FHWA-SA-96-008

U.S. Department
of Transportation

**Federal Highway
Administration**

November 1995

Technology Applications Programs

Innovation Through Partnerships

This publication can be found on the internet at
http://www.dot.gov/dotinfo/fhwa/hta/fhwahta.html

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List of Abbreviations

AASHTO ..... American Association of State Highway and Transportation Officials

FHWA ..... Federal Highway Administration

IVHS ..... Intelligent Vehicle-Highway Systems

ISTEA ..... Intermodal Surface Transportation Efficiency Act of 1991

LTAP ..... Local Technical Assistance Program

LTPP ..... Long-Term Pavement Performance

MCTRANS .... Center for Micro Computers in Transportation

NHI ..... National Highway Institute

NHTSA ..... National Highway Traffic Safety Administration

OHS ..... Office of Highway Safety

OTA ..... Office of Technology Applications

R&D ..... Research and Development

R&T ..... Research and Technology

SHRP ..... Strategic Highway Research Program

Introduction

The technology applications mission of the Federal Highway Administration (FHWA) is to ensure the timely identification and assessment of innovative research results, technology, and products and the application of those that are determined to be of potential benefit to the highway community.

The technology applications program involves all areas of highway technology, including asphalt and concrete pavements, environment, structures, geotechnology, hydraulics, safety, motor carriers, and traffic operations and management. The program also includes activities related to the implementation of the products from the Strategic Highway Research Program (SHRP) and the administration of the Local Technical Assistance Program (LTAP) for FHWA.

This publication focuses on the four categories that, for the most part, comprise the technology applications program: demonstration, application, test and evaluation, and special. Technical activities are assigned to one of the categories depending on the stage of the technology, and, after development, what technology transfer or marketing approach would be most useful in reaching the intended users.

- **Demonstration Projects**—Efforts to promote nationwide a proven material, process, method, equipment item, or other feature that FHWA has targeted for adoption by the highway community.

- **Application Projects**—Individual efforts to assess, refine, or disseminate an emerging technology. Such efforts may include contracts, regional or national seminars or workshops, specifications, notebooks or pamphlets, instructional/ how-to guides, open houses, and focused clearinghouses that are not part of demonstration or test and evaluation projects.

- **Test and Evaluation Projects**—Efforts to evaluate innovative or emerging technologies that have been identified as having a great potential for use nationwide.

- **Special Projects**—Evaluation efforts of industry and the FHWA in conjunction with interested States to evaluate a material, process, method, or other feature. An effort begins with a technology sharing meeting, progresses through a work plan and several control experiments (or operational tests) to a closeout evaluation. These special projects can lead to a demonstration, test and evaluation, or a combination of the two types of projects.

The FHWA effort includes staffs in the Office of Technology Applications (OTA), the program offices, and the field offices. In many cases, FHWA program office staff manage these projects in their areas of specialization. OTA is the central office for administering the technology applications program.

Each project write-up in the four categories includes its project number, its title, description and status section, and the name, organization code, and telephone number for the project manager and, where appropriate, for a project coordinator. The description section includes information about the reasons for initiating the project and the background and processes related to the individual project. The status section includes a discussion of the current and some past activities of the project.

The publication is arranged according to the subjects reflected in the table of contents. Within these sections, the projects are organized under the four categories. In the back of the report, an index lists the project numbers under the four categories, cross referencing them to their pages in the main section of the report. There is also a special index for SHRP projects only.

SHRP projects are described under one of the four categories and are identified by the SHRP logo. More SHRP projects and activities will be added as they come on line.

The LTAP is administered separately from these projects, with delivery of technology and products accomplished for the most part through the 50 Technology Transfer Centers. The program's activities are discussed in other publications, including a resource catalog developed for FHWA by the LTAP National Technology Transfer Clearinghouse.

In a similar vein, the joint State- and FHWA field office-directed experimental projects program is available periodically in publications based on records accumulated electronically in the National Experimental Projects Tabulation.

Asphalt Mix Technology

Asphalt is the predominant material used for paving in the United States. More than 500 million tons of asphalt are placed on America's highways annually. Selecting, designing, producing, specifying, and placing asphalt material has been the subject of research and analysis dating from the 1820s to today's Strategic Highway Research Program (SHRP) and Stone-Matrix asphalt (SMA).

Today there is a spectacular array of mixes, from dense graded to large stone and from open graded to stone-matrix asphalt. However, as an early leader in asphalt mix design (Francis Hveem) cautioned us more than 80 years ago, regardless of arrays and names, "...the materials...will all continue to act and respond to the same natural laws." Research to understand these laws, both on the road and in the laboratory, has intensified over the last several decades as the volume, type, axle load, and tire pressure of today's traffic continuously increases. Additionally, crude supplies are less consistent, quality stone is more expensive and less available, recycling old pavements demands a better understanding of the natural laws, and the service-life expectancy of pavements needs to increase in order to reduce construction delays.

This technology group evaluates and promotes design, control, and testing techniques to improve asphalt mixes. The SHRP Superpave incorporates a full system approach to mix design and analysis, including a performance-based binder specification and tests, a design technique that uses consensus standards, and testing techniques to perform design mixes. There is also an innovative technique to evaluate and predict performance in the laboratory.

While Superpave provides for a full approach to mix designs, the search for mix innovation continues with the evaluation of the American version of European stone-matrix asphalt and results for Georgia DOT's R&D program (the Georgia Loaded Wheel Tester). These projects demonstrate a decade-long commitment to evaluating and adopting better technology.

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 SUPERPAVE MIX DESIGN SYSTEM, MIX VERIFICATION, and 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 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.

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 1980s 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	No. of States Participating	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 underway 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 a 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 materials on European SMA Synthesis also are available upon request.

Stone Matrix Asphalt project in Frederick, Maryland.

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

Description

FHWA, in cooperation with AASHTO and SHRP, initiated a pooled fund study that gives 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 needed 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 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. Procurement of these devices for all State DOTs 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 oneset 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 Field Implementation Asphalt

Description

This project will provide 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 let in FY 1995 and will last for 3 to 5 years.

Technology Transfer Aids

On-site training, field, and telephone technical assistance.

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; the tests were 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 electronically controlled. The modified device is capable of testing multiple samples at one time and handling 75 by 125 by 375 mm samples. The temperature and hose pressure are also 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 currently being tested. 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.

National Asphalt Training Center II

Description

This project,previously designated as DP101 originally established a national training center on the Superpave asphalt binder/mix analysis system. The major objective of the center was to teach engineers and technicians Superpave equipment operational techniques and to develop educational materials. The training center, located at the Asphalt Institute in Lexington, Kentucky, established a uniform and accurate application of Superpave asphalt design and analysis systems. During the initial phase of Superpave training, from July 1993 to February 1995,sixteen 1-week asphalt binder courses and fourteen 1-week Superpave mix design courses were taught. Initial site visits and mix design work was also conducted on projects in Arizona, Kansas, Minnesota, Kentucky and Maryland.

The next phase of this effort, designated as the National Asphalt Training Center II, will be to develop and conduct training courses on mix analysis/pavement performance predictions using the Superpave shear tester and indirect tensile tester. Also, a limited number of the initial binder and mixture courses will continue to be presented. However, the major emphasis of binder and mix design training will be to move the training from a national centralized location to the users. Additionally, Superpave technical assistance will be available on-site to highway agencies.

Another important aspect of this effort is to coordinate testing efforts of five Superpave Centers. These Centers will conduct analysis of the equipment as well as procedural ruggedness and precision/bias.

Background

An essential step for effective use of the new Superpave asphalt binder and mixture design tools is training and dissemination information to those individuals from government and industry who are required to operate the equipment and perform the new tests. This initial training is urgently needed to establish a uniform and accurate application of the SHRP asphalt binder/mix design and analysis systems.

Project Manager

John Bukowski, HTA-21, (202) 366-1287

Status

On September 1, 1995 the FHWA awarded the Asphalt Institute, Lexington KY a $3.5 million contract on Superpave Advanced Training and Field Assistance. Under this effort, the OTA over the next 5 years will utilize the Asphalt Institute to provide additional Superpave laboratory trainingin the two critical areas of mixture design and mixture performance prediction. This activity at the Institute will continue the theme of the National Asphalt Training Center, started with the FHWA initial Superpave implementation training efforts in 1993. Additionally, a large part of the upcoming effort will be devoted to conducting joint efforts with the Superpave Regional Centers, ruggedness efforts on Superpave mix procedures, local on-site training, technical assistance and workshops.

On-site technical visits are currently available to State DOTs. One week binder and mix courses have started, with pilot mix analysis training courses schedulded in Spring 1996.

Publications

Superpave Asphalt Binder Test Methods (Illustrated Lab Methods), FHWA-SA-94-068

Background of Superpave Asphalt Binder Test Methods, FHWA-SA-94-069

Background of Superpave Asphalt Mixture Design and Analysis, FHWA-SA-95-003

Superpave Asphalt Mixture Design (Illustrated Lab Methods), FHWA-SA-95-004.

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, 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 for achieving quality construction and high-performance asphalt pavements.

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 deteriorationand 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 have also 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.

SP-202 Break and Seat of Jointed Reinforced Concrete Pavements

Description

This project was established to field test the effectiveness of breaking and seating jointed reinforced concrete pavement (JRCP) slabs prior to application of asphalt concrete (AC) overlays. The purpose of the research is to identify any effects associated with different levels of breaking effort (as measured by the resultant crack spacing in the JRCP) in reducing reflective cracking in asphalt concrete overlays over time. It also seeks to define the optimum breaking effort that balances thermal movement of the fractured slab at old joints and working cracks with loss of structural support for carrying traffic loads.

Background

In June 1989, FHWA, working with industry, cosponsored a technical forum with State engineers to discuss the concepts of breaking and seating JRCP. This technical forum provided the framework of the experimental design.

West Virginia, Ohio, Kentucky, and Louisiana State highway agencies participate in this experiment and have constructed the control and test sections. In addition to the core test sections constructed by all participating States, a variety of additionalsupplemental experimental sections unique to each State were constructed and are being monitored.

Monitoring includes deflection testing of the pavement before, during, and after construction, as well as annual visual distress surveys of the AC overlay. It also includes measurements of thermally induced horizontal movement at joints and working cracks in the underlying JRCP. Movement is measured by an inexpensive mechanical displacement gauge developed by Pennsylvania DOT in cooperation with Pennsylvania State University. Gauges are mounted on the slab face of the underlying JRCP slabs at the lane-shoulder joint.

Project Manager

James Walls, HNG-42, (202) 366-1339

Status

Test section construction was completed in early 1992; sections constructed earlier have been monitored since the fall of 1990. The experiment is scheduled to be completed after collection of 5 years of monitoring data.

The project is now in the monitoring phase and preliminary reports on the projects are available. Upon completion of the experiment, FHWA will develop and publish construction guidelines in the FHWA pavement design guide.

Technology Transfer Aids

Construction Summary reports are available through the Office of Technology Applications (subject to availability).

Concrete Mix Technology

The current focus in the concrete mix technology (CMX) group is on field management of concrete mixes and the design and construction of high-performance concrete bridges and pavements. Technology transfer activities continue with the use of a mobile concrete laboratory to conduct workshops on state-of-the-art concrete technology. Seminars on the selection and use of concrete admixtures to enhance the performance and durability of concrete mixes are major elements of the technology group. Innovative and rapid testing methods for concrete are emerging as a means of increasing productivity and quality. This technology group includes a 1-day workshop on nondestructive testing technology and an equipment loan program. In the Strategic Highway Research Program (SHRP) area, showcase activities include mix design and construction aids, concrete durability, alkali-silica reactivity, and high-performance concrete bridges. All activities and technologies in the CMX group are focused on producing and testing for a more durable and better-quality concrete.

DP-75 Mobile Concrete Laboratory

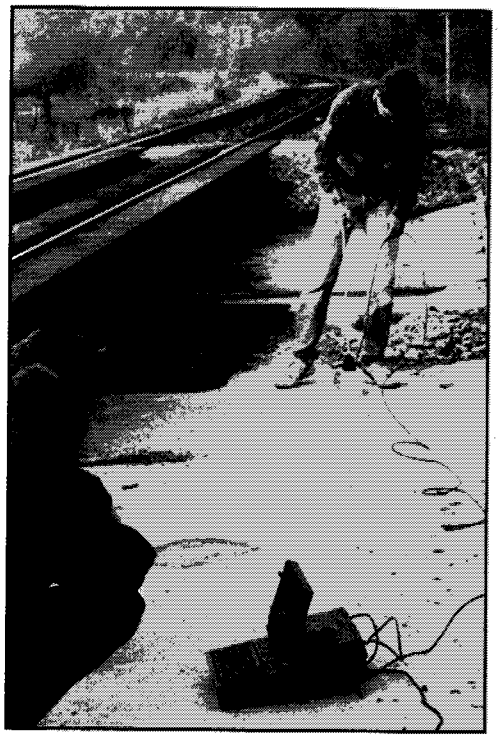
Description

The project's goals include demonstration of state-of-the-art concrete technology in materials selection, mix design, 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 focusing heavily on rehabilitation and reconstruction, highway engineers place ever greater demands on Portland



Impact Echo Device being demonstrated in the field.

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.

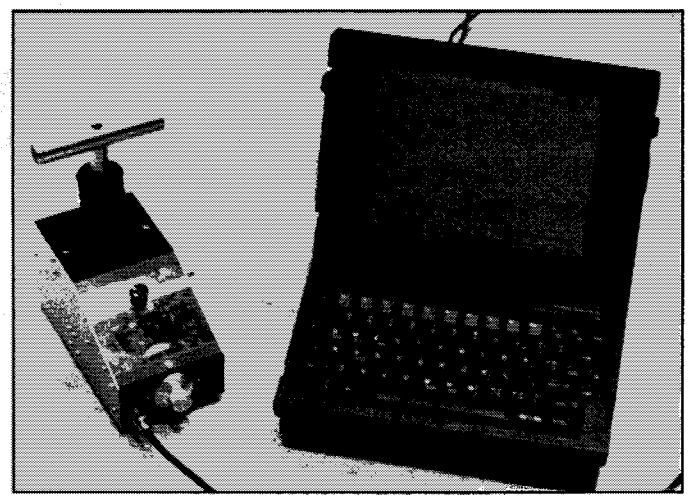
With the use of a mobile concrete laboratory, 26 field demonstrations have been performed in the last 5 years. Two-day workshops on state-of-the-art concrete technology have been conducted in 44 States. Twenty 1-day seminars on "Concrete Admixtures" have been conducted. Many presentations, including 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 haveattended 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
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



The Impact Echo Device.

