to build and maintain longer lasting pavements, the 20-year long-term pavement performance (LTPP) program is almost at its midpoint. The program is, however, already delivering products, such as the modified Georgia faultmeter and the falling weight deflectometer calibration procedures.

Some of the products now available relate to materials testing, pavement performance monitoring, and equipment standards and calibration procedures. Still under development are products directed at the selection and effectiveness of maintenance strategies, performance of various rehabilitation techniques and materials, and the selection of design features for new construction or total reconstruction.

## Strategic Plan Published

In September 1995, the LTPP program published ***The Long-Term Pavement Performance Roadmap: A Strategic Plan.*** The plan was developed with input from State and provincial highway agencies, the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), industry, academia, and FHWA.

The *Roadmap* contains a data analysis plan for developing LTPP products, and it identifies critical issues facing the LTPP program. The *Roadmap* also provides a brief history of the LTPP program, its partners, and their roles. It charts a course to the program's near-term and longer term destinations.

The *Roadmap* is being widely distributed to help inform the highway community about the projects and products of the LTPP program. AASHTO has sent copies of the *Roadmap* to each State.

Just as the LTPP program is a dynamic process, so too is the *Roadmap*; the report will be updated periodically to reflect changing needs and priorities.

A new pocket-sized brochure describing the LTPP program was published by FHWA in October 1995. The brochure, titled *Improving Pavement Technology: A 20-Year Journey*, consists of a series of commonly asked questions and answers about the LTPP program.

## National Conference To Be Held in March

To provide an update on the LTPP program's accomplishments and the products being developed by the program, FHWA will convene a conference in Irvine, California, in March 1996. The conference, "Improving Pavements with LTPP: Products for Today and Tomorrow," will be held March 26-28 at the Arnold & Mabel Beckman Center of the National Academies of Science and Engineering.

The conference will focus upon LTPP products that contribute to increased pavement life; early products available from

the LTPP program, and the path to developing additional anticipated products.

The conference is intended primarily for State, Federal, and industry engineers and managers with responsibilities for delivering pavement programs. The conference will also be of interest to engineers involved in the conduct of the LTPP studies or other pavement research programs.

The conference is cosponsored by:

- American Association of State Highway and Transportation Officials
- American Concrete Pavement Association
- American Trucking Associations
- Canadian Strategic Highway Research Program
- National Asphalt Pavement Association
- National Stone Association
- Transportation Research Board

## LTPP Product Preview

In January 1996, FHWA will distribute a new brochure containing a list of the available and planned LTPP products. The *LTPP Product Preview* will include a description of each product, its status, and a name of the person to contact for more information.

Products will be grouped in four categories: materials testing, design guidelines, pavement monitoring procedures, and equipment standards and calibration. The Product Preview will be used to develop implementation plans for the products. Engineers and managers who desire to be among the earlier users of the products will also find the brochure helpful.

## SPS-3/4 1995 Field Evaluations Completed

Expert teams of engineers from State highway agencies, industry, and FHWA have completed their evaluations of the performance of various preventive maintenance treatments constructed in 1990 as part of SHRP. Regional teams conducted on-site field evaluations of the specific pavement studies (SPS) experiments (flexible pavements, SPS-3, and rigid pavements, SPS-4) during August, September, and October 1995. Each field review was 6 to 10 days in length. More than 81 experimental sites and 405 test sections were visited.

The review teams' subjective evaluations will be used to complement the LTPP data analysis now under way on the 5 years of performance data collected at the sites. The objective of this analysis effort is the formulation of sound conclusions

### Publication Requests

To request a copy of

- *The Long-Term Pavement Performance Roadmap: A Strategic Plan* (FHWA-RD-95-200)
- *LTPP Product Preview*
- LTPP Conference Brochure

contact the Pavement Performance Division, Office of Engineering R&D, at 703-285-2355 (fax: 703-285-2767).

and recommendations on the performance and use of these preventive maintenance treatments—that is, what works, and what doesn't. A national summary report detailing the observations, conclusions, and recommendations of the review teams is being developed by an FHWA contractor, Nichols Consulting Engineers, and should be available in early 1996. A final report on the entire SPS 3&4 project is also being prepared. Technology transfer materials and manuals of practice will be developed to assist highway agencies in implementing the study findings.

## Monitored Traffic Data Now Included in National Information Management System

The LTPP National Information Management System now includes actual traffic data collected at monitored general pavement studies (GPS) sites. State and provincial highway agencies have been collecting the data since 1990, but access to the data was delayed until standardized processing procedures could be developed.

The newly available traffic data covers the 1990-1993 period and contains information on

- traffic and truck volumes,
- weight distributions of axle groups by vehicle type, and
- equivalent single-axle load estimates.

The information is based on vehicle counts collected at more than 470 GPS sites and vehicle weights measured at nearly 400 GPS sites in 48 States and provinces.

## LTPP Activities at the 1996 TRB Annual Meeting

The LTPP program will be very visible at the 1996 Transportation Research Board Annual Meeting in Washington, D.C. The activities start on January 6 with the Data Analysis Working Group meeting. At the SHRP Coordinators meeting on January 7, highlights of the LTPP program will be presented in the plenary session. An LTPP exhibit will be set up at the technology fair that follows the coordinators meeting.

The international LTPP coordinators will meet on January 7. Participants will share the status of their LTPP activities and explore opportunities for further cooperative efforts.

On January 8, Session 42 will feature a series of presentations on the *Roadmap*, related AASHTO activities, and LTPP products.

### Data Sampler Software

To obtain a copy of the Data Sampler and Data Request software program, contact Barbara Ostrom at 703-285-2514 (fax: 703-285-2767; email: bkostrom@intergate.dot.gov).

The program is furnished on a single 90-mm (3.5-inch) disk. It requires a computer running under Windows version 3.0 or higher, 2 megabytes of hard disk space, and 4 megabytes of RAM.

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U.S. Department of Transportation
Federal Highway Administration

# Memorandum

Subject: SHRP Information Clearinghouse

Date: July 22, 1994

From: Associate Administrator for Safety and System Applications, Washington, D.C. 20590

Reply to Attn of: HTA-3

To: Regional Administrators

One of the challenges in conducting the SHRP implementation program is communication, within FHWA, and with all of our partners regarding the structure and status of the program, and about the numerous opportunities to participate. One communication tool is the FHWA's SHRP Product Implementation Status Report. Prepared quarterly, the Status Report captures the highlights of the SHRP implementation program. Attached is the June issue. To date, the FHWA has utilized its traditional communication mechanisms supplemented by extensive use of E-mail directly to the FHWA SHRP coordinators in the regions and divisions. The Status Report is one example of the information that is distributed via E-mail to our field offices. National and regional meetings have also been used to tell the story. The FHWA also publishes the SHRP FOCUS monthly newsletter which is sent to 8,500 individuals nationally and internationally.

One of the recommendations which the FHWA received regarding SHRP implementation communication was to establish a computer based information system. One that would allow any interested party to learn what is planned, who is doing it, and when it will happen. The SHRP Information Clearinghouse contains: (1) Status Report, (2) Product Information, (3) Calendar, (4) Directories, and (5) SHRP Report Abstracts.

The Clearinghouse, which is operated by the Office of Technology Applications is currently accessible to all users via a modem and an 800 telephone line. The only requirement for operation of the system is that a user execute a series of computer commands on his or her initial entry. These instructions have been E-mailed directly to the region and division SHRP Coordinators. We are currently exploring options to access the Clearinghouse on the FHWA WAN and AASHTO VAN.

As the principal potential users of the SHRP products, the State highway agencies need to be introduced to the Clearinghouse and provided the computer instructions. To strengthen the SHRP implementation partnership, we are

requesting that the division offices inform the State highway agencies about the Clearinghouse. To assist the divisions, attached are:

A suggested letter from the division office to the State introducing the Clearinghouse - please modify the letter to suit local conditions,

Sufficient quantity to provide two computer diskettes to each State, and

An information page describing the Clearinghouse.

The letter to the State should also go to the Local Technical Assistance Program (LTAP) Technology Transfer Centers in each State and in Puerto Rico. A limited number of SHRP products are of interest to small and local governments. The FHWA is funding a contract to promote SHRP products to local governments through the LTAP technology transfer centers. Information on the implementation efforts for local governments is also contained in the Clearinghouse data bases and each center is being sent directly a copy of the diskette. A separate distribution will be made to the four technology transfer centers for American Indian tribal governments.

Industry, national associations and trade publications, academia, and international users will be informed about the Clearinghouse through magazine articles in FOCUS, PUBLIC ROADS, other magazines, and general advertisements. Please feel free to inform regional and local industry and publications regarding the availability and access to the Clearinghouse.

The regions, divisions, and States have all cooperated enthusiastically and significant progress has been made toward the adoption of the SHRP products. However, a lot remains to be accomplished and your continued support and participation is critical to the overall success of the implementation effort. The Headquarters SHRP implementation team is available to assist you. Please do not hesitate to contact any of the individuals identified in the Status Report for assistance.

Dennis C. Judycki

Attachments

U.S. Department of Transportation
Federal Highway Administration

# SHRP Information Clearinghouse

As part of its SHRP implementation program, FHWA has initiated numerous activities, including workshops, exhibits, technical assistance, and test and evaluation projects. Keeping track of all that information is a formidable task.

FHWA created the SHRP Information Clearinghouse to make it easier for State departments of transportation, industry, academia, the international community, and others to check the status of the SHRP products and to get information about FHWA's implementation activities.

The Clearinghouse is actually a set of five databases, housed in an IBM-compatible computer. A customized software program links the databases and provides a graphical user interface. FHWA regularly reviews and updates the data.

The Clearinghouse includes:

- The full text of the most recent version of FHWA's SHRP Implementation Status Report

- Product Information
  - -Historical and current information
  - -Information on the showcase workshops and contracts
  - -Information on the States participating in test and evaluation projects for SHRP products

- Calendar of SHRP-related exhibits, workshops, training programs, and meetings

- A directory of FHWA contractors, technical working group and expert task group members, technical assistance sources, SHRP coordinators, and others involved in SHRP implementation activities

- Abstracts of all SHRP reports - as well as information on ordering the reports

The Clearinghouse runs in a user-friendly Windows environment. It is easy to navigate; the user selects from a series of menus. There are no special computer hardware or software requirements, but a mouse is recommended.

The SHRP Information Clearinghouse became operational in July 1994. You can reach the Clearinghouse through FHWA's local-area network or by using a high-speed (9600 baud or faster) modem to dial directly into the host computer. To request a copy of the self-installing software (which you will need to dial in to the Clearinghouse), contact Tonya Inc. at 202-289-8108. For more information about the SHRP Information Clearinghouse, contact FHWA's Office of Technology Applications (fax 202-366-7909).

U.S. Department of Transportation
Federal Highway Administration

# Memorandum

Subject: Implementation Plan for the Strategic Highway Research Program (SHRP) Products

Date: June 3, 1993

From: Executive Director

Reply to Attn of: HTA-3

To: Associate Administrators
Regional Administrators
Federal Lands Highway Program Administrator

The Federal Highway Administration (FHWA) continues to put a priority on the implementation program for the SHRP products. Most recently, the attached plan on SHRP products implementation was developed under the direction of the FHWA SHRP Implementation Coordination Group (SICG). The plan describes the overall approach, the partnerships that are considered essential to the successful implementation of the SHRP products and the roles of the involved organizations, including our field offices. Also, attached is a companion document that lists the organizational memberships of the various committees and task forces associated with this program.

The plan was developed with the understanding that it is a living document that would grow and change in response to the needs of the users of the SHRP products. It provides the framework by which the specific individual product(s) implementation plans, both national, regional and State, will be developed. To be successful, the specific product implementation plans must be tailored to meet regional and State conditions. It is strongly recommended that the regions and divisions be active participants with the States and industry in the development of these implementation plans.

During the coming months, FHWA will continue to put in place the SHRP products implementation mechanisms and activities such as the four technical working groups, the development of specific national plans and the showcase contracts referred to in the plan. However, within the framework described in the plan you are encouraged to begin planning the development of regional strategies and possible organizational structures that include our partners. I strongly encourage you to become actively involved in this process and in the subsequent implementation activities.

The Office of Technology Applications (OTA) is available to provide additional information regarding the SHRP implementation plan and to assist your staff in the development of regional and State plans. During this summer and fall visits by OTA staff to your Region, meetings will be held to discuss the program with your staff.

E. Dean Carlson

Attachments

Federal Highway Administration
HTA-3:CChurilla:ljp:366-6626:5/26/93
cc: HOA-1
HOA-2
HOA-3
HOAES
HST-1 3401
HTA-1
HTA-3 Official File

US Department of Transportation
Federal Highway Administration

# Memorandum

Subject: SHRP Products Implementation

Date: November 22, 1993

From: Executive Director

Reply to Attn of: HTA-3

To: Associate Administrators
Regional Administrators
Federal Lands Highway Program Administrator

The Federal Highway Administration (FHWA) has made significant progress in the SHRP implementation activities at the national level. The four Technical Working Groups (TWGs) have been formed and are addressing the development of product-specific implementation plans, contracts for various SHRP implementation support functions are in place, and the first of the showcase contracts has been awarded. Attached for your information is the SHRP Implementation Status Report that describes the FHWA activities. This report is routinely distributed on E-mail to the region and division office SHRP coordinators.

One of the SHRP support activities is a Speakers Bureau that provides FHWA a mechanism to respond to the many requests for presentations on SHRP products. When FHWA staff is unable to respond to a request for a SHRP presentation, the Speakers Bureau can provide a knowledgeable individual from the private sector. The FHWA also has other means available when we wish to utilize an individual from a State highway agency as a SHRP products speaker. Please contact Charlie Churilla (202-366-6626) in the Office of Technology Applications if we can help in this regard.

One of the field office SHRP implementation activities that is extremely important is working with the State highway agencies to establish or foster the operation of SHRP implementation activities. A number of States have established SHRP implementation committees as a means to coordinate the evaluation and adoption of SHRP products. In those States that have such a committee, the region and division offices can play valuable roles as an information source on the products and a champion for the many implementation activities being offered by FHWA. I am requesting that you encourage the Division Administrators to discuss SHRP implementation with their State counterparts. In those instances where an implementation process does not exist, the importance of taking action now should be stressed.

In the many instances where such a committee or process already exists, the discussion should focus on the strengthening of the State-FHWA implementation partnership. To assist you in this effort, attached are copies of a SHRP Implementation videotape prepared by FHWA.

During the life of the SHRP, an annual State Coordinators' meeting was held in conjunction with the Transportation Research Board (TRB) Annual Meeting. The SHRP meeting is being continued by FHWA, with the support of TRB, and will focus on the implementation activities and the continuation of the Long Term Pavement Performance program. In the past, this meeting has been extremely well attended with representatives from 70+ percent of the States. Attendance by a regional office representative, and at your discretion from one of your division offices, is recommended. Washington Office Directed Travel has been approved for the SHRP Coordinators' meeting.

Also, during the fall, representatives from the Headquarters offices involved in the SHRP implementation efforts have visited most of the regional offices to provide firsthand information on the SHRP implementation activities and to discuss the region and division offices' roles in these activities. One of the items specifically addressed during several of these meetings was the funding for the SHRP implementation activities at the regional and State levels. As the national implementation plans are developed by the TWGs, each region will have the opportunity to develop regional plans for specific products or showcase group of products. Activities in the regional plans may include test and evaluations, regional equipment purchases, and associated administrative costs for the regional technical committees. The Office of Technology Applications is available to assist your office in the development of these regional plans and to provide the funding for these field-led implementation activities. Detailed information regarding the funding of the regional plans will be forthcoming.

For the SHRP implementation to be a success, it requires the active participation by all the partners. At the national level, TRB, AASHTO, and FHWA have taken a number of significant steps towards this goal. However, to ultimately reach the goal, the States in cooperation with the FHWA field offices and local industry must act. I, again, want to strongly encourage you and your staff to continue to be active participants in the implementation process.

E. Dean Carlson

2 Attachments

Technical Report Documentation Page

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15. Supplementary Notes

16. Abstract


The Intermodal Surface Transportation Efficiency Act of 1991 fully supported the implementation of research results from the $150 million Strategic Highway Research Program (SHRP). Successful implementation of SHRP by and large will be measured by successful implementation of the asphalt research.

In a unique cooperative spirit, the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the SHRP Project Management Office have worked together to develop a plan that ensures the research will indeed be implemented. This paper describes important aspects of this partnership and focuses on key elements of the plan. These elements include:

- The large scale procurement and evaluation of new equipment.
- Integration of equipment procurement with national training agenda.
- Use of mobile laboratory support.
- Integrated activities with standards setting functions of AASHTO.
- Integrated use of other funding sources for followup research and implementation - National Cooperative Highway Research Program (NCHRP), FHWA Administrative Funds, and Federal-aid Planning and Research Funds.
- The unique role of users-producer groups and technical working groups that represent public and private interests.

Finally, the paper discusses the very critical function of Specific Pavement Study 9 (SPS-9), Validation of the SHRP Superpave™ and Innovations in Asphalt Pavements, in the continuing refinement of the Superpave™ performance models and design methods.


| 17. Key Words | 18. Distribution Statement |
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| Strategic Highway Research Program, asphalt concrete pavement, asphalt, asphalt binder, asphalt mixture | No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161. |

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| Unclassified | Unclassified | 17 | |

US Department of Transportation
Federal Highway Administration

# Memorandum

Subject: INFORMATION: Distribution of Publication

Date: March 23, 1994

From: Associate Administrator for Safety and System Applications

Reply to Attn of: HTA-13

To: Regional Administrators
Federal Lands Highway Program Administrator

Distributed with this memorandum is Federal Highway Administration Technology Applications Program, April 1994, Publication No. FHWA-SA-94-028, an update of the July 1993 publication (FHWA-SA-93-075). This provides a current listing of all technology transfer projects and an up-to-date status on the activities within the project. The Office of Technology Applications (OTA) will continue to update and distribute this publication periodically in order to keep the field offices, States, and Technology Transfer Centers up to date on the technology transfer activities underway.

Sufficient copies of this publication are being distributed to provide 6 copies to each regional office and 10 to each division office. Direct distribution is being made to the division offices; copies for State highway agencies are included with the copies for the division offices. Two copies are also being sent to each Local Technical Assistance Program Technology Transfer Center.

A limited number of additional copies are available from the FHWA Research and Technology Report Center, HRD-11, Room A-200, 6300 Georgetown Pike, McLean, Virginia 22101-2296.