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.

TE-34 SHRP Concrete Showcase Contracts

Includes Concrete Mix Design and Construction Aids, Concrete Durability, and Alkali-Silica Reactivity

Concrete Mix Design and Construction Aids

Description

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

Background

Packing diagrams have been developed by SHRP for use in achieving dense concrete. The diagrams illustrate mix design techniques. Properly used, the mix design may improve tensile strength and durability. Curing tables have been developed and includetemperature, 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 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 currently 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

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 assessing the 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 in late 1995 will 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 Flourescent Microscopy

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 the 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 Manager

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 DOTs. 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 the developmental 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.

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 have also 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. In a future NHI course, the scope of the workshop portion of this project will be expanded 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 upon 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.

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 experience and obtain information relating to finance, research, design, construction, maintenance, and performance to assist in the development of appropriate actions for enhancing the U.S. highway system. Follow-up visits to Germany and Austria provided 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 T2 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 videotape on the Michigan project is available from the Office of Technology Applications.

SP-201 Accelerated Rigid Paving Techniques (FASTRACK)

Description

This project evaluates techniques that will allow concrete paving to be used in situations where there is limited time to close traffic lanes. Coordinated efforts include technical assistance to State DOTs, evaluation of test sections, cosponsorship of workshops and national conferences, the integrated use of concrete mobile laboratories, and a task force to develop detailed practices and procedures. Two major technical issues, including the strength values at which the pavement can be opened to traffic and temperature management of concrete slabs, were studied by a joint task force. The task force has analyzed recent research and development findings that use different modeling techniques to allow for earlier opening values than those currently considered acceptable. Many State specification values for either compressive or flexural strengths as criteria for opening to traffic have been established independent of pavement thickness, traffic type, or curing techniques.

A second issue involves determining the proper use of curing blankets to accelerate strength gain and to maintain a uniform temperature gradient within the slab. The literature is devoid of any in-depth discussion of these issues and there are no known models capable of analyzing the

system. A concise report (including the technical papers developed by the task force) was published in 1995.

Background

The typical reaction to using concrete paving where there is limited time to close lanes has been "And what are we to do about the traffic?" For the last several years, FHWA has worked closely with the paving industry to evaluate a family of techniques that will allow for the effective use of concrete in these situations.

Project Manager

Suneel Vanikar, HTA-21, (202) 366-0120

Status

Sixteen States have participated. Industry and the Office of Technology Applications (OTA) continued mutual activities through 1995. A joint task force with participation from industry, State DOTs, and FHWA was organized in 1990. Task force goals have been accomplished. A report on the strength values at which the pavement can be opened to traffic and slab temperature management techniques was completed and has been included in a report summarizing work accomplished in the States.

Technology Transfer Aids

Technical assistance and site visits, equipment loan through Demonstration Project 75, "Mobile Concrete Laboratory," and speakers.

Publications

FHWA reports on six accelerated rigid paving projects available through the Office of Technology Applications. A report entitled, "Accelerated Rigid Paving Techniques, State-of-the-Art" is available from the Portland Cement Association.

SP-204 Retrofit Load Transfer

Description

This project is underway and calls for working with the concrete paving industry to establish doweled load transfer across faulted joints or working cracks in jointed concrete pavements. This concept calls for the production cutting of three slots in at least one wheel path per pass, with each slot able to accommodate a 38 mm (1.50 in) diameter, .450 m long (1.5 ft) epoxy-coated dowel.

Project Manager

Roger Larson, HNG-42, (202) 366-1326

Project Coordinator

Suneel Vanikar, HTA-21, (202) 366-0120

Status

A contract for a 53 km (33 lane mile) project to retrofit three 38 mm (1.50 in) epoxy-coated dowel bars per wheelpath at each undoweled joint or working crack in the outside (truck) lane of eastbound I-90 in the State of Washington has been successfully completed. A national openhouse was held in Seattle on June 21-22, 1994 to discuss the technique and visit the construction project. A Technical Working Group of FHWA, State Highway Agency, Industry, and Academia met on June 23, 1994 to develop technical guidance to help implement this promising technology. An airport runway texturing machine developed by Concrete Textures, Inc. was modified to construct six slots at one time at each square or skewed joint or crack. After patching, the lane was diamond ground to restore the ride and the joints or working cracks were resealed. Magnum Diamond and Machinery, Inc. also demonstrated a newly-developed, very maneuverable machine to cut three slots at a time in one wheelpath. The bid price for this project was $34.50 per dowel installed, compared to the previous price on experimental projects of $60 to $65.

Based on the success of this project, Kansas constructed a project to restore load transfer across working cracks of all lanes of about 13 kilometers (eight miles) of a jointed reinforced concrete pavement on I-70 near Abilene. In addition, they constructed some supplemental SPS-4 sections

to allow a longer-term evaluation of technique effectivenes. The low bid for this project was $22.50 per dowel installed. The diamond saw used on this project was developed by Cushion Cut. Immediately prior to starting the Kansas project, this saw was used to construct one mile of dowel bar retrofit on I-29 in South Dakota. In the fall of 1994, it was also used on a small maintenance contract in Minnesota to install experimental sections designed to evaluate other cost-effective alternatives for lower-volume roads.

In a separate effort, work was completed in June 1994 in Indiana that demonstrated the feasibility of using carbide technology to dry mill three slots in one wheelpath for working cracks in JRCP. This procedure significantly reduces the secondary preparation time and labor needed to prepare the slots, increases the production rate, and reduces the delay time to the traveling public during construction. There has not yet been a long-term performance evaluation of this approach. However, the initial construction report and the first annual evaluation report are now available. This equipment is now being used on a New Jersey project to restore load transfer on some older JRCP and will be used on a similar project in West Virginia starting in September 1995.

A draft of a new chapter on Load Transfer Restoration for the FHWA Pavement Rehabilitation Manual is currently available and will be finalized shortly. A draft report summarizing the results of SP-204 is being prepared and is expected to be finalized by the end of the 1995 to close out this effort.

Information on this effort and the SPS-4 experimental sections in Kansas and South Dakota has been furnished for inclusion in the workshops being developed to promote preventive maintenance activities developed under the Strategic Highway Research Program.

A national Concrete Pavement Restoration workshop is currently being planned by the American Concrete Pavement Association in conjunction with FHWA. This workshop will be held in the Northeastern U.S. in April 1996 and will include current guidance on this and other concrete pavement restoration techniques.

Technology Transfer Aids

A videotape of the Washington State project prepared for the Washington DOT is now available and will be copied and distributed in the future. Videotapes of the Kansas SPS-4 and Indiana projects are also available. Exploratory phone calls are welcome.

Construction and Maintenance Technology

The Construction and Maintenance Technology group focuses on innovative construction, maintenance and contracting technologies. All of the technologies in this group have common, interrelated objectives designed to improve quality, enhance operational efficiency, and reduce the initial and life-cycle costs of construction and maintenance activities. The CMT group includes such critical areas as innovative contracting practices, quality management in support of the National Quality Initiative, and products produced under the Strategic Highway Research Program's (SHRP's) Highway Operations program. The SHRP program areas focus on preventive maintenance and effective control of snow and ice.

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

During the past decade, there has been a conscious effort within the United States to promote a correlation between American products and quality. In general, this effort has focused on 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 promulgated 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 State-level NQI activities has been provided.

An "NQI National Conference" was 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 5-day courses and 41 of the 56 available 2-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, including 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.

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 SHAs have participated at least once.

By far, the most popular technique employed has been cost-plus-time bidding. Twenty-six States and the District of Columbia have used this method thus far. Six SHAs 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 SHAs have undertaken projects using the lane rental concept to reduce road-user impacts and eight SHAs 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-27 Innovative Pavement Materials & Treatments

Description

This project provides States an opportunity to evaluate SHRP pavement maintenance products and techniques by introducing preventive maintenance technologies 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
Michael Smith, HNG-42, (202) 366-4057

Project Coordinators

Jim Sorenson, HNG-42, (202) 366-1333
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 work-

shop 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, a 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 surrounding SHRP technology has three parts:

SHRP Snow and Ice Technology

- Anti-icing Technology developed through a technical services support agreement with the 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 Testing and Evaluation 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

Products/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 techniquesover the 1993/94 and 1994/95 winter periods. 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 during 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.

A Technical Working Group was established in 1993. During 1994, the LTPP Division continued to revise these software packages based on 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.

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 eventually result in more accurate and consistent distress identification and performance data.

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 the 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 include 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 to evaluate pavement design, construction, rehabilitation, materials, mix designs, and preventive maintenance as they relate to the 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 with (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 the engineering applications demonstration activity are:

- Historical Performance Data
- Evaluation of Pavement Design Procedures
- 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.

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, leading to more uniform evaluations of pavement performance.

The manual is divided into three sections each focusing 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. Testing 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

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 widely used 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 on 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-21 Pavement Condition Measurement

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
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 testing 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 development of the equipment. Commercial development in the private sector is also encouraged.

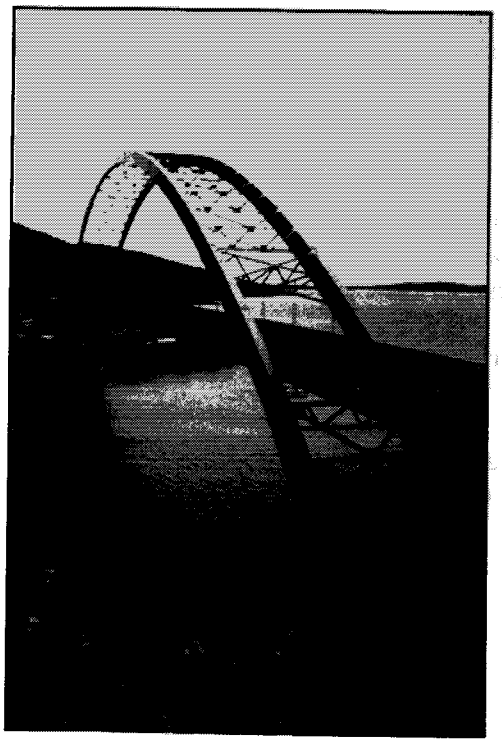
Technology Transfer Aids

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

Bridge Design and Construction

As with many other segments of civil engineering, bridge design 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. 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 that account for variability of loads, lack of accuracy in 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 uncertainty in the prediction of resistance. Properly applied, the LRFD code 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 their applications 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 will include 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 formal 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 LRFDcode: 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.

DP-99 Bridge Design and Analysis

Project Coordinator

The coordinator for DP-99 projects is Terry Halkyard, HTA-22, (202) 366-6765

Load and Resistance Factor Design (LRFD) of Bridges

Description

This project helps engineers understand new state-of-the-art LRFD bridge design codes developed and adopted on a trial basis by AASHTO.

The LRFD method applies statistically determined factors to bridge design parameters. It uses a series of load factors and resistance factors to account for variabilities in properties of loads and material resistances. The LRFD specifications employ statistical methods and probability theory to define the variations in loading and material properties, and the likelihood that various loads combinations will occur simultaneously.

Background

Since 1931, the design and construction of highway bridges in the United States has been governed by the Standard Specifications for Highway Bridges published by AASHTO. Over time, there have been numerous revisions and updates and the specifications have begun to resemble a patchwork quilt. A number of major gaps and inconsistencies were compounded by a lack of commentary to explain the intent or background of any of the specificationprovisions. After reviewing several options, AASHTO decided to develop an entirely new bridge code that would incorporate state-of-the-art bridge engineering and would be based on the load and resistance factor design approach. After review and consideration, the new specification is expected to be adopted by AASHTO for use by any agency that designs bridges in the United States. This new specification is a radical departure from the traditional design philosophy ofWorking Stress Design (WSD), which requires that the total stress caused by all design loads be less than a specified percentage of the bridge material's stress limit. While this design concept has worked well for many years, engineers have known that neither loads nor material properties can be defined with accuracy and precision. The LRFD code,

with its extensive commentary, is seen as state of the art and technically easy to maintain, as well as ultimately easy to understand and use by bridge designers.

Project Manager

Terry Halkyard, HTA-22, (202) 366-6765

Status

A 5-day training course on LRFD design of bridge superstructures is available. A contractor began work in September 1995 on development of a companion course on LRFD design for bridge foundations. The course is expected to be available in mid-1996.

Load Factor Design

Description

This project (DP-81) was developed to demonstrate the Load Factor Design (LFD) method to bridge designers and to provide hands-on training in the LFD computer program MERLIN DASH for the design of straight steel stringer bridges.

Background

The Load Factor Design method is an important advancement in the state of the art that provides significant savings in the design of new steel bridges. The concept of applying statistically determined factors to bridge design loads has been incorporated in the design code by the American Association of State Highway and Transportation Officials (AASHTO), which has adopted the LFD method for bridge superstructures.

Project Manger

Tom Krylowski, HTA-22 (202) 366-6771

Status

DP-81 has been closed-out. Representatives of all FHWA offices and most States have attended demonstrations. A metric version of the MERLIN DASH program has been developed.

BRASS

Description

Bridge Rating and Analysis of Structural Systems (BRASS) is a system of computer programs developed by the Wyoming DOT to assist bridge engineers in their efforts to design and determine load capacity of highway bridges. Involved in the BRASS programs are BRASS-GIRDER (steel and concrete, including prestressed), BRASS-PIER, BRASS-TRUSS, BRASS-CULVERT, BRASS-SPLICE, BRASS-PAD (elastomeric bearing pads), BRASS-SCREED, BRASS-POLE (cantilever sign, luminaire and signal support structures), and BRASS-DIST (wheel line distribution factors). A workshop to train bridge engineers to use BRASS has been developed.

Project Manager

Huai Wang, HNG-32, (202) 366-4602

Status

Presentations of the BRASS workshop have been made in Connecticut, Oklahoma, Arizona, Hawaii, Delaware, New York, Nevada, and Maryland. Work is underway by Wyoming DOT to include SI units, in addition to the current English units, and to incorporate Load and Resistance Factor Design Specifications. This work is expected to be completed in 1997. Additional workshops are planned after the conversion is completed.

BRUFEM

Description

Bridge Rating Using the Finite Element Method (BRUFEM) is a system of computer programs developed by the University of Florida, with Florida DOT sponsorship, to develop better bridge rating systems using finite element technology. BRUFEM consists of four FORTRAN programs:

- BRUFEM1, a preprocessor for steel and concrete bridges that develops a finite element model and prepares input files for the finite element program.

- SIMPAL, a finite element program that solves the finite element model created.
- BRUFEM3, a post-processor that reads the SIMPAL output and performs bridge ratings based on the appropriate service level or strength criteria.
- SIMPLOT, a graphics post-processor.