Dennis C. Judycki

Dennis C. Judycki

Attachment

## DP-75 Mobile Concrete Laboratory (SHRP)

**DESCRIPTION :** The project's goals include demonstration of state-of-the-art concrete technology in materials selection, mix designs, laboratory testing, and field testing. Project activities include guidance for updating specifications and use of computer technology for design, testing, and data storage. A partnership with manufacturers, contractors, industry associations, and academia is maintained in all of the project's activities.

This project demonstrates the use of innovative laboratory and in situ testing equipment, and promotes high-performance concrete and the use of chemical admixtures. This project also supports the activities of SP-201, "Accelerated Rigid Paving Techniques."

**BACKGROUND :** With today's construction heavily involved in rehabilitation and reconstruction, highway engineers place ever greater demands on Portland cement concrete. These demands include lower permeability, higher and earlier strength, and improved workability. Many concrete admixtures are available today that specifically address these demands. However, to understand and effectively use these admixtures, innovative mix designs, testing equipment, and techniques are a prerequisite.

With the use of a mobile concrete laboratory, 26 field demonstrations have been performed in the last 5 years. Two-day workshops on state-of-the-art concrete technology have been conducted in 44 States. Twenty 1-day seminars on "Concrete Admixtures" have been conducted. Many presentations, including the mobile concrete laboratory, have been given at national, regional, and local FHWA and industry meetings. More than 2,500 State DOT and FHWA engineers have attended workshops, seminars, and field demonstrations. Under the equipment loan program, in situ testing equipment has been loaned to 20 States.

**PROJECT MANAGERS :** Suneel Vanikar, HTA-21, (202) 366-0120 and Gary Crawford, HTA-21, (202) 366-1286

**STATUS :** In 1995, mobile laboratory field demonstrations were conducted in Texas, Ohio, and Virginia. One-day nondestructive testing (NDT) workshops were held in Missouri and Iowa. This NDT workshop will be presented in several States over the next few years. This workshop includes some SHRP-developed products. A Concrete admixtures seminar was presented in Hawaii.

The remaining States will be visited over the next several years, with many States asking for repeat visits as the SHRP-developed products are included in the laboratory. The 1-day admixture seminars will continue for a few more years. Additionally, this mobile laboratory will support efforts related to implementing SHRP-developed concrete technology. The major emphasis for the next several years will be on field demonstrations of the SHRP-developed products and implementation of Performance Related Specification for Concrete Pavements.

**TECHNOLOGY TRANSFER AIDS :** Mobile laboratory, telephone and on-site assistance, speakers, specialized workshops and seminars, and nondestructive equipment loan program. A new mobile concrete laboratory was acquired in 1995.

**PUBLICATIONS :** FHWA reports on several field studies available through the Office of Technology Applications.

## DP-84 Corrosion Survey Techniques

**DESCRIPTION :** The objective of this project is to demonstrate and document the latest concepts and test procedures for corrosion surveys on reinforced concrete structures. A secondary objective is to work in conjunction with States to collect data on structures that already have protective systems and to determine their effectiveness. The project is divided into three distinct modules:

- Executive Presentation Slide presentation and some equipment demonstration.
- Equipment Demonstration Slide presentation on bridge evaluation techniques and 1- to 2-day equipment demonstrations.
- Hands-on Training and Testing. Three to four days of hands-on experience with equipment.
- A loan program for States that are interested in a particular piece of equipment.

Several products developed under the Strategic Highway Research Program (SHRP) are being demonstrated as part of this project.

**BACKGROUND :** Deterioration of reinforced concrete by corrosion of the reinforcing steel is the most frequent cause for needing maintenance, rehabilitation, or replacement of concrete structural elements. The ability to identify an active corrosion process in the early stages is the most important factor in minimizing the cost of corrosion-related repairs.

Today's equipment is lighter, stronger, more durable, and is capable of interfacing with microcomputers through CADD-like software. Additionally, with the growing attention paid to concrete substructure corrosion, this equipment solves some of the difficulties of surveying vertical surfaces over rivers, coastal waters, and freeways. Some tests that will be performed are half-cell potential survey, delamination mapping, rapid field measuring, chloride content, concrete cover survey, rebar corrosion rates, and crack measurement.

**PROJECT MANAGER :** Donald Jackson, HTA-22 (202) 366-6770

**STATUS :** This project was announced late in 1991. DP-84 has been presented 36 times since then. Interested States may request demonstrations from the project manager.

## DP-87 Drainable Pavements

**DESCRIPTION :** This project was developed to help State highway agencies and industry partners become more familiar with new techniques in permeable base and edgedrain system design and construction. This project concentrates on the use of permeable bases with concrete pavements and consists of a workshop that features a slide presentation, design manual, and field construction technical assistance. It also incorporates a hydraulic demonstration model that presents the drainage rate of various aggregate materials used in road building, including permeable bases.

**BACKGROUND :** Water in the pavement section is recognized as a major factor in pavement deterioration and early loss of pavement service life. In recent years, highway engineers have recognized the cost benefits of providing permeable bases to drain the pavement section. New aggregate gradations and stabilizing materials for base courses have been used to provide a balance between drainability and stability. Construction engineers also have developed new techniques for placing and compacting permeable base material.

**PROJECT MANAGER :** Robert Baumgardner, HNG-42, (202) 366-4612

**STATUS :** More than 40 workshops have been completed to date. Scheduled presentations concluded in March 1994. The scope of the workshop portion of this project will be expanded in a future NHI course to include retrofit edgedrains and drainage of flexible pavement. (See DP-87 Phase II, page under Asphalt Pavement Design and Construction.)

**TECHNOLOGY TRANSFER AIDS :** Workshop available on request (subject to long-range planning). specifications from Wisconsin, technical assistance, construction evaluation monies (limited), computer software available from PCTrans, University of Kansas, and McTrans, University of Florida.

## DP-87 Drainable Pavement Systems (Phase II)

**DESCRIPTION :** This project was developed to help State highway agencies and industry partners become more familiar with new techniques in permeable base and edgedrain system design and construction for concrete pavements. This phase of the project will concentrate on the use of permeable bases with asphalt pavements and, as with concrete pavements under Phase I, consists of a workshop that features a slide presentation, design manual, and field construction technical assistance.

**BACKGROUND :** Water in the pavement section is recognized as a major factor in pavement deterioration and early loss of pavement service life. In recent years, highway engineers have recognized the cost benefits of providing permeable bases to drain the pavement section. New aggregate gradations and stabilizing materials for base courses have been used to provide a balance between drainability and stability. Construction engineers also have developed new techniques for placing and compacting permeable base material.

**PROJECT MANAGER :** Robert Baumgardner, HNG-42, (202) 366-4612

**STATUS :** This project is being expanded in an NHI course to include retrofit edgedrains and drainage of flexible pavement. In addition, a contract has been awarded to Applied Research Associates to develop a microcomputer program to calculate pavement subsurface drainage.

**TECHNOLOGY TRANSFER AIDS :** Workshop available on request (subject to long-range planning), equipment demonstration.

## DP-89 Quality Management

**DESCRIPTION :** The goal of this project is to build top-level support and awareness of quality management and to provide training to State highway agencies in statistical quality control techniques. It is part of the National Quality Initiative. This project involves four quality management activities.

- Participate on a joint FHWA/AASHTO/industry steering committee to guide and help focus efforts on the quality of construction, performance, and quality management with emphasis on a partnership effort.
- Develop (jointly) and issue broadly based national policy/goals.
- Hold high level seminars for upper management of Federal, State, industry, and others to educate and gain support.
- Provide technical training, guidance, and tools to others responsible for implementation.

**BACKGROUND :** There has been a conscious effort within the United States during the past decade to promote a correlation between American products and quality. In general, this effort has been focused in the manufacturing industry. The United States has begun to promote the concept of American quality because quality is an important factor in maintaining global competitiveness.

With the emphasis on quality again moving toward national significance, this project will provide direction and address a broader role of quality in the highway environment.

**PROJECT MANAGER :** Don Tuggle, HNG-21, (202) 366-1553

**PROJECT COORDINATOR :** Gary Henderson, HTA-22, (202) 366-1283

**STATUS :** In an effort to widely disseminate the principles and ideals begun at the National Quality Initiative Seminar in Dallas/Ft. Worth, Texas on November 10, 1992, four AASHTO Regional NQI Seminars involving well over 10,000 people nationwide have been conducted. Additional support of state-level NQI activities has been provided.

An "NQI National Conference" will be held in Alexandria, VA on November 14 and 15, 1995. The first-ever NQI Achievement Award will be presented for the best highway project at this conference.

A 5-day training course (*Materials Control and Acceptance: Quality Assurance*) and a 2-day workshop (*Quality Management for Managers*) is being co-sponsored with the National Highway Institute. Approximately 38 of the 50 available five-day courses and 41 of the 56 available two-day workshops have been presented. Several statistical quality assurance computer programs have been developed by the New Jersey DOT. A technical review of the user manual has been completed, and distribution of the manuals and programs is expected by the end of 1995. In addition a number of workshops and seminars have been supported such as a technician training and certification workshop in Platteville, Wisconsin and a quality assurance specifications development workshop in Little Rock, Arkansas.

**TECHNOLOGY TRANSFER AIDS :** One-week course, two-day workshops, technical assistance, speakers, and computer programs.