A workshop to train bridge engineers in the use of BRUFEM has been developed.

Project Manager

Huai Wang, HNG-32, (202) 366-4602

Status

BRUFEM workshop presentations were held in Alabama, California, and Oklahoma in 1994. No workshops have been requested in 1995.

AASHTO BDS

Description

With the AASHTO Bridge Design System (AASHTO-BDS), bridge engineers can analyze, design, and rate steel, reinforced concrete, and prestressed concrete girder bridges by using a bridge model generation option for routine bridge design and a general structure option for finite element analysis of complex structures. The AASHTO-BDS program has beeen enhanced through development and incorporation of substructure models for the design and analysis of pier bents and bent caps. Other program improvements that are underway include the capacity to design and rate superstructures and substructures using the LRFD code.

Project Manager

Terry Halkyard, HTA-22 (202) 366-6765

Status

The AASHTO-BDS enhancements (including alpha and beta testing of the software and development of the manuals) are scheduled to be completed by October 1996.

Bridge Rating Through Nondestructive Load Testing

Description

Load rating through testing defines a more realistic live load capacity. The primary objective of this project is to develop a comprehensive manual and a practical training course to provide an alternative bridge rating method based on nondestructive load testing.

Background

Based on their theoretical capacity, many bridges in the United States are classified as structurally deficient and are load posted or closed to traffic. However, bridge engineers have long recognized that many of these structures have a reserve capacity beyond that indicated by analysis.

Bridge load testing has been in use for many years without formal procedures for interpreting and using the results. A recently developed manual discusses the Diagnostic and Proof methods oftesting and introduces equations for rating bridges accordingly. General instructions on loadings, measurements, equipment, test procedures, and examples are included.

Project Manager

Terry Halkyard, HTA-22, (202) 366-6765

Status

Two pilot workshop sessions were conducted under the original contract, which was primarily drawn to develop the manual and workshop materials. A contract will be awarded in 1996 to conduct workshop sessions under the NHI training program.

Technology Transfer Aids

- Two-day NHI workshop on load rating of bridges through nondestructive load testing.
- Training courses on the LRFD method of design for superstructures and foundations, NHI course presentations, and comprehensive participant manuals.
- Hands-on workshops with manuals on the BRASS & BRUFEM computer programs.

DP-102 Bridge Construction

Narrow Gap Improved Electroslag Welding

Description

This project involves conducting workshops and developing guidelines to promote the new Narow Gap Improved Electroslag Welding (NGI ESW) process developed by the Oregon Graduate Institute (OGI) under a FHWA research contract. The new NGI ESW process has the potential to save significant time and dollars in steel bridge fabrication.

Background

On February 16, 1977, the Federal Highway Administration issued FHWA Notice 5040.23, whichplaced a moratorium on using ESW for weldments on primary structural tension members on bridges. The notice followed the discovery of a fractured flange in a major river crossing structure. That notice effectively eliminated the use of the ESW process from all bridge welding even though the process is allowed by the "AASHTO Standard Specifications for Highway Bridges" for welding compression members.

NGI ESW is a high-deposition process that is particularly economical for welding thick materials. Because of the economics, the promise of the process, and concern for the safety of welded structures, FHWA initiated research at the Oregon Graduate Institute of Science andTechnology. The research has been successfully completed. Equipment, weld consumables, welding procedures, and criteria were developed and proven in laboratory and limited field trials by the OGI researchers. The NGI ESW process, with suggested modifications proposed by the researchers, is now an option and has the potential to impact welding techniques for fabricating heavy weldments.

Project Manager

Krishna Verma, HNG-32, (202) 366-4601

Status

A 2-day workshop on the new NGI ESW method is under development by the Industrial Research Laboratory (BIRL) at Northwestern University. It will include hands-on welding demonstrations. A total of 18 workshops - two per FHWA region - will be conducted over an 18-month period beginning in late 1995.

Technology Transfer Aids

Workshop on Electroslag Welding.

AP-44 Bridge Technology Workshops

Description

This project provides well-planned workshops on specific technical subjects as a forum for the effective exchange of innovative technology information. OTA supports such workshops on a regional, tri-regional, and national basis.

Background

Workshops have been held to highlight new bridge engineering technology and new policies and procedures. They are open to bridge engineers and bridge program managers from State and Federal agencies and private sector companies. Since 1989, several conferences and workshops have been sponsored:

- Tri-regional workshops on scour monitoring and bridge inspection.
- Tri-regional workshops on bridge-related ISTEA requirements, including bridge management systems.
- A Region 5 workshop on bridge aesthetics.
- A Region 10 conference on seismic retrofit of bridges.
- A national conference, co-sponsored by the Transportation Research Board, on the Load and Resistance Factor Design of bridges.

- A national conference, co-sponsored with the Transportation Research Board, on bridge management systems.
- A national conference, co-sponsored with the New Jersey DOT, on non-destructive testing of bridges.
- Regional workshops on bridge management systems including PONTIS.
- A regional workshop on removing lead-based paints.
- An International Conference on Design and Construction of Deep Foundations.

Project Manager

John Hooks, HTA-22 (202) 366-6643

Status

The 4th Bridge Engineering Conference, co-sponsored by the Transportation Research Board, was conducted August 27-30, 1995 in San Francisco. Planning is well underway for two major conferences. A National Seismic Conference on Bridges and Highways will be held December 10-13, 1995 in San Diego, and a Structural Materials Technology, Nondestructive Testing Conference will take place February 20-23, 1996 in San Diego. Preliminary planning is also underway for an International Symposium on High Performance Concrete, to be co-sponsored by the Precast/Prestressed Concrete Institute, October 19-22, 1997, in New Orleans.

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 pro-

gram. 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 has been to develop improved criteria and testing methods for the mechanical properties and behavior of high-performance concrete. The training anddissemination of information to personnel (governmental and industry) required to perform tests and mixture design is an essential step in 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 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 program 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 DOTs, 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 decisionmaking 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 condition of bridge elements with or without intervening actions.

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

4. Develop multi-period procedures and reporting capabilities.

Efforts to define modern bridge management have led to a cooperative effort with California DOT and the TWG to 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 initiated 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 to 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).

DP-71 Bridge Management Systems

Background

DP-71 was initiated in 1985 as a series of workshops designed to introduce bridge engineers and bridge program managers to the basic concepts and early methods of bridge management. It is now a multipronged effort to implement sophisticated BMSs; train bridge engineers, managers, and inspectors; and promote advanced hardware and software to manage bridge condition data and select high-priority bridge projects.

PONTIS BMS

Description

Pontis is a comprehensive computer program that has been developed and tested. Pontis isa state-of-the-art BMS that represents a radical new approach to decisionmaking for bridge programs. The software incorporates dynamic, probabilistic models and a detailed bridgedatabase for predicting maintenance, improvement, and replacement needs; recommending optimal policies; and scheduling projects within budget and

policy constraints. Pontis differs from the inventory and management software now used by the 50 States, in that its description of bridge conditions is more detailed and its models are designed to operate on groups of bridges or whole inventories, rather than on individual structures. As many as 13 States have evaluated Pontis and have conducted extensive Beta testing. The program software and manuals have been distributed, and all States will be able to evaluate and consider implementation of Pontis in a comprehensive BMS.

Project Manager

George Romack, HNG-33, (202) 366-4606

Status

The Pontis BMS computer program has been thoroughly evaluated and enhanced as part of a rigorous beta testing program. Pontis has been transferred to the American Association of State Highway and Transportation Officials (AASHTO) as an AASHTOWARE project for future maintenance, support, and enhancement. Forty-three highway agencies have purchased the first year's license to use Pontis and to participate in the project to produce Version 3.0. Version 3.0 was officially released in July 1995. AASHTO is currently developing a workplan for Version 3.1.

Bridge Management Training

Description

The objective of this project is to develop a training course on bridge management principles, practices, and systems for inspectors, engineers, and managers involved in implementing and maintaining the comprehensive bridge management systems required under the Intermodal Surface Transportation Efficiency Act of 1991.

The three overall training objectives are to familiarize upper- and mid-level highway agency managers with essential BMS principles, concepts, and objectives; to provide practical guidance and information to middle managers on development, establishment, and implementation of an effective BMS; and to provide practical training to bridge inspectors who are responsible for collecting and recording bridge inspection data.

Project Manager

George Romack, HNG-33, (202) 366-4606

Status

Development of a formal bridge management training course was initiated in the summer of1994 after award of a contract to develop and conduct training. Pilot courses are planned to test the three course modules: the executive briefing (January 1996); the BMS software session (January 1996); and the element level inspection training module (October 1995).

Regional BMS Network

Description

Bridge engineers from FHWA field offices are being trained as specialists in bridge management and bridge management systems. They will serve as a technical resource to the State and local DOTs to consult and train in bridge management, BMS software, organizational structures, and collection and processing of bridge data. They will also coordinate bridge management technology transfer activities at the regional level.

Project Managers

Mike Fraher, (817) 334-4380
Tom Breslin, (518) 472-4244

Status

The regional BMS network includes eight members from FHWA's regional office and division offices. Two-day seminars on PONTIS and BMS practices are being conducted and an independent training session for bridge inspectors is also being provided.

BMS Training for Bridge Inspectors

Description

Typical BMSs developed today require bridge inspection data to be reported in a format very different from that now used. Ultimately, thousands of bridge inspectors must be trained to identify and quantify bridge elements and condition State data. Training for bridge inspectors will be provided in three ways: by the FHWA regional BMS specialists,

through the future BMS training course, and in the existing NHI "Safety Inspection of In-Service Bridges" course.

Project Manager

George Romack, HNG-33, (202) 366-4606

Status

A BMS version of the 2-week NHI bridge inspection course is now being presented to States that plan to adopt element-level data collection and reporting systems.

Project Coordinator

John Hooks, HTA-22, (202) 366-6712

Technology Transfer Aids

- Two-week NHI course "Safety Inspectors of In-Service Bridges" (CoRe Element version).
- Three-day NHI course on bridge management and bridge management software.
- One-day NHI course on CoRe Element bridge inspection.

Nondestructive Evaluation / Testing

Bridge integrity and durability for long-term service is a continuing nationwide concern. This concern is usually addressed by the ongoing bridge inspection programs that are conducted by or for all agencies that own bridges used by the traveling public. Visual inspection with some surface cleaning of paint or other coverings is usually adequate. However, these coverings mask underlying structural materials. In many circumstances, inspection beyond what is possible with the naked eye is desirable and critical. For instance, delaminations in reinforced concrete members, corrosion or flaws in pre-stressing strands, fatigue cracks in steel members, concrete decks covered with an asphalt wearing course, and structural details such as pin and hangars that make vital components inaccessible to the inspectors.

In these cases, a nondestructive evaluation (NDE) method is necessary to reveal flaws or anomalies that are potentially damaging to the structural member or to the entire bridge. Some techniques commonly applied to bridges for several decades include liquid dye penetrant, magnetic particle, and ultrasonics. Applications are most successful on steel bridge details, concrete, and timber bridge members. These tests are well-established because specifications are well-defined, training programs are readily accessible, qualified technicians are routinely available, and manufacturers have developed reliable, easy-to-use materials.

Other less common techniques involve sophisticated technology and hardware. Examples include wrapped and grouted cables on cable-stayed bridges; anchorages for these cables, complicated structural steel details, and pre-stressing strands encased in concrete members. Research and development in several unrelated disciplines, such as defense, nuclear facilities, and the aircraft industry has resulted in several new technologies with strong potential for application to highway structures. Techniques such as acoustic emission, impact-echo, magnetic flux disturbance, and ground-penetrating radar have been tested to varying degrees, but proven, cost-effective applications have not been fully developed, nor have qualified technicians or engineers been trained. In some cases, instrumentation is still at the prototypical stage and further refinement is necessary before final evaluation. Several of these emerging systems also lend themselves well to unattended operation, remote monitoring, and data collection.

This situation represents a significant challenge to technological application programs. A well-crafted partnership of public agencies is necessary to make these systems available, reliable, and beneficial. This partnership should include bridge owners and engineers, Federal and State research and technology personnel, in addition to private concerns (manufacturers, universities, and consultants). The "market" for these technologies must be created by proving their effectiveness and reliability

to bridge owners who will use the results. It must also be demonstrated to the manufacturers who provide a portion of the money to develop, test, and refine the technology. Proven applications must be developed and proper test protocols established. Trained personnel must be prepared to install equipment, run tests, and interpret data.

TE-23 Nondestructive Evaluation and Testing

Field Trials of the Acoustic Emission Bridge Monitor

Description

The purpose of this project is to test and evaluate the Acoustic Emission Bridge Monitor through demonstrations and field trials, and to develop Application Guidelines and produce two educational videotapes.

Background

Locating and evaluating cracks in steel bridges is a difficult and time-consuming process. With about 90,000 steel bridges on the Federal-aid highway system, bridge inspection personnel spend many hours looking for cracks and bridge engineers spend many more hours evaluating the severity of the cracks found. Most cracks cannot be located visually until they are at least ½-inch long and a significant portion of the fatigue life of the detail has been lost. Cracks can be found much earlier and important evaluations can be made of known cracks by using acoustic emission (AE) testing equipment.

Project Manager

Terry Halkyard, HTA-22, (202) 366-6765

Status

There have been three types of AE field trials:

1. Monitoring bridge details with fatigue cracks caused by out-of-plane bending and similar uncracked details.

2. Checking details on bridge structures that had been inspected with ultrasonic equipment and that yielded unclear results.

3. Testing areas that had been retrofitted to strengthen a cracked detail.

The AE monitoring of cracked and uncracked (similar) details on one structure showed no cracks to be propagating at the details where there were no visible cracks. However, on another structure, the AE monitoring located a small crack beneath the paint where it could not be visually located. Ultrasonic inspection on two structures yielded unclear results and AE monitoring showed no active cracks. On a third structure, where ultrasonic inspection revealed an internal anomaly in a weld but was unable to characterize the stability (actively growing or passive) of the anomaly, AE monitoring revealed that the anomaly was indeed active. The weld has been cored, but the final report on the exactnature of the anomaly has not been published.

The project has concluded and the two videotapes and final report are expected to be available from the Office of Technology Applications late in 1995.

Advanced Bridge Inspection Techniques

Description

This project will further the use of innovative NDE technology by demonstrating and testing equipment and instrumentation to the States. Systems now being considered are AE, magnetic field disturbance (MFD), impact-echo, and magnetic perturbation of cables (MPC). Others will be added for testing and evaluation as this evolving technology matures.

Background

A recent national bridge inventory indicated an alarming number of this country's bridges classified as either structurally deficient or functionally obsolete. To compound the problem, Federally required inspections, which are usually performed visually, often fail to detect cracks or other hidden defects that would affect the structural reliability of bridges.

For more than 20 years, FHWA has encouraged and sponsored research and development of instrumentation to provide State highway agencies with better tools for the nondestructive evaluation (NDE) of bridges. Bridge inspection technology development has become an evolving process as new systems and procedures continually emerge. These rapid advances have caused a backlog of sophisticated instrumentation and equipment in need of further development and testing. In most cases, the technology may remain on the shelf or is rarely used because there

are no practical, cost-effective applications on which testing can be performed, or because of a lack of proven test procedures or field experience by test personnel.

Project Manager

Tom Krylowski, HTA-22, (202) 366-6771

Status

Development of a demonstration project on NDE for highway structures has been deferred to 1997 in order to collect more data on promising technology. A contract for an "Impact Echo System for NDE of Post-Tensioned Concrete Bridge Structures" was successfully completed in mid-1994. Additional studies are subject to available funding. States may request to participate in this project to evaluate promising, innovative bridge inspection techniques.

Project Coordinator

Tom Krylowski, HTA-22, (202) 366-6771

Technology Transfer Aids

Drafts of the Guidelines for applying AE technology to bridge inspections have been completed. Guidelines to applying AE technology for in-process weld monitoring have been developed as well.

Publications

Three videotapes on AE testing have been prepared. Field Trials of the Acoustic Emission Weld Monitor (FHWA-TS-88-021) and Evaluation of Steel in Concrete Bridges: The MFD System (FHWA-SA-91-026) are available from the Research and Development Report Center, HRD-11, 6300 Georgetown Pike, McLean, Virginia 22101-2296.

Corrosion Engineering

Corrosion is a natural electrochemical process in which the energy gained in the conversion of iron ore to steel is released in the form of a direct current. The combination of ferrous ions with an electrolyte at the anode produces corrosion products that can occupy up to seven times more volume than the parent steel. In reinforced concrete structural elements, the electrolyte is (concrete containing water and oxygen), which causes the anodic reinforcing steel to corrode. The corrosion products exert detrimental tensile forces in the concrete that produce delaminations, cracking, and subsequent spalls of the structural element.

The combined technology that has resulted from previous FHWA R&D, developments in commercial corrosion hardware, and the SHRP program in concrete and corrosion provides an impressive array of equipment and methods to evaluate corrosion in reinforced concrete, determine the condition of the concrete element, and determine methods for proper repair, rehabilitation, and protection. The next challenge is to evaluate and demonstrate the effectiveness of the technology and to market the successful results to a variety of users.

On structural steel members such as steel girders and floorbeams, a coating system is used to prevent corrosion. However, in severe environments or after long periods of service, the coating system breaks down and corrosion will occur unless the system is repaired or replaced. Continued corrosion of steel members can lead to severe loss of section with detrimental effects on the service capacity and safety of the structure. Older coating systems were formulated with heavy metals, such as lead and chromium, which have been proven to be hazardous to human health. Therefore, the removal, containment, storage, and ultimate disposal of these old coating systems has become an expensive, environmentally complex problem.

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, which includes 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 causative factor in maintenance, rehabilitation, or replacement of concrete structural elements. The ability to identify active corrosion in the early stages is of primary concern 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 growing attention being 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 include the 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 by contacting the project manager.

DP-91 Cathodic Protection Techniques

Includes Cathodic Protection [CP] for Reinforced Concrete Structures and CP for Reinforced Concrete Bridge Decks

Cathodic Protection (CP) for Reinforced Concrete Structures

Description

DP-91 was established to package and promote CP applications for reinforced concrete structures and to develop solutions to certain problems. This demonstration project provides technical assistance and seed money for construction and evaluation. Acontinuous evaluation of the complete system of installing CP is performed to update the state of the art of CP on structures. This project also provides training to the users of CP to protect their structures and demonstrates several products developed under the Strategic Highway Research Program (SHRP), as well as the results of the LongTerm Pavement Performance Program report.

Background

In certain areas of the country, salt intruding into the concrete is deteriorating bridge structures. This causes spalling as the reinforcing steel corrodes. Salt can come from either de-icing operations or from coastal environments. Protection systems and design criteria are available that will inhibit corrosion and concrete deterioration in new structures.

However, existing structures that are already with contaminated salt are very difficult to handle. Often, with the only choices available are to continue patching spalls or to replace the entire structure. Cathodic

protection (CP) for structures is a cost-effective alternative to replacement and other types of rehabilitation methods. Extending this type of protection to vertical surfaces (such as pier columns and faces of pier caps) has been a challenge. This process involves fastening the anode system to a vertical surface, thus working against the force of gravity.

The Office of Technology Applications has worked closely with the private sector, other FHWA offices, and State highway research personnel in modifying anodes for use on vertical surfaces. CP has been successfully applied to substructure units in a variety of forms. Projects with different anodes were used on pilot projects in several States. Owners are also advised that CP can only be as effective as their commitment to maintain it once systems are installed.

Project Manager

Donald Jackson, HTA-22 (202) 366-6770

Status

Several pilot projects are underway with a variety of anodes being evaluated. Prior evaluation of the systems and extended coordination with the CP industry took place during 1994. A CP course is being developed that will explain the new technology's application relative to reinforced concrete structures. Pilot projects in several States are being evaluated. Information from these projects will be used to more efficiently install CP on substructures. Also, FHWA maintains close coordination with the CP industry to overcome the shortage of anode supply companies. An "International Conference on Corrosion and Cathodic Protection" will be held in November 1996 in Florida. FHWA will also co-sponsor a Corrosion and Cathodic Protection Conference with the National Association of Corrosion Engineers (NACE) in 1995. Location has yet to be determined.

Technology Transfer Aids

Telephone assistance is available from the project manager. Financial assistance in the form of "seed money" may also be available.

Cathodic Protection for Reinforced Concrete Bridge Decks

Description

This activity has provided technical assistance and funding to encourage States to try CP systems on bridge decks. The demonstration included a slide presentation to help inform State and Federal engineers about corrosion problems and cathodic protection solutions. DP-34 has helped to pioneer most of the technological advances made in the application of cathodic protection of bridge decks, including coke-breeze asphalt overlays, slotted systems, mounded systems with overlays, and anode meshes.

Background

The premature deterioration of reinforced concrete bridge decks has become a great concern to highway engineers in the past few years. Both newly-constructed decks (some as new as 2 years) and older decks that have provided good service for many years are deteriorating at an alarming rate. The most common and serious form of deterioration is the delamination of the concrete at the level of the top mat of reinforcing steel and eventual spalling of the deck surface. Delamination of concrete results from the internal tensile forces created by the buildup of corrosion products around the reinforcing steel. CP is the external application of a direct current to the surface of the top mat of steel in amounts sufficientto overcome the internal current flow that occurs when the concrete no longer has the protection normally provided by alkaline content.

Project Manager

Donald Jackson, HTA-22, (202) 366-6770

Status

DP-34 is being closed out. A final report will be published in 1996. More than 60 decks in 35 States, including first, second, and third-generation systems, were installed; more than 15 years of technical assistance to the States and industry was provided. Reports and guide specifications were developed. Several work orders for application and evaluation of CP to bridge decks are still active. An updated slide presentation is available upon request, and technical assistance is available on a limited basis.

DP-94 Lead-Based Paint Removal

Description

This project will address the most cost-effective systems for lead-based paint removal:

- Protection of workers against hazards of ingesting lead particles during surface preparation operations.
- Methods of containing debris from the surface preparation.
- Guidelines and methods for storage and disposal or alternative uses of the material collected from the surface preparation.

Occupational Safety and Health Administration (OSHA) regulations for worker safety will be covered, as well as Federal and State environmental protection regulations. Standard tests for evaluation of toxicity of wastes will be demonstrated.

Background

The hazards associated with removal and disposal of lead-based paints from highway structures are becoming an increasingly critical parameter in the costs associated with maintaining steel bridges painted with lead-based paints. Safety of the worker during paint removal operations is a key health issue, and long-term hazards associated with leachable lead compounds from disposed paint and abrasives is also a serious concern.

Project Manager

Terry Halkyard, HTA-22 (202) 366-6765

Status

Guidelines for lead-based paint removal are in the final stages of editing and will be available early in 1996.

TE-42 Assessment of Physical Condition of Reinforced Concrete Structures

Description

The objective of this project is to conduct a national effort that includes a series of regional workshops, an equipment loan program, and technical support in order to evaluate, showcase, and promote the use of SHRP products for assessing the physical condition of reinforced concrete bridge components.

Background

Deterioration of reinforced concrete by corrosion of the reinforcing steel is the most frequent cause of maintenance, rehabilitation, or replacement of reinforced concrete structural elements. The ability to identify an active corrosion process in the early stages is an important factor in minimizing the cost of corrosion-related repairs. The SHRP study identified several viable techniques that could be combined with the existing technology to provide a "toolbox" for an integrated approach to the condition assessment of reinforced concrete bridges.

The selection of techniques and procedures for application is based on several criteria. Most important is the ability of the method to carry out the required function at an acceptable performance level. Simplicity of operation is another important criterion, and the technology must also be field-ready, rugged, and possess a high degree of reliability.

Preliminary recommendations are:

Delamination Detection - Sounding of concrete surfaces is recommended. Methods using stress waves may be economical if used concurrently to detect other types of damage or deterioration.

Corrosion Detection - Half-cell potential measurement is recommended.

Structural Damage - Stress wave (impact-echo and pulse velocity) methods are recommended.

Reinforcing Cover and Location - Magnetic flux methods are recommended.

Deteriorated Concrete and Voids - Stress wave methods are recommended.

Moisture Content - Neutron methods are recommended.

Strength Assessment - Rebound Hammer or penetration methods, backed up by compressive strength of drilled cores, are recommended.

Prestressed and Post-Tensioned Structures - At this time, only visual methods can be recommended; no quantitative methods are field-ready.

Petrography - This is recommended only when conditions related to concrete quality are involved and data cannot be obtained by any other method.

Project Manager

Donald R. Jackson, HTA-22, (202) 366-6770

Status

The contract for this Showcase project was awarded to Concorr Inc. on August 3, 1994. A pilot showcase is planned for December 1995. Showcase presentations will be available in the spring of 1996.

Technology Transfer Aids

Showcase workshops on assessment of physical condition of reinforced concrete structures.

TE-43 Methodologies for Reinforced Concrete Removal, Repair, Protection, and Rehabilitation

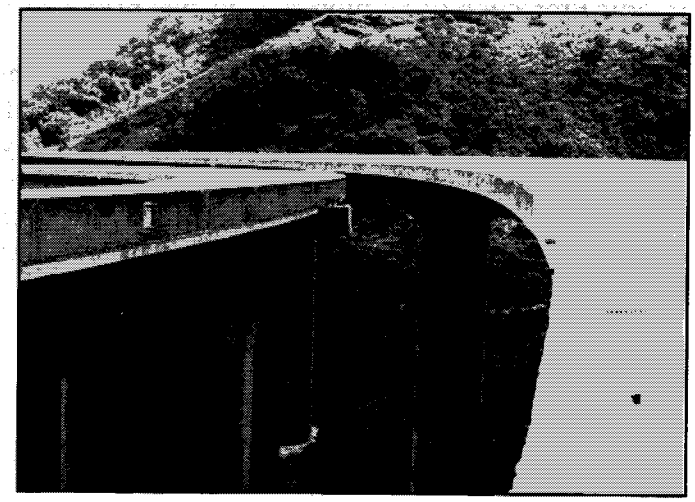
Description

The objectives of this project are: to identify all SHRP equipment, software (computer programs), specifications, test procedures, and reference documents related to methodologies for removal, protection, and rehabilitation of reinforced concrete bridge decks and substructures; to obtain multiple sets of such equipment and software, and sufficient copies of all

relevant technical documents for national distribution; to develop a workshop and instructional materials to explain, demonstrate, and promote the equipment and test procedures; to present two pilot workshops and up to 20 additional workshops to highway engineers and technicians at various locations; to make up to 20 additional presentations to highway engineers and technicians at various seminars, conferences, and other meetings; to develop and implement a program to lend equipment to States participating in such a loan program and to provide all necessary equipment, maintenance and training, and technical support (site visits, telephone support, etc) to State technicians and engineers; to cooperate with AASHTO and with the Cement and ConcreteReference Laboratory (CCRL) in a program for the round-robin testing of the equipment and procedure; to prepare technical materials for publications; and to provide reports describing the results of all activities.

Background

State highway agencies are faced with the continuing challenge of protecting, repairing, and rehabilitating concrete bridges exposed to chloride-laden environments while adhering to the constraints of a limited budget. Under the SHRP research program, several methods designed to foster attainment of these objectives have been developed. These methods include standard physical, chemical, and experimental protection, repair, and rehabilitation methods. Each method is described with respect to limitations, estimated service life, estimated construction price or cost, construction procedures, quality assurance and construction inspection methods, and material performance specifications. In addition, rapid bridge deck protection, repair, and rehabilitation methods are presented. Two mechanized concrete removal methods, milling and hydrodemolition, are compared to the traditional method, pneumatic



breakers. The three concrete removal methods are discussed with respect to labor- and capital-intensive operations, work characteristics, and quality management and control. The advantages of combining the strengths of the three removal methods are also presented. Methods are presented to estimate the service life and remaining service life of concrete bridge components. Economic models are presented to enable selection of the most cost-effective methods (i.e., those with minimum life-cycle cost) from the menu of protection, repair, and rehabilitation methods.

Project Manager

Donald R. Jackson, HTA-22, (202) 366-6770

Status

The contract for this Showcase project was awarded to Wilbur Smith Associates of Falls Church, Virginia, on August 10, 1994. A pilot showcase has been scheduled for December 1995. The finished showcase will be available for presentation in spring 1996.

Guide Specifications for Cathodic Protection of Concrete Bridge Decks

Description

This document was prepared under the auspices of the AASHTO-AGC-ARTBA Joint Committee by Task Force 29 of the Subcommittee on New Highway Materials. The goal of the Task Force was to delineate concise guidelines that can be used by highway agencies as standard specifications for Cathodic Protection of Reinforced Concrete Bridge Decks.

The intent of this publication is to define standard specifications applicable to the nation's bridges. It is recognized that there are bridges that do not match the standard and would besubject to special study and design. The standard bridge deck is a reinforced, double mat rebar with a 6- to 9-inch slab. Standardization is expected to permit contractors to install these systems efficiently, thus providing an economical system to the bridge owner.