## DP-90 Mobile Asphalt Laboratories

**DESCRIPTION :** This project is a major Office of Technology Applications initiative to promote Strategic Highway Research Program (SHRP) findings in the asphalt area. This project uses two mobile laboratories to provide State highway agencies with a hands-on demonstration of the SHRP SUPERPAVE design system and field management techniques.

***The major objective of the project is to promote the Super Pave Mix design system and mix verification / volumetric quality control in the field.***

The typical project centers on transplanting a mobile lab to an active paving project at the invitation of the State. Once it is on site, State, contractor, and Federal engineers can witness, compare, and critique the test procedures and sequences.

**PROJECT MANAGERS :** Thomas Harman, HTA-21, (202) 366-0859; John D'Angelo, HTA-21, (202) 366-0121; and John Bukowski, HTA-21, (202) 366-1287.

**STATUS :** The use of mobile laboratories for asphalt mix is ongoing. The concepts of Mix Verification and Voids Acceptance have been demonstrated and field simulated in more than 38 States in the last 8 years. As an additional service, more than 50 Federal and State contractors, engineers, and technicians have spent 2 to 5 days in a mobile laboratory learning and strengthening their skills in the asphalt mix area. In 1991, a formal 2-day workshop was added to the demonstration. In 1993, key elements of the SHRP SUPERPAVE mix design system were also added to the workshop. During 1994 and 1995 the laboratory provided field control on several projects using SUPERPAVE designed mixes.

A report detailing the results of the field simulation was voted the "Best Paper of the Year 1991" by the Association of Asphalt Paving Technologists. This report, *Summary of Simulation Studies*, is available from the project managers.

The remaining States will be visited over the next several years. With the addition of the SUPERPAVE system, many States are expected to request repeat visits as they explore the adoption of the new techniques. The mobile laboratory has supported other OTA activities, such as stone matrix asphalt (SMA), and is expected to perform this support activity more frequently in the next few years.

**TECHNOLOGY TRANSFER AIDS :** Mobile laboratory (subject to scheduling), telephone and on-site assistance, speakers, and specialized workshops and seminars.

**PUBLICATIONS :** *Summary of Simulation Studies*, by J. D'Angelo and T. Ferragut, 1991.

## DP-108 Pavement Management Analysis

**PURPOSE :** To demonstrate how various PMS prioritization methods are used to identify justifiable and cost-effective pavement preservation strategies for various funding levels and develop multi-year prioritized list of pavement preservation projects.

To demonstrate how PMS pavement performance data is used to perform engineering analyses that could evaluate pavement design, construction, materials and maintenance procedures as they relate to performance of pavements.

**BACKGROUND :** The ISTEA Interim Final Rule for management systems requires each State Highway Agency to develop a PMS for the National Highway System capable of performing various pavement analyses.

These analyses included pavement performance analysis to analyze the current and predicted performance of specific pavement types, investment analyses to estimate total cost for present and projected conditions across the network, and investment strategies to prioritized pavement preservation projects with recommended preservation treatments that span single and multi-year periods using life-cycle cost analysis.

The regulation also requires the PMS to be capable of performing engineering analyses for appropriate network sections that could evaluate pavement design, construction, rehabilitation, materials, mix designs, and preventive maintenance as they relate to performance of pavements.

State examples of pavement performance, multi-year prioritization methods, cost analyses and engineering analyses will be used to develop two to three-day demonstration sessions. The project consists of two demonstration activities.

- The first activity consists of a series of PMS outreach sessions to provide one-on-one discussions and technical assistance to States that are developing the analyses required to perform **multi-year prioritization of pavement preservation projects.**

- The second project consists a demonstration of the **use of PMS performance data in engineering applications.**

The main topics to be demonstrated in the multi-year prioritization demonstration activity are:

- Pavement Performance Analysis
- Selection of Pavement Preservation Strategies and Treatments
- Cost Analyses
- Effects of Budget Constraints
- Project Selection Process

The main topics to be demonstrated in the use of PMS performance data in engineering applications demonstration activity are:

- Historical Performance Data

- Evaluation of Pavement Design Procedure
- Evaluation of Pavement Construction Practices
- Materials Performance Analysis
- Pavement Preservation Analysis

**PROJECT MANAGER :** Luis Rodriguez, HNG-41, (202) 366-1335.

**STATUS :** A contract has been awarded for the multi-year prioritization demonstrations. Demonstration sessions are expected to begin in the first quarter of 1996.

Bids are currently being evaluated for a contract to perform PMS engineering analysis demonstrations. The contract should be awarded by the end of 1995 and sessions are expected to begin in early 1997.

## Bridge Design and Construction

Bridge design, as many other segments of civil engineering, has evolved from early art forms to a sophisticated science. A hundred years of experience have been assimilated into the engineering practice, and modern research and development findings have been re-examined, tested, proven in service, and codified into bridge specifications and practice. The traditional design philosophies and methods, such as Working Stress Design (WSD) and Ultimate Strength Design (USD), are still used in bridge design. However, recent developments in bridge design specifications have departed from the traditional approaches to incorporate more rational methods.

Load Factor Design (LFD) was a first step toward implementing a bridge design code based on statistical factors accounting for variability of loads, lack of accuracy in the analysis, and the probability of simultaneous occurrence of different loads. Load and Resistance Factor Design (LRFD) extended the philosophy to include resistance factors that account for the variability of material properties, structural dimensions and workmanship, and the uncertainty in the prediction of resistance. The LRFD code, properly applied, is expected to lead to more rational bridge designs that will produce more economical and durable highway bridges. A concerted effort to train bridge designers in the concept of load and resistance factors, as well as the application to bridge design, is crucial to the successful implementation of the new codes.

The LRFD specifications are ideal for assimilating new developments in bridge materials and construction methods, such as electroslag welding and high performance concretes, since resistance factors can be modified as necessary to represent uncertainties in material properties. Part of this project will involve promoting new bridge materials and construction methods and also implementing the LRFD code in bridge design software.

Recent innovative developments in bridge design codes, bridge materials, and construction methods have led to the establishment of 10 milestones.

1. Develop and initiate formal training sessions for the design of bridge superstructures and bridge foundations using the LRFD code.
2. Develop and initiate formal training sessions for the use of nondestructive load testing to determine load ratings of bridges.
3. Develop and initiate a demonstration project on electroslag welding for steel bridges.

4. Approve the LRFD specifications as the sole AASHTO code for design of highway bridges.

5. Upgrade major bridge design, analysis, and rating software with LRFD code: BRASS. AASHTO BDS.

6. Use High-Performance Concrete in a prestressed concrete bridge in Virginia.

7. Prepare Technology Transfer material and conduct a regional seminar on the use of High-Performance Concrete in a prestressed concrete bridge in Texas.

8. Use High-Performance Concrete in parallel structures conventional concrete in one, HPC in the other.

9. Establish an equipment loan program for SHRP-developed High-Performance Concrete test equipment.

10. Establish design and construction guidelines for High-Performance Concrete.

## AP-21 Geotechnical Microcomputer Programs

**DESCRIPTION :** This project has involved the development of several geotechnical programs under contract with geotechnical microcomputer programming firms. These programs have been made available to the States by the OTA.

**BACKGROUND :** The microcomputer industry has undergone rapid changes in recent years. New developments in hardware and software make the use of the microcomputer in civil engineering applications more feasible, practical, and almost indispensable.

The microcomputer can be used to solve many geotechnical problems that need repetitive and yet complicated calculations, such as analyzing embankment and foundation deformations, estimating pile behavior under static and dynamic forces, and calculating foundation settlements. Five of the microcomputer programs developed or under development are:

**COM624P:** Analyzes the behavior of piles or drilled shafts, subjected to lateral loads using the p-y method.

**EMBANK:** Determines one-dimensional compression settlement because of embankment loads.

**SPILE:** Calculates the ultimate static pile capacity in cohesive and cohesionless soils.

**RSS:** Analyzes stability of slopes that contain soil reinforcement. The analysis is performed using a two-dimensional limiting equilibrium method.

**MSEW:** Designs and/or analyzes required reinforcement for mechanically stabilized retaining walls, which does not consider specific facing configurations.

**DRIVEN:** This program is the updated version of the SPILE Program.

**PILE FOUNDATION :** This program will be developed based on the University of Florida program - LPGSTAN which is capable of analyzing bridge foundations subject to extreme events (hurricanes, ship and ice imports). The program will extend its capabilities to include the analysis and design of sound walls, retaining walls, signs and high mast lighting structures.

**PROJECT MANAGER :** Chien-Tan Chang, HTA-22, (202) 366-6749

**STATUS :** The SPILE Program has been upgraded, the new program is called Driven. This program is estimated to be completed by the end of 1995. RSS Program has been completed. It will be tested for about 2 months and will be distributed early December 1995. Contracts are being negotiated to develop a new version of MSEW program and a multiple faceted program called Pile Foundations.

## AP-102 SHRP Distress Identification Manual

**DESCRIPTION :** The *Distress Identification Manual* is a pictorial rating manual for distress identification on highway pavements. The manual's photographs, descriptions, and illustrations provide a reference for the consistent identification and quantification of the severity and extent of pavement distress. It also provides a common language for describing cracks, potholes, rutting, spalling, and other pavement distresses. As a "distress dictionary," the manual has the potential to improve inter- and intra-agency communication while leading to more uniform evaluations of pavement performance.