Background

Cathodic protection (CP) is the only known means of mitigating the corrosion of reinforcing steel, which is caused by the presence of the chloride ion in existing bridge decks. The routine use of CP for the protection of pipelines and underground structures prompted the development of new technologies that would allow the successful application and operation of CP on bridge decks. The first installation of an impressed current CP system on a bridge deck took place in California in 1973, and utilized high silicon cast iron anodes affixed to the deck and covered with a 2-inch lift of conductive coke breeze asphalt topped with a 2-inch wearing course of asphaltic concrete. Since that pioneering effort, the field of cathodic protection for reinforced concrete bridge decks has matured into a proven technology with several available design options and should be considered as a value-engineering alternative in the rehabilitation of salt-contaminated bridge decks.

As with any new technology, the advancement of the state of the art in bridge deck CP involves the interaction of Federal and State government agencies with researchers, contractors, and private industry. In 1982, the Federal Highway Administration issued a position paper on cathodic protection systems that promoted the widespread implementation of CP as a rehabilitation technique for bridge decks. The intensive research and product development by private industry that followed has led to a new generation of anodes and a substantial reduction in the cost of materials and installation. The final determinant for the success of any technology, however, must come in the form of successful performanceunder field conditions. The satisfactory operation of over 350 systems in 42 States in the United States and 8 provinces in Canada offers suitable testimony to the viability of CP.

Project Manager

Donald R. Jackson, HTA-22, (202) 366-6770

Status

The Task Force No. 29 document was submitted to the AASHTO Committee for "Construction and Maintenance " for approval in June 1994. Approval was granted in November 1994. Copies are available through AASHTO.

Manual for Corrosion Protection of Concrete Components in Bridges

Description

This document was prepared under the auspices of the AASHTO-AGC-ARTBA Joint Committee by Task Force 32 of the Subcommittee on New Highway Materials. The goal of theTask Force is to catalogue and evaluate concrete corrosion protection systems and develop criteria, specifications and construction procedures that will improve the ability of concrete superstructure and substructure elements (excluding highway pavements) to withstand corrosive environments, and the corrosive effects of chlorides from de-icing chemicals or salt water.

Background

Corrosion of reinforcing steel in bridge decks has caused both structural and rideability problems, and has been recognized as a national problem for more than 15 years. In the past 7 years, an even more serious problem has surfaced with other load-carrying members of highway structures: they are evincing the same destructive effects of corrosion noted in bridge decks. The measures for bringing this problem under control involve considerations in new construction and rehabilitation of the present inventory. These protection methods - epoxy coated bars, inhibitors, additives, etc. - act to delay or offset the effects of chloride infiltrations. The objective of this study was to document the types of systems being used for this purpose, noting the differences in techniques. Successes and failures of these systems are noted by providing the technical evaluation results for each system. With the above information, guidelines for the use of each system will be developed.

Project Manager

Donald R. Jackson, HTA-22, (202) 366-6770

Status

The Task Force No. 32 document was submitted to the AASHTO Committee for "New Highway Materials" for approval in 1992. Copies are available through AASHTO for anyone requesting a copy.

Technology Transfer Aids

To be published in 1995 and distributed by AASHTO: Guide Specifications for Cathodic Protection of Concrete Bridge Decks, AASHTO-AGC-ARTBA, Task Force #29.

Published in 1992 and distributed by AASHTO: Manual for Corrosion Protection of Concrete Components in Bridges, AASHTO-AGC-ARTBA, Subcommittee on New Materials, Task Force #32.

Showcase workshops on methodologies for reinforced concrete removal, repair, protection and rehabilitation.

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, the private sector, and academia to collect data on new structures protected using the chloride extraction method. Pilot projects will include installations on both decks and substructures.

Background

Corrosion of reinforcing steel is recognized as one of the major contributors to the deterioration of reinforced concrete structures, and 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 the 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 implemented on three sections of the Virginia deck and three piers of the South Dakota bridge early in the spring of 1995. The procedure was also implemented 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.

SHRP chloride collection kit first generation modification.

SHRP evaluation Rate of Corrosion Device - GECOR-6.

Geotechnical Engineering

Geotechnical engineering has been critical to highway construction since engineers realized that successful civil works depended on the strength and integrity of the foundation material. Classical geotechnical engineering is usually linked to the pioneering work of Karl Terzhagi, who proposed many of the concepts and relationships upon which today's geotechnical practice is based.

Much of the work in recent years has been to improve on Terzhagi's empirical relationships with the analyses based on rational formulae, field data, and high-speed computers, which make sophisticated analysis possible. As an example, empirical pile driving formulae (for example, the EN formula) have been replaced with pile driving requirements based on the Pile Dynamic Analyzer (PDA), as demonstrated in OTA's Demonstration Project 66.

Analysis, design, and construction methods have improved dramatically in recent years as a result of concentrated research, development, and technology transfer efforts. Added to this has been the extensive experience gained by demonstration projects on pile foundations (DP-66) and permanent ground anchors (DP-68). The development of microcomputer-based geotechnical software has also accelerated replacement of simplistic empirical methods with rigid analytical procedures.

While the engineering developments have been dramatic, there needs to be greater promotion to support application of these new procedures. Seven activities will provide innovative technology and new developments in geotechnical engineering to a widespread community of geotechnical construction and structural engineers. The seven activities are as follows:

1. Beta test and distribute final user-friendly microcomputer programs for design of geotechnical features. Programs under development are Mechanically Stabilized Earth Walls, Driven, and Pile Foundations.

2. Conduct an "International Conference on Design of Highway Bridges for Extreme Events."

3. Establish a recommended design method for extreme design conditions on bridges, including ship impacts, scour, and seismic events; issue an FHWA Technical Advisory; conduct a national conference to disseminate technical information on the recommended design method(s) for extreme design conditions and status of the R&D program to develop an improved method.

4. Implement the results of an R&D program to define an improved method of bridge design for extreme events by incorporating the results in the AASHTO code and conducting workshops.

5. Update technical guidance on driven pile foundations and provide NHI training totransportation engineers in design and construction monitoring of deep foundations.

6. Develop a comprehensive series of Geotechnical Engineering Circulars as state-of-the-art resources on geotechnical engineering practice; publish the first in the series on dynamic compaction.

7. Develop and present a training course on application of the Load and Resistance Factor Design (LRFD) code to design highway bridge foundations.

Project Coordinator

Chien-Tan Chang, HTA-22, (202) 366-6749

DP-83 Structure Foundations

Pile Foundations (old DP-66)

Description

This project promotes application of modern technology to pile design and construction monitoring, thereby reducing foundation costs and/or increasing confidence in the foundation. To achieve this goal, the project was developed in different phases.

Phase I was a comprehensive classroom demonstration on the practical aspects and economic advantages of rational pile design and construction monitoring. Phase II field demonstrations of modern construction monitoring techniques included a wave equation computer program, the pile driving analyzer, rapid methods of static load testing, and the saximeter (inspection assistance instrument).

Field demonstrations were often performed in conjunction with construction projects, thus providing a direct comparison with existing State procedures and opportunities for cost savings. The results of each field demonstration were documented in a report that provided specific recommendations for improvement in State practices.

Background

Approximately 20 percent of all funds allotted to bridge construction by the FHWA and State and local transportation departments is spent on pile foundations. In the early 1980s, many pile design and construction monitoring practices resulted in unnecessarily conservative designs because they were based solely on experience and tradition with little theoretical background.

Because of this project, States have achieved substantial cost savings on major bridgeprojects. For example, the State of Washington saved $5 million on an I-90 project in Seattle. Oregon saved $1.5 million on the Alsea Bay Bridge project. Based on a 1991 survey, six impressive changes occurred in State transportation agency piling practice during the life of this project:

1. The American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges (1991 Interim) incorporates many of the procedures and recommendations from the demonstration manual.

2. AASHTO and the American Society for Testing and Materials have developed test standards for dynamic testing of driven piles.

3. Approximately 30 State agencies have implemented the wave equation computer program.

4. Approximately 41 State agencies have used the pile driving analyzer; many use it routinely.

5. Several agencies have implemented computerized design procedures and developed load test result databases.

6. Approximately 30 percent of agencies have made major revisions to their standard specifications for foundations.

Project Manager

Jerry Di Maggio, HNG-31, (202) 366-1569

Status

A contract was awarded to Goble Rausche Likins and Associates Inc., Cleveland, Ohio, to update the FHWA DP 66 Manual entitled Design and Construction of Driven Pile Foundations and to conduct a series of 2- and 4-day workshops.

The manual has been drafted and is currently under review by the Technical Working Group. It will be published in early 1996.

Pilot workshop presentations were planned for Portland, Oregon in October 1995, and Tallahassee, Florida in November 1995. An NHI course will be developed from these workshops.

Design of Highways and Bridges for Extreme Events

Description

This project is a multistage effort to improve the state of the practice for designingbridges for extreme events, such as ship impacts, scour, and seismic events. Project Activities are as follows:

- Identify and evaluate contemporary design methods; select a currently recommended designmethod and publish an FHWA Technical Advisory describing the method.
- Outline a comprehensive R&D program to develop an improved design method.
- Conduct a national conference and several smaller workshops to disseminate technical information on the best current method(s) and status of the R&D program.
- Initiate further technology transfer activities to implement the new methods.

Background

A bridge design method consists of a design process coupled with an appropriate analysis model. Current design methods for bridge substructures and superstructures for special events are not well-defined in existing design specifications and technical references. As a result, designs vary widely from very conservative and costly to extreme and unsafe. AASHTO specifications provide little guidance for special design event loading combinations or for the load magnitudes when combinations are applied.

The current state of the practice for design of bridges subjected to extreme events such as vessel impact, earthquakes and flooding is often unreasonably simplistic. Current design methods often fail to consider three-dimensional interaction between the bridge elements: pile-soil, pile-soil-pile interaction between piles within a group, pile-group structure, and

proper substructure-superstructure interaction and response. This simplistic approach may result in significant increases in bridge costs. In addition, current design processes are not interdisciplinary or interactive. The design process is partially phased and segmented between structural, geotechnical, and hydraulics engineers. Each discipline develops their design segment with lite inter-disciplinary input, and often with little regard for their impact on other disciplines. This lack of interaction between disciplines and the use of simplistic analysis models has very often resulted in overly conservative and expensive designs.

This situation has been exacerbated by recent requirements to focus on special design events such as ship impact, seismic, and scour effects. The development of a new rational design methodology (design process and analysis model) is needed to permit rational and cost-effective designs of bridge substructures and foundations.

Project Manager

Chris Dumas, Region 3, (410) 962-2464

Status

The 2nd Technical Working Group meeting was held September 26-29, 1994, in San Francisco, California, to select best current methods, outline critical R&D needs, and define the format and objectives of the national conference scheduled for November 1996 in Atlanta, Georgia.

The primary focus of this meeting was current and future procedures for the design of highway bridges for seismic events. Presentations where made by California DOT, Oregon DOT, Washington DOT, and a variety of West Coast consulting engineers. In addition, presentations on future methodologies were made by Lawrence Livermore Labs, PMB Engineering (Offshore Oil), and the University of California at Berkeley. In response to need areas identified at the first two TWG meetings, three small Purchase Order (P.O.) projects are currently underway:

Synthesis Report on Loading Combinations of Extreme Events. This is a jump-start activity by the FHWA to define the problem, identifyt potential solutions, and develop strategies for a much larger NCHRP project. This project was voted a top-five research priority by the AASHTO Bridge Committee ant both their 1994 & 1995 meetings.

Guidelines for the Structural Design of Highway Bridges Subject to Vessel Impact. A consensus was reached at the first TWG meeting that the Florida DOT (FDOT) procedures constitute the best current design

method for highway bridges subjected to vessel impact. In accordance with the TWG, FHWA funded a P.O. to develop guidelines that provide a detailed step-by-step delineation for the FDOT procedure. A complete draft of guidelines was presented to the TWG at the San Francisco meeting for review and comment. The TWG indicated that the guidelines needed greater detailing on how a coupled-foundation-to-structure analysis is performed. The third P.O. (described below) was developed to address this need.

Guidelines for the Design of Lateral Loaded Foundations. These guidelines will provide a detailed step-by-step procedure for a coupled-foundation-to-structure analysis. This will include the equivalent pile length method, equivalent spring method, and equivalent foundation stiffness matrix method. The Guidelines will be a stand-alone FWHA document that will be feathered into other FHWA documents such as "Guidelines for the Structural Design of Highway Bridges Subject to Vessel Impact."

A third workshop was tentatively scheduled for the fall of 1995 in Tallahassee, Florida. The focus of this workshop will be implementation of the tools and documents found and/or developed as part of the overall project.

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 madeavailable 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 morefeasible and practical, and indeed, almost indispensable.

The microcomputer can be used to solve many geotechnical problems that require repetitive, complex 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 caused by embankment loads.

SPILE: Calculates 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 (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." It is estimated that this program will be completed by the end of 1995. The RSS Program has been completed. It will be tested for about 2 months and will be distributed in early December 1995. Contracts are being negotiated to develop a new version of the MSEW program and a multifaceted program called Pile Foundations.

AP-131 Geotechnical Engineering Circulars

Description

The objective of this project is to develop a series of comprehensive and practical manuals that provide state-of-the-practice methods and techniques to assist the highway engineer in the design and construction of highway facilities. No other agency or group has assembled such a complete set of manuals for geotechnical engineering. These manuals will be modeled after the well-respected set of hydraulic engineering circulars and hydraulic design series, and they are expected to become a mainstay of geotechnical engineering practice worldwide. The first manual will concentrate on design and construction on weak foundation soils using dynamic compaction. The manual will expand and update the 1989 FHWA technology transfer package that summarized the design and construction features of the dynamic compaction technique.

Background

Dynamic compaction densifies soils to relatively great depths by applying energy at the ground surface. This technique has been used to densify natural and fill deposits varying from 3 to 10 meters below ground and has applications for various civil engineering construction projects.

From 1980 to 1986, the Federal Highway Administration conducted comprehensive research to investigate the use of dynamic compaction in highway applications. In 1989, FHWA prepared a technology transfer package that summarized the design and construction features of the dynamic compaction technique.

Project Manager

Chien-Tan Chang, HTA-22, (202) 366-6749

Status

A 5-year contract was awarded to GeoSyntec Consultants Inc., Atlanta, Georgia, in September 1994 to develop 10 engineering circulars in various geotechnical engineering disciplines. Under a separate contract, a circular on dynamic compaction has previously been completed. The third circular is being developed and will be published late in 1995. GeoSyntec

has completed the final draft of the circular on earth retaining systems and publication is planned for early 1996.

Technology Transfer Aids

- Computer programs COM624P, EMBANK, and SPILE are available from the McTrans Center for Microcomputers in Transportation, University of Florida at Gainesville, Florida. Pile foundation manual; NHI presentations of the classroom portion of old DP-66.
- Manual on advanced methods for slope stability; NHI workshop presentations.
- NHI training course on Rockfall Rating and Rockfall Hazard Mitigation.

Publications

Manual on Design and Construction of Driven Pile Foundations, (FHWA-DP-66-1; also available from the National Technical Information Services [NTIS No. PB89 122568/AS]). Static Testing of Deep Foundations (FHWA-SA-91-042) is available from the Office of Technology Applications. The Osterberg Cell for Load Testing Drilled Shafts and Driven Piles is available from the office of Technology Applications. FWHA Geotechnical Metrication Guidelines is available from the office of Technology Applications.

Ground Modification Techniques

Ground modification is an all-encompassing generic term describing techniques and processes that mechanically or chemically modify existing subsurface materials to improve their engineering properties. A variety of geotechnically related problems, such as bearing capacity, total and differential settlement, liquefaction, void collapse, and slope retention, can be solved. Improvement by ground modification allows existing ground materials to perform as part of a civil engineering work, such as a highway fill, a retaining wall, or a bridge foundation.

Ground modification techniques address a common set of problems that transportation engineers must face:

- Construction confined to specific locations must be adapted to the particular geologic conditions. For example, site material is unsuitable for load bearing requirements and excavation and replacement with suitable material is prohibitively expensive or environmentally unacceptable.

- Construction in heavily urbanized areas that uses existing surface and subsurface structures and services, and where the geometrics and adjacent structures prohibit excavation for "conventional" construction.

- Construction that must have minimal impact on the traveling public and nearby inhabitants and/or must be completed as rapidly as possible.

Originally developed in Western Europe or the Far East, most of the ground modification methods used by the United States transportation community are in their infancy. On projects completed to date, savings of 50 to 70 percent have been common in comparison to conventional treatments. Each method has its own unique limitations, primarily regarding applications and the types of material for which they are cost-effective. Available methods include light weight fill materials; mechanically stabilized earth (MSE); several methods of grouting (chemical, compaction, jetgrouting); stone columns; wick drains; geosynthetics; deep soil mixing; vibro-compaction; and micropiles dynamic compaction. Materials successfully treated to date range from natural soil deposits such as gravel and clay, to man-made deposits such as sanitary landfills and mine spoil.

A need currently exists for the United States transportation community to gain a detailed understanding of how to appropriately use these techniques in cost-effective applications, specify and contractually administer such specialty items, perform and review designs, and effectively monitor this type of construction to ensure a quality product. With these overall objectives in mind, four milestones have been established:

1. Develop and implement technically sound and practical design procedures, construction monitoring techniques, and recommended specifications and contracting packages for ground modification techniques.

2. Develop and conduct stand-alone workshops and seminars on MSE walls and slopes, soilnail walls, and ground improvement techniques in general.

3. Sponsor field evaluations of innovative uses of several of the promising techniques.

4. Incorporate LRFD concept in ground modification design procedures.

DP-82 Mechanically Stabilized Earth (MSE) Walls and Slopes

Description

The primary objective of this project is to demonstrate that MSE walls and slopes can be designed and constructed at a reasonable cost to solve site-specific problems. The project is directed toward geotechnical, structural, and construction engineers who design and construct geotechnical facilities (embankments, cut slopes, retaining walls, and structures). The demonstration project will have two major elements:

- Workshops to present an overview of all the available ground modification techniques.
- Workshops and seminars (involving industry) on MSE walls and slopes; follow-up activities will include:
  - Technical assistance on the design and construction monitoring aspects of MSE walls and slopes for specific projects.
  - Development and distribution of practical technical guidelines.
  - Selected full-scale monitoring of MSE wall and MSE slope construction projects.

Background

Mechanically stabilized earth walls and slopes are constructed with "reinforced soil." Reinforcing elements such as steel strips, steel or polymeric grids, or geotextile sheets are placed in the soil to improve tensile resistance. Placing reinforcing elements in the soil significantly strengthens the soil and allows very steep slopes or even vertical walls to be constructed without support from a massive structural system at the face.

Project Manager

Jerry DiMaggio, HNG-31, (202) 366-1569

Status

A stand-alone workshop on MSE walls and slopes is now under development and is scheduled for formal announcement in early 1996. Pilot sessions are scheduled for October 1995 in Baton Rouge, LA and December 1995 in Raleigh, NC. A contract to develop the MSE workshop and comprehensive design manuals on MSE applications and on corrosion of reinforcing elements was awarded in the fall of 1993. Technical assistance has been provided to several States during the project development phase, and several joint FHWA-State-industry seminars have been held.

A general ground modification seminar is also being developed under the same contract and will be available after announcement of the MSE workshop and the soil nailing workshop (DP 103). The seminar will briefly address all ground modification techniques and focus on their cost-effective application, specifications, and contracting and quality assurance methods.

DP-103 Soil Nail Walls

Description

The primary objective of this project is to demonstrate the cost-effective and technically correct application of soil nailing by the U.S. transportation community. The project is directed toward geotechnical, structural, and construction engineers who design and construct geotechnical facilities (embankments, cut slopes, retaining walls, and structures). The demonstration project will have four major elements:

- Soil Nailing Field Inspector's Manual.
- Design Guidelines and Guide Construction Specifications Manual.
- 2-day workshop on soil nail wall design and construction.
- Project-specific Technical Assistance, including:
  - Technical assistance on the feasibility, design, and construction monitoring aspects of soil nail walls on specific projects.
  - On-site construction inspector training.

Background

The basic concept of soil nailing is to reinforce and strengthen the existing ground by installing closely-spaced steel bars, called "nails," into a slope or excavation as construction proceeds from the "top down." This process creates a reinforced section thatis itself stable and able to retain the ground behind it. The reinforcements are passive and develop their reinforcing action through nail-ground interactions as the ground deforms both during and following construction. Nailswork predominantly in tension but are considered by some to also work in bending/shear under certain circumstances. Generally, the soil nails significantly increase the apparent cohesion of the soil through their ability to carry tensile loads. A construction facing is also usually required, and is typically shortcrete reinforced by welded wire mesh. For permanent walls, the shortcrete construction facing is typically covered in cast-in-place concrete facing.

Project Manager

Ron Chassie, HEO-010, FHWA Region 10, Portland, OR
Phone: (503) 326-2095; Fax (503)325-3928

Status

Project development includes the following: a summary report for a 1992 European scanning tour titled FHWA Tour of Geotechnology-Soil Nailing was prepared and distributed in early 1993. The French soil nailing manual, Recommendations Clouterre 1991, has been translated into English and was distributed in 1994. The FHWA Soil Nailing Field Inspector's Manual has been prepared and was also distributed by OTA in 1994. A testing program to determine ultimate structural capacities of soil nail wall shortcrete facings is underway at UC San Diego and will be

completed late in the summer of 1995. The facing test program includes testing full-size test panels to failure and analytical modeling, and is a cooperative program co-sponsored by FWHA, Caltrans, and Industry. A Design Guidelines and Guide Construction Specifications Manual and 2-day training workshop are under development and will be completed and made available to State DOTs in the spring of 1996. The manual will be "practitioner oriented" and will include step-by-step design procedures, hand calculation-worked design examples, example plan details, and guide construction specifications. Project-specific design and construction technical assistance, including field inspector training, is now available.

Technical assistance has been provided to several States during the project development phase. A team of Federal Highway, State Highway, and private consultants recently traveled to Europe to investigate soil nailing techniques. The results of their trip are being incorporated into the project.

A pilot session is scheduled for December 1995 in Olympia, WA.

Project Coordinator

John M. Hooks, HTA-22, (202) 366-6643; Fax (202) 366-7909

Publications

Soil Nailing Field Inspectors Manual (FHWA-SA-93-068) is available from NTIS and OTA.

English translation of the French manual "Recommendations Clouterre-1991" (Soil Nailing Recommendations-1991, FHWA-SA-93-026) is available from NTIS.

"FHWA Tour for Geotechnology - Soil Nailing" (FHWA-PL-93-02 is available from H.I.-10; Attention Mr. Steve Gas).

Hydraulic Engineering

Historically, the Federal Highway Administration (and before that, the Bureau of Public Roads) has been a leader in the evolution of hydraulic engineering. For almost 40 years, this agency has provided guidance and training to the bridge and roadway design communities through the Hydraulic Design and Hydraulic Engineering Circular series. As computers, and later, microcomputers became popular, FHWA expanded into these areas by providing software that automated many hydraulic design and analysis concepts.

This tradition continues as recently completed research is put into practice, proven hydraulic principles are improved upon and updated, and new technology becomes available.

As the 21st century approaches, FHWA will meet new challenges in hydraulic engineering with even newer technologies. Concepts such as Geographic Information Systems (GIS) and CD-ROM applications, adapted from other disciplines, are only two innovations currently under consideration.

There are four continuing goals and milestones within this high-priority area:

1. Metricate all Hydraulic Engineering Circulars, the Hydraulic Design Series, hydraulic computer programs and documentation, and training materials.

2. Revise, update, and enhance these materials as new technology becomes available.

3. Develop and implement new design and analysis procedures and computer programs as research-in-progress is completed.

4. Train hydraulic engineers, bridge and roadway designers, and technicians in innovative hydraulic engineering practices.

Project Coordinator

Tom Krylowski, HTA-22, (202) 366-6771

Hydraulic Engineering

(Includes AP-26, AP-89, AP-103, AP-132)

Project Manager

All projects are managed by Tom Krylowski, HTA-22, (202) 366-6771; Larry Arneson, HES-08, (303) 969-6715; and Chris Dunn, HST-010, (503) 326-2095.

Bridge Deck Drainage Hydraulic Engineering Circular 21

Description

This project has been closed out and a manual of guidelines and procedures for designing bridge deck drainage systems was produced. The manual is a compendium that includes design theory, step-by-step design procedures, and illustrative examples. Drainage system design is approached from the standpoints of hydraulic capacity, traffic safety, structural integrity, practical maintenance, and architectural aesthetics. Guidance is provided for selection of a design gutter spread and flood frequency. The manual stresses the advantages of designing to minimize the complexity of bridge deck drainage systems. System hardware components, such as inlets, pipes, and downspouts, are described. Guidance is also provided for selection of a design gutter spread and flood frequency.

Background

While it is rare that poorly designed bridge deck drainage is directly responsible for a structural failure, it can cause problems such as structural member deterioration, abutment and pavement corrosion, and ponding on the roadway. These problems can be minimized through good design practices that collect runoff, channel it into drains, and transport it away from the bridge.

Status

This project has been closed out. The Design of Bridge Deck Drainage (SA-92-010) manual is available from the Office of Technology Applications and the Research and Technology Report Center, HRD-11, 6300 Georgetown Pike, McLean, Virginia 22101-2296.

Hydrology

Description

In this project, a new manual based on Hydraulic Engineering Circular (HEC-19) will be developed. The manual, Hydrologic Design of Highways, will be incorporated into the Hydraulic Design Series (HDS) and designated HDS-2. New material will be included, such as arid area technology, information from the National Flood Hydrograph study, Storm Water Management, GIS, and revisions to the Soil Conservation Service Sections.

The manual will be used as a text for a new National Highway Institute training course entitled "Practical Highway Hydrology" and will be distributed to highway engineers for use in designing highway drainage structures.

Background

In 1984, FHWA published the Hydraulic Engineering Circular (HEC-19) Hydrology. Since then, the circular has been used extensively by hydraulic engineers and has been thesubject of an NHI training course. Suggestions to revise and improve the material were received from numerous users, which led to the development of HDS-2.

Status

The contract to develop HDS-2 was awarded on October 1, 1992. HDS-2 will be available in late 1995.

WSPRO Enhancements

Description

With this project, the WSPRO computational model will be improved with the addition of recent research on overtopping procedures. Input and output will be improved and graphics will be added to make WSPRO more accessible and responsive to the user. A programmer's manual will be prepared to further assist users.

Background

In the late 1970s, the United States Geological Survey (USGS) began a cooperative effort with FHWA to develop a bridge backwater computer program. The result of these efforts was the Bridge Waterways Analysis Model: WSPRO (Water-Surface Profiles). Over the past several years, FHWA and USGS have developed and promoted the use of WSPRO. In addition to analyzing 1-D steady flow in open channels, WSPRO can be used to analyze flow through bridges and culverts, embankment overflow, and multiple-open stream crossings.

Status

A contract was awarded on October 1, 1992. Beta testing of the revised program began in early 1994 and continued for approximately one year. Several training sessions using the beta version of WSPRO have been given. The project will be completed in late 1995. Follow-up work will include a contract to develop an addition to the Hydraulic Design Series, Hydraulics of Bridge Waterways Using WSPRO (HDS-6).

Update Hydraulic Software and Guidelines

Description

The overall objective of this project is to update hydraulic software and guidelines. The primary focus of the effort is the conversion of existing hydraulic microcomputer programs, training materials, Hydraulic Engineering Circulars, and Hydraulic Design Series to the SI metric system.

Background

The International System of Units (Système International d' Unites) is commonly referred to as the SI or metric system and is the system used today by most nations. In fact, the United States is the only industrialized country not on the metric system of measurement. As a part of the U.S. effort to convert to the metric system, FHWA has taken a number of steps to expedite the transition. This project is one such effort.

While the conversion to metric progresses, FHWA will use the opportunity to update, correct, and generally make any change considered necessary to improve its hydraulic software and guidelines.

Status

A 4-year contract was awarded in September 1993. Work began immediately on HYDRAIN (computer programs, documentation, and training materials), as well as HEC-18, HEC-20, and the "Stream Stability" training course (NHI 13046) scheduled for completion in mid-1995.

Storm Drain Design Manual

Description

This project will develop a comprehensive, state-of-the-art storm drain design manual to guide highway drainage facilities design. The manual will become one of FHWA's Hydraulic Engineering Circulars, designated HEC-22, and will be based on the publication Design of Urban Drainage Design, material from the NHI course "Urban Drainage Design," and other sources. Additional information will be included from a recent FHWA staff study on junction losses.