The manual is divided into three sections that focus on particular types of pavement: (1) asphalt concrete surfaced, (2) jointed Portland cement concrete, and (3) continuously reinforced Portland cement concrete. Each distress is clearly labeled, described, and illustrated.

**BACKGROUND :** In 1987, the Strategic Highway Research Program (SHRP) began its largest and most comprehensive pavement performance the Long-Term Pavement Performance (LTPP) program. The *Distress Identification Manual* was developed as a tool for the LTPP program. It allows States and others to provide accurate, uniform, and comparable information on the condition of LTPP test sections. Moreover, it enables individuals and agencies to interpret LTPP data or to correlate LTPP findings with their own research efforts.

**PROJECT MANAGER :** James Walls, HNG-42, (202) 366-1339

**STATUS :** The SHRP distributed multiple copies of the latest color version of the *Distress Identification Manual* in July 1993. NHI will offer several training courses on the Manual to State and local highway agencies starting in the Fall of 1995.

Copies of the training materials will be made available to academia and the Technology Transfer Centers.

**TECHNOLOGY TRANSFER AIDS :** The project manager will continue to provide technical advice and participate in conferences, seminars, workshops, and user training sessions. Test and evaluation by a limited number of States is also anticipated.

**PUBLICATIONS :** *The Distress Identification Manual for the Long-Term Pavement Performance Project* can be purchased from the Transportation Research Board. Telephone: (202) 334-3214; Fax: (202) 334-2519 Cost: $20.

## AP-118 Falling Weight Deflectometer Quality Assurance Software (SHRP)

**DESCRIPTION :** This project develops, markets, and distributes generic versions of the Strategic Highway Research Program's (SHRP's) Falling Weight Deflectometer (FWD) Quality Assurance software for use by State highway agencies. The generic versions accommodate various FWDs, sensor numbers, sensor spacings, and test protocols.

**BACKGROUND :** The SHRP FWD Quality Assurance Software is a spinoff product of SHRP's Long-Term Pavement Performance (LTPP) studies. It is one of four spinoff products SHRP recommended for FHWA implementation activities in 1992.

Falling Weight Deflectometers are used widely by highway agencies to collect pavement response data used in pavement rehabilitation design, pavement management systems, and forensic examinations of failed pavements. The overall goal of the SHRP FWD Quality Assurance Software is to ensure the consistent collection of high-quality pavement deflection data.

To provide quality assurance for FWD data collection, SHRP developed four software programs and established reference calibration centers at several State highway agencies to provide for quality measurement and data collection.

Since many of the State highway agencies either own or contract for deflection testing services by an FWD, the use of this quality assurance software should provide improved testing data. Unfortunately, all of this software was written specifically for SHRP and its methods. As an example, the programs are written to read data files from Dynatest FWD with seven sensors at the prescribed SHRP sensor spacing.

**PROJECT MANAGER :** Max Grogg, (518)431-4224.

**STATUS :** A Technical Working Group was established in 1993. During 1994 the LTPP Division continued to revise these software packages based upon their need, experience, and input from the Technical Working Group. These modifications should be completed by October 1995. In 1996 a consultant contract will be executed to perform the software modification. Additional funding will provide for training on the software and the calibration centers. Limited field testing by the SHAs will be conducted, and modified generic software will be marketed.

## TE-14 Innovative Contracting Practices

**DESCRIPTION :** The objective of this project is to identify innovative contracting practices for evaluation and documentation that have the potential to reduce life-cycle costs to State highway agencies, while maintaining product quality and an acceptable level of contractor profitability. Practices tested under this contract include design/build, warranties, guarantees, lane rental, cost plus time bidding, and incentives/disincentives.

**BACKGROUND :** This project resulted from the work of a 1988 Transportation Research Board (TRB) task force that spent 3 years exploring innovative practices in the U.S. and abroad. Its findings were released as Transportation Research Circular Number 386, titled "Innovative Contracting Practices" (1991).

Another initiative relative to innovative contracting practices resulted from an asphalt pavement study group's 1990 European tour. The group was impressed with what it saw and recommended three innovative practices that could be pursued through a test and evaluation effort:

- Functional contracts (design/build),
- Warranties of riding surfaces, and
- Lane rental.

In addition, a fourth practice, cost-plus-time bidding, has gained widespread acceptance from State highway agencies.

**PROJECT MANAGER :** Wady Williams, HNG-22, (202) 366-0606

**STATUS :** This project has been operational for over 5 years and approximately 65 percent of the SHA's have participated at least once.

By far, the most popular technique used has been cost-plus-time bidding. Twenty-six States and the District of Columbia have used this method thus far. Six SHA's have either completed design/build contracts or have initiated such contracts. Contacts have been completed in Arizona and Colorado with favorable results. Total project time was substantially less than would have been expected for conventional design-bid-build projects, there was no significant change in design costs, and claims were essentially eliminated. Six SHA's have undertaken projects using the lane rental concept to reduce road-user impacts and, eight SHA's have chosen to use and evaluate warranty provisions.

In 1995 FHWA published *Rebuilding America: Partnership For Investment*, FHWA publication No. FHWA-PD-95-028, which contains descriptions of innovative practices and a list of projects using these practices.

**TECHNOLOGY TRANSFER AIDS :** Lane rental specifications, background information on warranties and guarantees (from the Transportation Research Board), and telephone and speaker assistance.

# TE-18 Stone Matrix Asphalt

**DESCRIPTION :** The goal of this project is to test and evaluate the use of Stone Matrix Asphalt (SMA) on several test sections of U.S. highways to determine its construction feasibility and cost-effective performance. DP-90's mobile asphalt laboratories, its staff, and the Turner-Fairbank Highway Research Center staff are available to assist other States with SMA mix design information. The mobile asphalt laboratories provide materials analysis on-site while supporting quality control and compliance.

**BACKGROUND :** In 1990, a team of State, industry, and Federal engineers from the U.S. participated in a European Asphalt Study Tour. Their mission was to identify promising asphalt technologies. Of the asphalt mixture technologies studied, SMA had great promise for use in this country.

SMA is an asphalt mixture developed in the 1980's in Germany to provide a rut-resistant pavement surface layer. SMA's proven performance is attributed to a "gap graded" aggregate gradation that provides a stone-to-stone structure held together by a durable asphalt cement, mineral filler, and fiber matrix. SMA is routinely used in many parts of Europe.

**PROJECT MANAGER :** John Bukowski, HTA-21, (202) 366-1287

**STATUS :** Interest in SMA remains strong. To date, project presentations have been made at nearly 100 locations to thousands of government and industry individuals interested in the various aspects of material selection, design, construction, and performance. Continuing interest in SMA is evident by the increasing number of States that participate and the tonnage of SMA used in projects.

| Year | Number of States | Tons of SMA |
|---|---|---|
| 1991 | 4 | less than 50,000 |
| 1992 | 12 | 100,000 |
| 1993 | 15 | 200,000 |
| 1994 | 23 | 300,000 |
| 1995 | 27 | 400,000 |

Extensive monitoring is under way on more than 50 separate test sites constructed in Maryland, Georgia, Virginia, Texas, California, Alaska, Arkansas, New Jersey, Kansas, Illinois, Ohio, Michigan, Wisconsin, Indiana, and Missouri. Data from these projects are being analyzed and model specifications have been disseminated. Further evaluation is targeting mixture design, cost reduction, quality control, and predictive performance of the SMA pavements. SMA sites are being visited and evaluated by a contractor, which should lead to a greater understanding and more systematic evaluation approach. A mix design research effort funded by the NCHRP 9-8 is underway at the National Center for Asphalt Technology and Auburn University. Efforts are also underway to use some of the Superpave mix technologies in designing SMA.

**TECHNOLOGY TRANSFER AIDS :** Telephone and on-site assistance, speakers, mix design assistance

(based on laboratory availability), and mobile laboratory (subject to long-range planning).

**PUBLICATIONS :** SMA Model Materials Selection and Construction Guidelines are available through the Office of Technology Applications and are also being distributed by the industry. Copies of material on European SMA Synthesis also are available upon request.

## TE-21 Pavement Condition Measurement (SHRP)

**DESCRIPTION :** This project evaluates and promotes state-of-the-art pavement condition evaluation equipment and consolidates previous ongoing activities with SHRP implementation efforts related to pavement condition measurement. The project will be expanded to include new technology as it becomes available.

Three kinds of equipment have been evaluated through field test and evaluation:

- SHRP Ground Penetrating Radar
- SHRP Seismic Pavement Analyzer
- Fully Automated Pavement Distress Measuring Equipment

**PROJECT MANAGERS :** Luis Rodriquez, HNG-41, (202) 366-1335 and George Jones, HNG-41, (202) 366-1338.

**STATUS :** The final report on the fully automated pavement distress measuring equipment has been completed and distributed to all State highway agencies. Reports on additional equipment analysis will be issued upon completion of field test and evaluation. A follow-up test was conducted in North Carolina during December 1994. North Carolina DOT is currently completing the data analysis from that test.

The Technical Working Group met and decided not to fund any additional testing of either the ground penetrating radar or the seismic pavement analyzer. The developers of both pieces of equipment are continuing with the equipments' development. Commercial development through the private sector is encouraged.

**TECHNOLOGY TRANSFER AIDS :** Test and evaluation in selected States through work orders and equipment loan. A follow-up program of workshops, seminars, and literature is envisioned.