Background

Efficient storm drain facilities design requires storm water runoff to be collected and conveyed through and along highway right-of-ways, while minimizing highway flooding and erosion of adjacent property. Several FHWA publications address storm drainage; however, none of these includes current research or new approaches to storm drain issues. Publications and materials from the American Public Works Association, the American Association of State and Highway Transportation Officials, and the National Highway Institute provide guidance about storm drainage facilities and drainage design. There are also numerous microcomputer programs that predict runoff and aid design and analysis of storm drains. With all of these materials, hydraulic engineers find it difficult to sort through the many available programs.

This project will provide the hydraulic engineer with a comprehensive and practical manual that collects all relevant technical material on storm drain design.

Status

A contract was awarded in September 1993. The first draft was reviewed in mid-1995. Completion is scheduled for early 1996.

Technology Transfer Aids

Computer Program: WSPRO, available from McTrans, University of Florida. NHI Course No. 13035, Bridge Backwater (WSPRO).

Publications

Users' Manual for WSPRO (FHWA-IP-89-027).

Underwater Bridge Integrity

In 1987, New York State lost 17 bridges because of scour, and 10 people were killed when the Schoharie Creek bridge collapsed. In 1989, when the Hatchie River bridge failed in Covington, Tennessee, another eight lives were lost. These and other less dramatic bridge failures point to an urgent need to improve the overall quality of the Nation's bridges. Although the National Bridge Inspection Program established in the 1970s took significant steps toward improving the condition of bridge elements above water, the inspection of bridge substructural elements below the water's surface was not similarly achieved.

In recent years, the NBIS has been revised to address this situation and now stipulates that all bridges be inspected underwater on a regular basis, not to exceed 5-year intervals. FHWA has also assisted the States in setting up underwater inspection programs through technical advisories, policy documents, and in particular note, the Demonstration Project "Underwater Inspection of Bridges" (DP-80). The project was very successful, exposing State personnel to state-of-the-art inspection equipment and enabling them to learn first-hand the criteria for a successful underwater inspection program.

During this time, and partially due to the success of DP-80, new technology to inspect, evaluate, and repair bridge components underwater has continued to emerge. There is an immediate need to transfer this technology to State highway agencies and other municipalities.

There are four major goals of this high-priority area:

1. Develop and present to the highway community projects that demonstrate state-of-the-art instrumentation for measuring and monitoring bridge scour. Fixed and portable equipment (including geophysical methods) will be included.

2. Through Work Orders, assist the Staes in obtaining and installing the instrumentation. Field data will provide valuable information for the Demonstration Projects.

3. Develop and present projects that showcase the latest available technology for evaluating and repairing underwater bridge components.

4. Work with the States to develop an underwater inspection and repair program.

DP-97 Underwater Bridge Integrity

Project Manager

The project manager for all DP-97 projects is Tom Krylowski, HTA-22, (202) 366-6671.

Scour Monitoring and Instrumentation (DP-97)

Description

This project will enable engineers and inspectors to better understand the scour phenomena and will present methods for estimating, measuring, and monitoring scour using state-of-the-art instrumentation. Portable and fixed instrumentation will be demonstrated. This activity, in conjunction with the ongoing NHI training course "Stream Stability and Scour at Highway Structures," is an attempt to assist the States in implementing the FHWA Hydraulic Engineering Circular, Evaluating Scour at Bridges (HEC-18), dated April 1993.

Background

Scour or erosion-related processes account for most of the highway bridge failures in this country. Because of a lack of field data, an understanding of the mechanism of scour is still extremely limited.

Status

Instrumentation selection, type of demonstration, and curriculum materials have been completed. Two pilot presentations have been held. Project demonstrations will follow by late 1995.

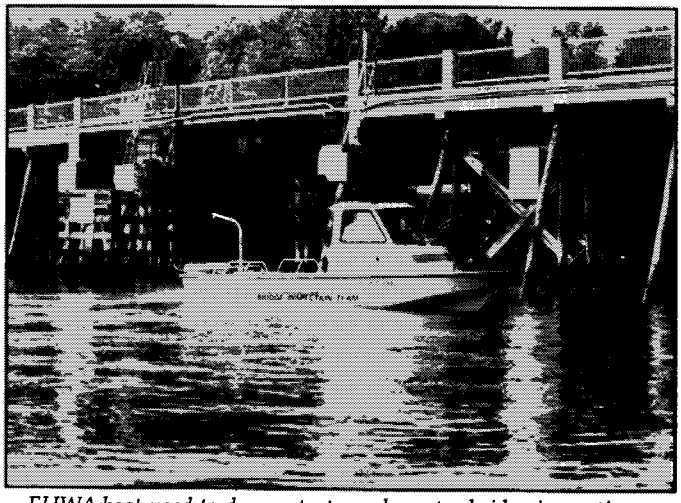
DP-98 Underwater Evaluation and Repair of Bridge Components

Description

This project is being designed to help the States conduct condition surveys of underwater bridge components using state-of-the-art instrumentation. The project focuses on bridges previously identified as needing rehabilitation. This activity is a follow-up to the highly successful Demonstration Project (DP-80), "Underwater Inspection of Bridges," which attracted representatives from all the States. Additional assistance will be provided by working with the States to identify potential repair strategies.

Background

Both projects were developed in response to an urgent need to improve the overall quality of bridge inspection. DP-80 was an award-winning project that brought together professional engineers/divers, the latest geophysical scour detection, and nondestructive testing technology. Instrumented-access watercraft, remote-operated underwater camera, and communications equipment was demonstrated to every State. The new project will build on DP-80, bringing state-of-practice evaluation and repair procedures and equipment to the States.



FHWA boat used to demonstrate underwater bridge inspections.

Project Manager

Tom Krylowski, HTA-22 (202) 366-6771

Status

Equipment selection, type of demonstration, and curriculum materials have been completed. Two pilot presentations have been held. Project demonstrations will follow by late 1995.

Technology Transfer Aids

NHI Course No. 13046, Stream Stability and Scour at Highway Structures.

Publications

Evaluating Scour at Bridges HEC-18 (FHWA-IP-90-017).

Stream Stability at Highway Structures HEC-20 (FHWA-IP-90-014).

Underwater Inspection of Bridges (FHWA-DP-80-1) and Video-Inspection of Timber Piles Bridges Unbroken.

All publications are available from the Research and Technology Report Center, HRD-11, 6300 Georgetown Pike, McLean, Virginia 22101-2296.

Safety Systems

The safety systems technology group focuses on priority programs and management systems that address highway safety issues. Projects in this group also serve to heighten the awareness of highway safety as it impacts the Nation—internally to the highway community and externally to the public. These projects target the highway community on important safety issues such as driver compliance with traffic control devices and safety management.

DP-92 Community/Corridor Traffic Safety Program

Description

DP-92 is administered by the Federal Highway Administration (FHWA) in coordination with the National Highway Traffic Safety Administration (NHTSA). This initiative will assist State agencies and local jurisdictions (city and county) to use and adopt Community/Corridor Traffic Safety Program (C/CTSP) concepts of their own design. DP-92 will support State or local efforts with limited financial grants and technical assistance.

The C/CTSP is a comprehensive approach that addresses highway safety problems involving engineering, enforcement, and public awareness and is used to reduce accidents and injuries. In this respect, FHWA's Office of Motor Carriers is called upon to help build on the comprehensive approach where commercial motor vehicles are involved. Similarly, local units of emergency medical service (EMS) may contribute resources and expertise.

NHTSA-sponsored Community Traffic Safety Programs (CTSPs) are included as major contributors to the C/CTSP in that they bring public or private opinion and participation to an action plan to solve the community's safety problems. CTSPs are a vital part of C/CTSP projects. In most instances, CTSPs are long-term and are considered an umbrella program that targets human (driver) behavior and focuses on education and law enforcement initiatives.

The NHTSA and FHWA collaborate in the C/CTSP. There normally are overlapping responsibilities among Federal Agencies, the State, and local jurisdictions (for example, management roles, funding sources, and technical expertise). C/CTSP has three advantages over the more traditional approach to treating high accident locations.

A comprehensive multidisciplinary approach to solving safety problems that looks not only at highway problems but also at driver and vehicle.

A mechanism to improve the use of existing resources through better communication and cooperation and combining the "4Es"—engineering, education, enforcement, and EMS.

The ability to look at long sections of highways, or multiple local jurisdictions (cities/counties), rather than at single highway "spot" locations or a single localjurisdiction.

Background

The C/CTSP was developed from CTSPs and the Pennsylvania Department of Transportation's (PennDOT's) "Corridor Safety Program" concepts, as follows:

- Identify highway safety problem areas within boundaries of geographical areas (highway corridors, counties, and cities).
- Form a multidisciplinary group to develop a comprehensive action plan to focus on the identified problems.
- Secure resources to implement the plan.
- Manage the process through all phases until program objectives are accomplished.
- Evaluate the project.

Project initiatives typically are low-cost, have the support of community leaders, and have community involvement in all project phases of planning, implementation, management, and evaluation.

Project Managers

Rodolfo Ramirez, HHS-22, (202) 366-6409
Peter J. Hatzi, HTA-31, (202) 366-8036

OMC Program Coordinator

James D. McCauley, HFO-30, (202) 366-0133

NHTSA Program Coordinator

Rita Weiss, NRO-20, (202) 366-0161

Status

As a result of this Demonstration Project, 13 States have signed agreements to use DP-92 funds to show the effectiveness of the C/CTSP. In addition, a project has been initiated with the North Dakota Department of Transportation in cooperation with the Native American Injury Prevention Coalition to facilitate implementation and evaluation of the

Community Cooridor Traffic Safety Program (C/CTSP) concept with the following four Native American Tribes:

1. The Devils Lake Sioux Tribe
2. Standing Rock Sioux Tribe
3. Three Affiliated Tribes
4. The Turtle Mountain Chippewa Tribe

CTSPs have more than 400 programs throughout the country and will participate to extend the C/CTSP into their communities. Many States have adopted or are at various stages of implementing a C/CTSP.

Publications

C/CTSP guidelines will be published in early 1996.

DP-104 Highway Safety Management Systems

Description

This project will provide technical assistance to the States, which will enable the initial development and implementation of a Safety Management System (SMS) as mandated by the 1991 Intermodal Surface Transportation Efficiency Act. DP-104 will develop a technology transfer program that promotes SMSs, provides technical assistance and training to States for implementing and operating a SMS, and showcases and markets SMS among States and local agencies.

Background

A SMS is a comprehensive process to reduce the number and severity of traffic crashes by selecting and implementing effective highway safety strategies and projects into the highway transportation system. The SMS incorporates safety into all phases of the decision-making process—highway planning, design, construction, maintenance, and operations.

Well-designed and implemented Safety Management Systems significantly reduce traffic crashes and resulting injuries and fatalities. FHWA

and the National Highway Traffic Safety Administration (NHTSA) are committed to developing a comprehensive technical assistance program for States interested in an SMS.

Project Managers

Fred Small, HHS-21, (202) 366-9212
Harry Hersey, HHI-20, (703) 285-2778

Project Coordinator

Vince Nowakowski, HTA-31, (202) 366-8037

Status

Phase 1 (a 4-week multi-disciplined training course) is under way and is entirely funded by NHI. A contract also has been awarded to develop a 1 1/2 day workshop/Demonstration Project of SMS case studies and good practices. Nine states with "good SMS Practices" have been identified and interviewed. Case studies for the workshop are being developed from these interviews.

DP-112 Public Safety Campaign to Improve Compliance With Traffic Control Devices

Description

In this project staff from Headquarters and a contractor are providing assistance to 32 localities to implement the "Model Red Light Running Campaign" for traffic control device compliance developed in AP-070. The technical assistance will consist of such things as (1) the development and conduct of surveys with which to determine attitudes, knowledge, and behavior regarding compliance with traffic signals; (2) assisting the locality with the development of a "Strategic Plan" for implementing the red light running campaign; (3) assisting as needed the locality during the campaign; (4) assisting with the development of a post-campaign survey to measure effectiveness of the effort; and (5) assisting with the preparation of the final report.

Project Manager

Mila Plosky, HHS-22,(202) 366-6902

Project Coordinator

David Smith, HTA-31,(202) 366-6614

Status

A Social Marketing firm has been contracted with to provide the technical assistance needed. Training for FHWA Regional and Divisional personnel has begun, and selections of localities have been made with grants awarded. Project staff from Headquarters and a contractor are proving assistant to 32 localities to implement the "Model Red Light Running Campaign" for traffic control device compliance developed in AP-070. The technical assistance consists of such things as (1) the development and conduct of surveys with which to determine attitudes, knowledge, and behavior regarding compliance with traffic signals; (2) assisting the locality with the development of a "Strategic Plan" for implementing the red light running campaign; (3) assisting as needed the locality during the campaign; (4) assisting with the development of a post-campaign survey to measure effectiveness of the effort; and (5) assisting with the preparation of the final report.

AP-53 Roadway Delineation Practices Handbook and Videotape

Description

Application of roadway delineation devices provides one of the most cost-effective benefits to the motorist. The goal of FHWA is to have good quality roadway delineation and markings on all roadways at all times. This project will produce a handbook and a 35-minute videotape in response to highway agencies' search for solutions to traffic operations problems through use of new and improved roadway delineation systems. These systems include raised/recessed pavement markers and post-mounted delineators that better define the roadway.

Project Manager

Travis Brooks, HHS-31,(202) 366-2188

Project Coordinator

Peter Hatzi, HTA-31,(202) 366-8036

Status

The 35-minute videotape is complete. The handbook will be distributed to FHWA and the State highway agencies in December 1994. The videotape is available from the Research and Technology Report Center, HRD-11, 6300 Georgetown Pike, McLean, Virginia 22101-2296.

AP-70 Agency Communications Plan for Safety Topics

Description

This project is designed to reduce traffic accidents through targeted public education campaigns. FHWA is developing a public outreach campaign to improve the behavior and performance of highway users by increasing their awareness of highway-related safety issues. A brainstorming process with headquarters and field suggestions identified potential campaign topics and implementation strategies. A two-pronged approach to this issue was established. The first activity is a short-term campaign for compliance with traffic control devices that initially focuses on compliance with traffic signals. The second is the framework for a long-term plan for FHWA to communicate highway safety messages to the public and to the highway community.

Project Manager

Mila Plosky, HHS-22, (202) 366-6902

Project Coordinator

David Smith, HTA-31, (202) 366-6614

Status

A comprehensive public outreach campaign designed to underscore the hazards of running red lights has been developed. This initiative features public information, education, and aggressive enforcement and has the support of the local business community as well as traditional highway safety advocates. FHWA is providing technical assistance through agency and contractor staff and intends to develop a model plan to be used by other States and localities. Charleston, South Carolina has completed the pilot project implementing the RLR campaign. Thirty two localities have been awarded grants to implement this plan. A brainstorming session consisting of Federal employees was held to discuss long-range plans. A final report outlining these plans is being prepared for approval.