## TE-25 Strategic Highway Research Program Work-Zone Safety Devices

**DESCRIPTION :** To improve safety and efficiency of day-to-day maintenance and operations of work zones, the Strategic Highway Research Program (SHRP) produced 12 devices that are applicable in work zones, especially for maintenance activities.

1. Salt Spreader Truck Mounted Attenuator (TMA)
2. Portable Crash Cushion **
3. Ultrasonic Detection Alarm
4. Infrared Intrusion Alarm **
5. Queue-Length Detector **
6. Portable Rumble Strip **
7. Direction Indicator Barricade **
8. Opposing Traffic Lane Divider **
9. Diverging Lights
10. Flashing STOP/SlOW Paddle **
11. All-Terrain Sign & Stand
12. Remotely Driven Vehicle

** Interest indicated by commercial fabricators.

The Salt Spreader Truck Mounted Attenuator is commercially produced and marketed exclusively by private industry. Six of the other devices, representing the basic SHRP developed concepts, are commercially available and are ready for trial field use. These include the Opposing Traffic Lane Dividers, Portable Rumble Strip, Flashing STOP/SLOW Paddle, Direction Indicator Barricades, Work Zone Intrusion Alarms, and the All-Terrain Sign Stand with Signs. The Portable Crash Cushion and the Remotely Driven Vehicle are being modified to improve their performance. The Queue-Length Detector and Diverging Lights have had technical problems that remain unsolved and also appear to have a limited market demand. Further work on these two devices is on hold.

**PROJECT MANAGER :** Joe Lasek, HHS-11, (202) 366 2174

**PROJECT COORDINATOR :** Peter Hatzi, HTA-31, (202) 366 8036

**STATUS :** Most of the devices have been exhibited by the FHWA and SHRP staff at many national and regional conferences and technical shows. The purpose of showcasing the devices during fiscal years 1992 through 1994 is to acquaint potential users with these new devices and to develop interest in their use.

FHWA supports activities to provide the various devices to State highway agencies for trial use and evaluation. A solicitation of interest was made to the State DOTs through FHWA division offices. Based upon responses, funds were provided to the States to acquire limited numbers of the devices for trial use under actual work conditions. In return information on the overall performance of the devices will be provided to FHWA.

Some additional funding will be made available in FY 1994 for acquiring Intrusion Alarms and other devices that may become available for trial use and evaluation. The funding will be provided under normal Federal aid procedures. Through this evaluation method, FHWA will accumulate an information base on the in-service performance of the various devices, while allowing the States to gain experience with them.

## TE-27 Innovative Pavement Materials & Treatments

**DESCRIPTION :** This project provides States an opportunity to evaluate SHRP pavement maintenance products and techniques by introducing preventive maintenance technology and principles. Technical assistance will be provided on surface treatments and guidance will be available in the use of innovative materials. SHRP technology in two areas is included:

- Effectiveness of pavement preventive maintenance: management concepts, optimum timing of various surface treatment applications, guide specifications for preventive maintenance, and a 1-day workshop.

- Innovative materials: pothole patching, crack sealing, joint sealing, spall repair and other materials and surface repair guidelines, introduction of objective data collection techniques for joint seal effectiveness, and a 1-day workshop.

**PROJECT MANAGER :** Patrick Bauer, HNG-21, (202) 366-1554 and Michael Smith, HNG-42, (202) 366-4057.

**PROJECT COORDINATORS :** Jim Sorenson, HNG-42, (202) 366-1333 and Gary Henderson, HTA-21, (202) 366-1283.

**STATUS :** Showcase contracts have been awarded for Preventive Maintenance and Innovative Materials, and pilot workshops have been conducted. Test and Evaluation programs are under development. The first pilot workshop was held in May, 1995, in Colorado. The second pilot is being held in September, 1995, in Arizona. It is anticipated that workshops for both technologies will be available in the late Fall of 1995.

**TECHNOLOGY TRANSFER AIDS :** Seminars, technical assistance, and field test and evaluation work orders.

## TE-28 SHRP Snow and Ice Technology

**DESCRIPTION :** This project tests and evaluates SHRP snow and ice technology products in five major areas: snowplow cutting edges, snow fences, roadway weather information systems, anti-icing technologies, and de-icing chemicals. The project will provide an opportunity for States to test and evaluate better designed snowplows and snow fences, improved storm forecasting and communication methods, and more efficient and effective snow removal and ice control methods.

The primary products emerging from this SHRP technology area are design guides, manual of practice for anti-icing operations, research reports, handbooks, evaluation methodologies, and improved snow removal equipment. Guidelines have been developed for evaluating equipment, materials, and methods for utilizing anti-icing technology. FHWA's implementation effort of the SHRP technology has three parts:

- Anti-icing Technology through a technical services support agreement with U.S. Army Corp of Engineers (Cold Regions Research and Engineering Laboratory CRREL).
- Showcasing contract incorporating workshops, field test and evaluation, and equipment loans.
- Field Test and Evaluations through work orders with State highway agencies.

**PROJECT MANAGERS :** Salim Nassif, HNG-21, (202) 366-1557;Chung Eng, HNG-21, (202) 366-1555.

**PROJECT COORDINATOR :** Gary Henderson, HTA-21, (202) 366-1283

**STATUS :** Product/technologies currently being evaluated include weather information systems for highway operations, anti-icing operations, innovative snow fence design and construction, and snow scoops. Additional products/technologies and participants will be added through the showcasing contract. Work orders were established with 15 State highway agencies to evaluate the effectiveness of SHRP anti-icing techniques over the 1993/94 and 1994/95 winter period. Work orders were also established with an additional seven State highway agencies; four to evaluate the Wels portable interactive weather prediction system, and several other weather services in terms of usefulness and accuracy for highway operations; two to evaluate snow fences designed in accordance with SHRP guidelines; and one to evaluate the effectiveness of the snow scoop retrofitted to their existing plows.

A showcase contract has been executed to package the various technologies and develop a series of workshops and seminars focusing on snow and ice technologies. Additional field trials will be initiated with selected States to further evaluate various products by winter 1995/96. Workshops will begin during the first quarter of 1996.

**TECHNOLOGY TRANSFER AIDS :** Workshops on snow and ice technology will be available in the near future. Following standard work order procedures, States may participate in field tests and evaluations of selected products. Technical assistance will be available to guide participants on proper application and evaluation of products/technology. Limited funding is available.

**Pavement Management Technology :** This technology group focuses on those technologies related to identification, evaluation, and testing for pavement distress and collection of pavement performance data. It includes a Distress Identification Manual and several pieces of equipment developed under the Strategic Highway Research Program's Long Term Pavement Performance (LTPP) program. Programs under this group will establish a continuing effort to test and evaluate emerging equipment and technology and will provide

comprehensive reports of testing results to the industry. This effort will result eventually in more accurate and consistent distress identification and performance data.

## TE-30 High Performance Rigid Pavements (HPRP)

**DESCRIPTION :** The immediate goal of the HPRP Program is to construct some selected highway projects to explore the applicability of other innovative concrete pavement design and construction concepts in the United States. The long range goal is further improvement of cement concrete pavement design, materials, and construction technology and equipment through innovation, research, training, and following pavement technology developments in other nations.

**BACKGROUND :** In 1992 a team of State, industry, and Federal engineers participated in the U.S. Tour of European Concrete Highways. Their mission was to review European concrete pavement experiences and obtain information relating to finance, research, design, construction, maintenance, and performance to assist with development of appropriate actions for enhancing the U.S. highway system. The follow-up visits to Germany and Austria obtained sufficient information to construct experimental sections using German design and Austrian exposed aggregate surface treatment technique to reduce tire/pavement noise..

**PROJECT MANAGER :** John M. Becker, HNG-40, (202) 366-1340

**PROJECT COORDINATOR :** Suneel Vanikar, HTA-21, (202) 366-0120

**STATUS :** In 1993 a 1-mile test section was constructed on I-75 (Chrysler Freeway) in downtown Detroit, Michigan. The design and construction procedures of the experimental pavement section were similar to those used in Germany and Austria. The project will be monitored for 3 years and evaluation reports have and will be prepared. An open house was organized during construction to demonstrate the European design and construction technology. FHWA plans to participate in additional projects incorporating some of the European and other innovative design features.

State Highway Agencies have been asked to submit proposals for HPRP projects by October 10, 1995. Expert Working Groups will be formed to select projects for FY 1996 funding, to evaluate HPRP performance and to oversee open house activities and to develop $T^2$ workshops.

**TECHNOLOGY TRANSFER AIDS :** Telephone and on-site assistance, speakers, and mobile laboratory.

**PUBLICATIONS :** *Report on the 1992 U.S. Tour of European Concrete Highways.* 1992, and *Summary Report of Follow-up Tour of Germany and Austria,* 1993. Both reports are available through the Office of Technology Applications. A video-tape on the Michigan project is available from the Office of Technology Applications..

# TE-34 SHRP Concrete Showcase Contracts

## CONCRETE MIX DESIGN AND CONSTRUCTION AIDS (SHRP)

**DESCRIPTION :** This project provides State DOTs and industry with SHRP-developed information on concrete mix design and curing tables along with providing technical assistance for implementation. Curing tables will aid resident engineers and contractors in their decision process.

**BACKGROUND :** Packing diagrams have been developed by SHRP to get dense concrete. The diagrams are used as mix design techniques. Properly used, the mix design may improve tensile strength and durability. Curing tables have been developed and include temperature, cement content, and critical dimensions to aid proper curing. The goal of these efforts is to obtain dense, impermeable, and durable concrete with minimum cracks.

**PROJECT MANAGER :** Suneel Vanikar, HTA-21, (202) 366-0120

**STATUS :** A Work Order was provided to the Indiana DOT in 1992 to perform field verification of packing diagrams, and field testing and evaluation are complete. A work order was provided to the University of Louisville for additional testing and evaluation in 1994 and is underway. Minnesota DOT conducted their own packing handbook evaluation in 1994. In 1994, the Missouri HTD examined the packing handbook for possible use in mix design.

In 1994, these products were promoted through presentations, and they will be incorporated into other SHRP-related implementation efforts for concrete durability and high performance concrete.

In 1995, the draft Packing Handbook evaluation report and the Curing Tables evaluation report were sent to AASHTO and distributed to members of the Technical Working Group.

**TECHNOLOGY TRANSFER AIDS :** Presentations are available upon request from the Office of Technology Applications.

## CONCRETE DURABILITY (SHRP)

**DESCRIPTION :** This project will showcase SHRP-developed products and provide education and technical assistance to State DOTs and the industry by developing and presenting workshops and providing testing equipment to State DOTs through an equipment loan program.

This implementation effort includes new test procedures for D-Cracking potential of aggregates, a revised test procedure for freeze-thaw durability, and specifications for aggregates. It will also include an expert system for rehabilitation strategy. The durability of concrete structures and pavements is a key issue in rebuilding infrastructure.

**PROJECT MANAGER :** Gary Crawford, HTA-21, (202) 366-1286

**PROJECT COORDINATOR :** Suneel Vanikar, HTA-21, (202) 366-0120

**STATUS :** Five impact echo devices, five in situ surface air flow permeameters and five hydraulic fracture devices have been purchased and are available through an equipment loan program. The impact-echo device has been loaned to ten agencies, the surface air flow permeameter has been loaned to eight agencies, and the hydraulic fracture device has been loaned to five interested highway agencies. The products are being promoted through a manual, workshops, equipment loans, and technical assistance. Consultant services were obtained in 1994 to develop and present workshops, showcase products, manage the equipment loan program, and provide technical assistance. A pilot workshop was held in Virginia in June 1995. Regional workshops will start in late 1995 and continue through 1996. Some products will also be demonstrated in the FHWA mobile concrete laboratory.

**TECHNOLOGY TRANSFER AIDS :** Workshops, equipment loans, and technical assistance through consultant services. A manual will be developed for the workshops.

## ALKALI-SILICA REACTIVITY (ASR) AND FLORESCENT MICROSCOPY (SHRP)

**DESCRIPTION :** This project will provide education and technical assistance to State DOTs and the industry while showcasing SHRP-developed products relating to alkali-silica reactivity (ASR) and florescent microscopy.

ASR is a problem for many States, particularly those with concrete pavements. This implementation effort includes identification of ASR, field and laboratory tests, mitigation of ASR in existing structures, and mix design procedures to reduce potential for ASR.

The project will develop and present workshops, provide testing equipment to State DOTs through an equipment loan program, and provide technical assistance.

**PROJECT MANAGE :** Roger Surdahl, HNG-23, (202) 366-1563

**PROJECT COORDINATOR :** Suneel Vanikar, HTA-21, (202) 366-0120

**STATUS :** Six ASR field detection test kits have been purchased. The consultant contract to develop a 3-day workshop and other showcase activities was awarded in 1993. A pilot workshop was held in Pennsylvania in late 1994. Workshop presentations started in 1995, and workshops were presented in Nebraska, New Jersey, North Carolina, Wyoming, Nevada, Oregon, Minnesota, and New Mexico. An equipment loan program has been established, and technical assistance is provided under the contract. Equipment loan and technical assistance were provided to Pennsylvania, Nevada, Idaho, Delaware, Oregon, and Indiana DOT's. Field testing of lithium compounds to minimize ASR is underway in New Mexico, Nevada, New Hampshire, and Pennsylvania.

In 1996, the products will be promoted through a manual, additional workshops, product showcasing, and technical assistance. Some products will continue to be demonstrated in the FHWA mobile concrete laboratory.

**TECHNOLOGY TRANSFER AIDS :** Workshops, equipment loans, and technical assistance through consultant services.

## Concrete Pavement Design and Construction

The concrete pavement design and construction technology group focuses on innovative designs and construction techniques that provide immediate solutions to specific Portland cement concrete pavement problems. The range of technologies addresses water in pavements, faulting joints and cracks, paving under limited time restrictions, pavement durability and economy, and methods of achieving improved overall performance through performance-related specifications.

Several projects incorporating emerging technologies for design and construction are in development stages. These include high-performance rigid pavement design and construction methods, various concrete pavement texturing techniques to minimize noise and enhance safety, and evaluation and implementation of performance-related specifications for concrete pavements.

## TE-36 High-Performance Concrete

**DESCRIPTION :** This national effort will include seminars, workshops, equipment loan programs, demonstration bridges, and technical assistance to evaluate, showcase, and promote high performance concrete and SHRP research products in high performance concrete. The initial goals are to obtain all equipment, specifications, test procedures, and reference documents related to the subject; organize the materials; develop seminar and workshop technology transfer materials; and plan an equipment loan program. The secondary goals are to present seminars and workshops, implement the equipment loan program, provide technical assistance, and construct Demonstration Bridges.

**BACKGROUND :** The Strategic Highway Research Program (SHRP) supported considerable research into high performance concrete. As a result of this research, new testing methods have been developed and some existing testing methods have been modified to 1) determine the validity of existing test methods; 2) give greater uniformity to test results; and 3) give engineers greater confidence in the material properties of high performance concrete.

A major goal of SHRP was to develop improved criteria and testing methods for the mechanical properties and behavior of high-performance concrete. The training and dissemination of information to personnel (governmental and industry) required to perform tests and mixture design is an essential step for the effective use of new field identification procedures, test procedures, and mixture design methods.

**PROJECT MANAGER :** Terry D. Halkyard, HTA-22, (202) 366-6765

**PROJECT COORDINATOR :** John M. Hooks, HTA-22, (202) 366-6643

**STATUS :** A national multi-year effort is planned that would target a maximum number of interested government and private industry engineers and technicians. This effort will promote the use of high performance concrete and the thorough evaluation of SHRP-developed products to transfer technology to a wide audience throughout the United States. High performance concrete is being used in bridges under construction in Nebraska, Texas and Virginia, and plans are being made for its use in bridges in New Hampshire, Ohio, Colorado, Georgia and Washington. A workshop on the use of high performance concrete in the Texas bridge is planned for early 1996.

**TECHNOLOGY TRANSFER AIDS :** Workshops on High Performance Concrete, technical assistance, speakers, and presentation materials.

### Bridge Inspection and Bridge Management

More than 40 percent of the Nation's 575,000 highway bridges are functionally obsolete or structurally deficient. These deficient structures represent significant impediments to the safe, economical use of the highway system and result in safety hazards, high user costs, and huge outlays for preservation and replacement. Balanced against this backlog of bridge needs is a generally inadequate level of funding by public agencies for infrastructure needs.

The collapse of the Silver Bridge in 1967 was the immediate catalyst for what became a comprehensive bridge safety inspection program mandated by the National Bridge Inspection Standards (NBIS). Every bridge on a public road must be inspected at least every 2 years and highway agencies across the Nation have inspection

staffs and programs that collect and update critical bridge inventory and inspection data. After almost 20 years, there is still a manifest need to more effectively analyze this data, to better define bridge needs, and to find effective solutions.

The complexities and costs associated with preserving the Nation's bridge infrastructure demand innovative approaches to collection and analysis of data and prediction of current and future bridge preservation actions. These needs, coupled with the availability of modern analytical methods and high-speed computers, are leading to the development of comprehensive bridge management systems. Prior to the late 1980s, there were no existing management systems adaptable to the management of bridge programs nor was there any clear definition of key bridge management principles or objectives. Therefore, in cooperation with AASHTO, California DOT, and a specially formulated technical working group (TWG) representing several State DOT's, OTA was able to establish the following primary requirements of a comprehensive Bridge Management System (BMS):

*General Procedures*

1. Identify and establish responsibility for data collection and management and for bridge decision making based on a comprehensive BMS.

2. Coordinate program and project-level decisions and coordinate bridge maintenance and improvement actions and a process of priority programming.

3. Ensure a clear method of communicating needs and programs to outside audiences.

*Functional Needs*

1. Automated database of bridge inventory, condition data, and a historical data file.

2. Deterioration models for projecting future condit[illegible] of bridge elements with or without intervening actions.

3. Identify costs related to feasible actions, user costs associated with a deficient bridge condition, and budget and other key constraints.

4. Develop multi-period procedures and reporting capabilities.

Efforts to define modern bridge management led to a cooperative effort with California DOT and the TWG to be develop the PONTIS BMS. With Pontis under development, and with the added incentive of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, six milestones were established:

1. Publish Version 2.0 of PONTIS, the BMS jointly developed by FHWA, California DOT and the TWG (complete); accomplish transfer of PONTIS support to the AASHTOWare software system (complete).

2. Develop and begin formal BMS training sessions for bridge inspectors and bridge managers (sessions to be underway beginning in October 1995).

3. Establish an FHWA network of BMS specialists and regional TWGs to provide BMS training and support to SHA and local agency bridge managers (underway).

4. Implement a Commonly Recognized (CoRe) Element system to define standard bridge elements

(complete); establish uniform method of converting core element condition data to NBI format (ready for adoption).

5. Each State implement a comprehensive BMS (underway).

6. Organize a new demonstration project to promote innovative computer hardware and software to improve efficiency and quality of bridge data collection and management (scheduled to begin in FY 1997).

# TE-39 SHRP Asphalt Support Projects

This project supports a multitude of activities to promote the SHRP asphalt program.

**PROJECT MANAGERS :** The managers for all TE-39 projects are: John D'Angelo, HTA-21, (202) 366-0121; Thomas Harman, HTA-21, (202) 366-0859; and John Bukowski, HTA21, (202) 366-1287.

## POOLED FUND EQUIPMENT STUDY SUPPORT (SHRP)

**DESCRIPTION :** FHWA, in cooperation with AASHTO and SHRP, initiated a pooled fund study that gives the participating States the opportunity to acquire SUPERPAVE asphalt binder and mix test equipment. Since the pooled fund announcement on January 10, 1992, States have committed at least a portion of the estimated $335,000 to purchase the equipment. The pooled fund study allows each State to use its Federal SP&R monies without matching funds.

**STATUS :** Procurement of the equipment is scheduled for a 4-year period. All participating States have received the SUPERPAVE binder equipment. The mix design equipment must go through further development with a series of first article testing. This process should allow for a more rigid analysis of the equipment prior to the purchase. The States have received the gyratory compaction equipment to begin work on the SUPERPAVE mix design system.

Procurement of the mixture analysis equipment and the SUPERPAVE Shear Tester and Indirect Tensile Tester will initially be limited to six units. These will be evaluated at SUPERPAVE Centers established in PA, AL, TX, NV, and IN as well as at the FHWA TFHRC. Equipment procurement for all State DOTs of these devices is scheduled for 1996.

**TECHNOLOGY TRANSFER AIDS :** Equipment on loan (subject to availability), State reports available through the Office of Technology Applications (subject to availability), and telephone assistance.

## SHRP ASPHALT EQUIPMENT LOAN PROGRAM

**DESCRIPTION :** This project evaluates asphalt binder equipment developed to support the binder specification under the Strategic Highway Research Program (SHRP). The Office of Technology Applications (OTA) has five sets of asphalt cement testing equipment, plus one set for OTA and one set for FHWA's Research and Development. This equipment includes:

- Bending beam rheometer with computer
- Dynamic shear rheometer with computer
- Pressure aging vessel
- Direct tension tester with computer
- Brookfield viscometer

Ruggedness and precision/bias data are being collected for the final specifications (a secondary but very important purpose of this project). OTA is working closely with the AASHTO Subcommittee on Materials to accomplish this expeditiously.

**STATUS :** All equipment has been delivered and will continue to be loaned to States within each user-producer group. Funding also involves workshops (that include the user-producer group concept) and evaluation monies, as required.

**TECHNOLOGY TRANSFER AIDS :** Equipment specifications, vendor list, and provisional test procedures. Binder technicians are available for on-site training, three-day workshops, and telephone assistance.

## SHRP F[illegible]D IMPLEMENTATION ASPHALT

**DESCRIPTION :** This project w[illegible]rovide technical assistance to the States in the local use of Superpave equipment provided under the pooled fund buy. A competitive contract was awarded to the Asphalt Institute for field engineers and technicians to assist the States. Assistance will include equipment setup, testing, test interpretation, local workshops, training in the design and construction of mixes, and guidance for the construction of Special Pavement Section (SPS) 9 design and construction. This project will be closely integrated with LTPP.

**STATUS :** The contract was be let in FY 1995 and will last for 3 to 5 years.

**TECHNOLOGY TRANSFER AIDS :** On site training, field and telephone technical assistance.

## SHRP SUPERPAVE MODELS

**DESCRIPTION :** This project will assist in completing the SHRP work on the model ~ that underpin SUPERPAVE. The effort will be completed through a competitive bid contract. The work will include software support, model documentation, and further refinement and documentation. The contract for technical assistance win be let in 1993 and operate for 3 to 4 years.

**STATUS :** Procurement is on hold until the SHRP reports on the models are made available to include in procurement documents.

## GEORGIA LOADED WHEEL TESTER (LWT)

**DESCRIPTION :** This project supports SHRP asphalt implementation efforts by evaluating innovative asphalt testing equipment. Products under consideration include the nuclear asphalt content gauge, indirect tensile test, moisture sensitivity tests, and most significantly, the Georgia Loaded Wheel Tester (LWT). While not directly associated with SHRP, this project will finance additional evaluations of SHRP-developed products not specifically identified in the pooled fund buy.

**BACKGROUND :** The Georgia LWT was developed by Dr. Jim Lai at Georgia Tech, in cooperation with

the Georgia DOT. It is a quick, efficient, and inexpensive method for determining rut susceptibility of surface mixes. Georgia DOT has developed a specification that is used on all high-traffic roadway projects and other projects where rutting susceptibility is a concern.

FHWA sponsored a round-robin test program with six State DOTs to evaluate the Georgia device, which was found to be repeatable and reproducible. A Work Order with Georgia DOT was issued by FHWA to modify the device to make it semiautomatic and controlled electronically. The modified device is capable of testing multiple samples at one time and handling 75 by 125 by 375 mm samples. The temperature and the hose pressure also are adjustable.

A second round-robin test program is planned to evaluate the modified device.

**STATUS :** Five States have evaluated the Georgia LWT and will report their findings during the next several years. Georgia Tech has upgraded several features of the LWT to make it semiautomatic and electronically controlled. This modified device is being tested currently. An Expert Task Group was assembled in late 1993 as States completed their evaluations. Funding for this project considers additional State evaluations of this and as yet undefined equipment and techniques that show promise.

**TECHNOLOGY TRANSFER AIDS :** Equipment loans, field and telephone technical assistance.

## Asphalt Pavement Design and Construction

The asphalt pavement design and construction technology group focuses on innovative techniques for design and construction of high performance asphalt pavements used in new construction, reconstruction, rehabilitation, restoration, or resurfacing.

Since 1987, the Federal Highway Administration (FHWA) has supported the "Development of Performance-Related Specifications for Highway Construction" as one of its high priority research areas. Performance-related specifications (PRS) require materials and construction tests, the results of which correlate to a known degree with the performance of the completed product. A series of FHWA, National Cooperative Highway Research Program (NCHRP), and State Planning and Research (SP&R) studies have produced the initial framework and at least a partial system of PRS for hot mix asphalt pavement construction.

The focus in the PRS is on quality control of construction selecting the best available materials and establishing the mix and pavement designs. PRS addresses three questions:

- What quality control tests need to be run *during* construction to minimize premature fatigue cracking or rutting?
- What is the impact on the subsequent performance of deviations from the target values of properties such as density or asphalt content, or both?
- What payment adjustments are appropriate when such deviations are encountered?

The focus of other projects under this technology group is to evaluate these specific technologies to determine the optimum procedure to achieve quality construction and high performance asphalt pavements.

## TE-44 Electrochemical Chloride Extraction from Reinforced Concrete Structures

**DESCRIPTION :** The objective of this project is to demonstrate and document the results established under the SHRP Study. A secondary objective is to work in conjunction with States, private sector, and academia to collect data on new structures protected using the chloride extraction method. Pilot projects will include installations on both the decks and substructures.

**BACKGROUND :** Corrosion of reinforcing steel is recognized as one of the major contributors to the deterioration of reinforced concrete structures, and the chloride ions that penetrate to the level of the reinforcing bars are a critical element in the corrosion process. One technique for dealing with this problem is chloride extraction. The electrochemical extraction of chloride from concrete structures is accomplished by applying an anode and an electrolyte to the concrete surface and passing direct current (DC) between the anode and the reinforcing steel, which acts as a cathode. Since anions (negatively charged ions) migrate toward the anode, it is possible to cause the negatively charged chloride ions to migrate toward the anode and away from the steel. Chloride extraction is similar in principle to cathodic protection (CP). The major difference is in the magnitude of the current, which is about 100 to 500 times that used for cathodic protection. The total amount of charge (current time) applied for chloride extraction is about the same as a CP system would deliver over a period of about 10 years. The other important difference is that chloride extraction is a short-term treatment, whereas cathodic protection is normally intended to remain in operation for the life of the structure.

**PROJECT MANAGER :** Donald R. Jackson, HTA-22, (202) 366-6770

**STATUS :** A work order with Virginia and South Dakota Departments of Transportation to install and evaluate the electrochemical chloride extraction procedure was approved for a bridge carrying 34th Street over I-395 into Arlington, Virginia, and a bridge in Sioux City, South Dakota. The procedure was installed on three sections of the Virginia deck and three piers of the South Dakota bridge in the early spring of 1995. The procedure was also installed on three substructure piers on a structure in Charlottesville, Virginia, in the Spring of 1995.

Open houses were held for the Virginia and South Dakota installations in August 1995. The Open Houses were well attended. Ten States were represented at the Virginia Open House, and five at the South Dakota Open House. The South Dakota Open House took place on August 9, 1995 in Sioux City. Fifty guests, representing Federal, State, academic and private sector organizations, attended each Open House.

# CHAPTER 11
# REGION / DIVISION ITEMS