AP-73 "Work Zone Safety Inspection" Training Course

Description

Ample guidance on the proper design of work zones is available, but additional instruction is needed for those who must implement the work zone design in the field. Proper work zone implementation and maintenance requires competent oversight and inspection. This project will develop a training curriculum and materials to teach State and local personnel to inspect and administer work zone traffic control and safety hardware. Two pilot course presentations have been conducted. Upon completion of course development, it will be offered under the National Highway Institute's (NHI's) training program as #38063.

Project Manager

James Koan, HHS-11, (202) 366-2155

Project Coordinator

Peter J. Hatzi, HTA-31, (202) 366-8036

Status

A contract was awarded. Presentations will continue into fiscal year 1996, following the completion of pilots. Additional presentations are expected to continue through FY 1997 as an NHI training course.

AP-101 Safety Outreach Initiatives

Description

This project focuses on innovative techniques to heighten highway safety awareness. The primary focus is on creating new partnerships and using their combined abilities to reach highway users.

Projects or activities supported include those that deliver safety information to the general public. For example, a highway users manual is being developed to educate users of the messages conveyed by signs, signals, and markings in support of safe vehicle operation. Also, an interactive highway safety kiosk is being developed to highten safety awareness. A previous effort in this area that remains active is the North Carolina Safety Exposition. The Office of Technology Applications provided financial and technical assistance to the North Carolina Governors' Highway Safety Office for a mobile safety exposition. High-tech animation, video, and set decorations are used to send messages to the public on compliance with traffic control devices and positive delineation. Also, messages on drunk driving and seatbelt and airbag use are communicated in other parts of the exposition.

Project Managers

Sid Louick, HHS-22, (202) 366-2154
Mike Burk, HTA-31, (202) 366-8033

Status

The Highway Users Manual is under development and should be available in FY 1996. Partners to support its distribution are being sought. The kiosk is under development and should also be available in FY 1996.

The project opened in June 1992. Private partnerships provide financial support along with NHTSA, FHWA, and the State of North Carolina. The mobile exposition remains on tour and visits major sporting events and population centers.

AP-101 remains open for unique projects and efforts that communicate highway safety messages to the public.

AP-114 Highway Routing of Hazardous Materials

Description

This project will publish revised guidelines for applying criteria to designate routes for transporting hazardous materials for national distribution. A second part of the project will develop training material, including a participant's notebook for a 2-day course on proper procedures to be used by States and American Indian tribes. The training will apply to jurisdictions that establish and enforce routing designations over which hazardous materials are transported within those jurisdictions. Training also includes limitations and requirements affecting these routings. This is a joint project among the Office of Technology Applications, the Office of Highway Safety, and the National Highway Institute (NHI).

Project Manager

Pam Deadrick, HHS-32, (202) 366-2159

Project Coordinators

David Smith, HTA-31, (202) 366-6614
Harry Hersey, HHI-20, (703) 285-2778

Status

The services of a contractor were secured in June 1993. The project is under way and guidelines have been completed. NHI training course has been completed with training material to be published and classes to begin upon funding from NHI.

Safety Hardware

The safety hardware technology group assesses, refines, and promotes the use of new and/or improved safety devices that have the potential to make roadways safer for the driving public and the highway worker. Examples of such devices include changeable message signs, breakaway devices for sign supports and utility poles, attenuators, barriers, crash cushions, and advance warning devices at work zones.

The many new challenges in this area include meeting the needs of the growing population of older drivers, maintaining sophisticated safety hardware properly, developing guidelines that mark the end of useful life of highway markings, and protecting highway workers as our Nation begins to repair its transportation infrastructure.

There is a major SHRP implementation effort in this area. For the past year, the SHRP Work-Zone Safety Devices have been on display at national conferences and shows. FHWA encourages trial use of these products by providing technical assistance and funds to States that participate in the evaluation process.

AP-12 Guidance on Use of Changeable Message Signs

Description

Two technology transfer publications about changeable message signs (CMSs)—Guidelines on the Use of Changeable Message Signs (FHWA-TS-90-043) and Guidelines on the Use of Changeable Message Signs—Summary Report (FHWA-TS-91-002) —comprise this project. The publications provide guidance on the selection of the appropriate type of CMS display and information on design and maintenance to improve target value and motorist reception of messages.

Background

CMSs play increasingly important roles in improved highway safety, operations, and use of existing facilities. CMSs have been used to provide advanced warning of major highway incidents and route diversion information. The use of CMSs for work zones has been very effective in alerting motorists of downstream lane closures during nighttime operations.

Project Manager

Peter J. Hatzi, HTA-31, (202) 366-8036

Status

This contract has been completed. Copies of both publications are available from the National Technical Information Services (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161.

Publications

Guidelines on the Use of Changeable Message Signs (FHWA-TS-90-043).

Guidelines on the Use of Changeable Message Signs—Summary Report (FHWA-TS-91-002).

AP-115 Technologies for Traffic Signal Compliance

Description

This project accelerates testing, evaluation, and implementation of technologies that will support compliance with traffic control devices. This proposal targets technologies associated with red-light-running detection equipment and determines its potential for enforcement and as a behavior modification approach to reduce red-light-running violation incidents and accidents.

One such effort is a jointly funded project between the FHWA, the Federal Transit Administration, and the Federal Railroad Administration. The Los Angeles County (California) Transportation Commission is conducting a project on its Metro Blue Line. Camera equipment has been installed at several intersections and enforcement efforts have begun. Other similar efforts are being conducted at railroad grade crossings and at highway intersections in Florida, Maryland, South Carolina, Virginia, and the District of Columbia.

Camera shown at railroad crossing with Fort Meade, Florida police officer.

Project Managers

Bing Wong, HHS-21, (202) 366-2169
David Smith, HTA-31, (202) 366-6614

Status

These projects are in various stages of development and will likely continue over the next 24 months.

Signs warn motorist.

AP-175 Railroad-Highway Grade Crossing Handbook Update

Description

The revised handbook is an element of the DOT Rail-Highway Crossing Safety Action Plan. Information to update the handbook will be obtained from a number of sources including FHWA, State, and local highway agencies, the railroad industry and suppliers.

Background

The handbook was last published in 1986. Since then there have been two major highway acts impacting rail-highway crossing improvements, changes to the Manual on Traffic Control Devices, major research projects carried out relevant to rail-highway crossings, and technological advances in crossing traffic control devices.

Project Manager

Bob Winans, HNG-12, 202-366-4656

Project Coordinator

Vincent Nowakowski, HTA-31, 202-366-8037

Status

A contract to update the Rail-Highway Grade Crossing Handbook was awarded to Richards and Associates in September,1995. A draft outline for the handbook has been submitted to the FHWA for review. The updated handbook should be ready for distribution by September,1997.

TE-11 Ice Detection and Weather Information Systems

Description

Initiated in 1989 as Special Experimental Project 13, this project is designed to encourage (and financially support) State highway agencies to evaluate and clearly document the usefulness of ice detection and highway weather information systems in accidents, reducing the use of deicing chemicals, and reducing maintenance personnel costs for snow and ice control.

Seven States and the National Park Service are participating. The evidence obtained thus far indicates that, with "real time" information, crews can be called in and released in a much more efficient manner, thus saving significant sums (savings greater than the system's cost). The safety of the traveling public is enhanced because maintenance crews have better knowledge of actual conditions and can respond accordingly. Operational planning is enhanced concommitant with pavement condition predictive services.

Background

During the last 20 years, a number of State highway agencies have installed ice detection and highway weather information systems. Previous evaluations have addressed performance of the system equipment rather than its usefulness, effects on highway safety, or cost-saving aspects. This project was initiated to address that need.

Project Manager

Chung Eng, HNG-21, (202) 366-1555

Project Coordinator

Vincent Nowakowski, HTA-31, (202) 366-8037

Status

The 1990-1991 winter was the last year State data was compiled for evaluation. The project summary report was distributed to the field in July 1993. This effort will be combined withoutput from the Strategic

Highway Research Program on Roadway Weather Information Systems (guidelines for system procurement and sensor location).

Publications

Ice Detection and Highway Weather Information Systems (FHWA-SA-93-053). Copies are available from the Research and Technology Report Center, HRD-11, 6300 Georgetown Pike, McLean, Virginia 22101-2296.

TE-24 Field Evaluation of Breakaway Timber Utility Poles

Description

This project was established to field test and evaluate the effectiveness of Breakaway Timber Utility Poles (BTUPs). Breakaway utility poles were designed and developed in January 1993 under an FHWA-sponsored research project.

Background

Each year, about 1,500 people are killed and 65,000 are injured nationwide because of collisions with some of the 88 million utility poles located within road and street rights-of-way. In addition to the human suffering involved, these collisions represent a substantial cost to the utility industry in damaged facilities and disrupted service.

Several countermeasures can reduce the hazards of vehicles hitting utility poles. For example, a utility line can be placed underground; a pole might be relocated farther from the edge of the roadway or in an inaccessible area; the number of poles could be reduced through joint use or by increasing span lengths between poles; poles might be located on only one side of the road; a pole can be shielded from impact by placing it behind an existing guardrail, or by placing a crash cushion in front of it; or a pole could be designed to "breakaway" upon impact.

Project Manager

Brian Gilleran, HHS-11, (202) 366-0915

Project Coordinator

Vincent Nowakowski, HTA-31, (202) 366-8037

Status

Five States are involved in evaluating BTUPs. Projects have been initiated in Virginia, Washington, and Texas. Kentucky has retrofitted 10 utility poles and is currently evaluating their inservice performance. Massachusetts has installed 19 new poles. These were monitored through February 29, 1992, and an evaluation report was submitted to the Officeof Technology Applications on September 1, 1992. A limited distribution of this detailed evaluation report was made in October 1992. A summary evaluation report was distributed to all FHWA field offices in May 1993.

Two videos have been developed on BTUPs. One is a technical video that updates an existing video on the concepts and installation of utility poles as breakaway poles. The other is a marketing video to stimulate state and utility company interest in the concept of BTUPs. These videos were distributed as a package in June, 1995 to the state DOTs for presentation to utility companies and other interested parties.

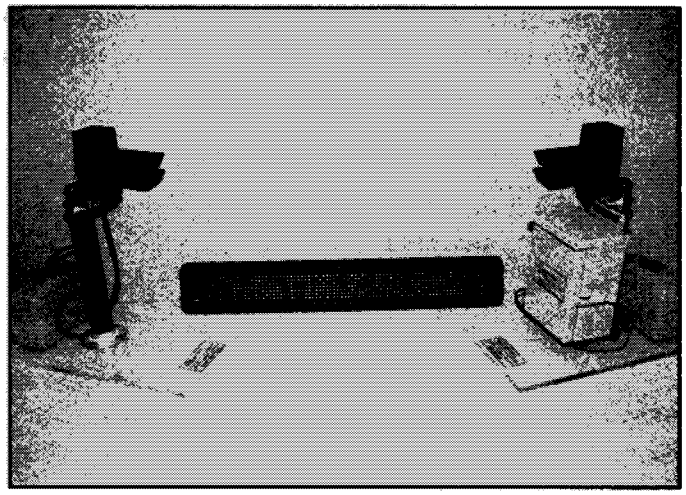
Publications

The detailed evaluation report titled The Breakaway Timber Utility Pole: A Survivable Alternative was prepared and a limited distribution was made in October 1992. A summary report of these evaluations was prepared and distributed to the field in May 1993. For further information on both reports, contact the Project Manager.

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

Descriptions

To improve the safety and efficiency of day-to-day maintenance and operations in work zones, the Strategic Highway Research Program (SHRP) identified 12 work zone safety device concepts that are applicable in work zones; especially for maintenance activities. There are currently eight manufactured devices available.



This queue detector warns motorists and workers of unexpected changes in traffic flow.

1. Salt Spreader Truck-Mounted Attenuator (TMA)
2. Vehicle Intrusion Alarm
3. Queue Detector
4. Portable Rumble Strip
5. Direction Indicator Barricade
6. Opposing Traffic Lane Divider
7. Flashing STOP/SLOW Paddle*
8. All-Terrain Sign & Stand

*This unit was not perfected, but commercial units using several different technologies have become available for performing the desired functions.

The Salt Spreader Truck-Mounted Attenuator is commercially produced and is marketed exclusively by private industry. The seven other devices, representing the basic SHRP-developed concepts, are commercially available and are ready for trial field use. These include Opposing Traffic Lane Dividers, Portable Rumble Strip, Flashing STOP/SLOW Paddle, Direction Indicator Barricades, Vehicle Intrusion Alarms, Queue Detector, and the All-Terrain Sign Stand with Signs. The Remotely Driven Vehicle is being evaluated and showcased by the Minnesota DOT. The original SHRP-designed portable crash cushion trailer is being evaluated by the

Iowa DOT. Four modified shorter-length portable crash cushions are being built for FHWA and are to be sent to Alabama, California, Minnesota, and New York for use and evaluation.

Project Manager

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Project Coordinator

Peter Hatzi, HTA-31, (202) 366-8036

Status

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

FHWA supports making the various devices available to State highway agencies for trial use and evaluation. A solicitation of interest was made to the State DOTs through FHWA division offices. Based on responses received, 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.

TE-29 Retroreflectivity

Description

Retroreflectivity, or nighttime visibility of signs and pavement markings, is recognized as essential for efficient traffic flow, driving comfort, and highway safety. To help State highway agencies improve the inservice performance of traffic signs and pavement markings, the Federal Highway Administration has initiated Test and Evaluation Project 29. The project uses newly-developed retroreflection technology to efficiently measure the nighttime visibility of signs and pavement markings. The two-part project addresses the evaluation of retroreflectometer equipment for measuring the nighttime visibility of signs and pavement markings

and the feasibility of establishing guidelines and their impact on the maintenance operation of State and local highway agencies. Results of this project should establish appropriate retroreflection guidelines for signs and pavement markings. The guidelines will help State and local highway agencies identify and determine when signs and pavement makings have reached the end of their useful life and need to be refurbished.

Background

TE-29 is one of three retroreflection projects.

This mobile sign retroreflectometer is a newly developed meter for measureing sign retroreflectivity.

Evaluation of All-Weather Pavement Markings

This project evaluates the visibility, durability, and safety performance of all-weather pavement markings installed by State highway agencies at test sites. These will be evaluated with the mobile pavement marking retroreflectometer, LASERLUX.

Project Manager

Ernest Huckaby, HSR-21, (703) 285-2372

6005 Support Contract

This contract supplements the All-Weather Pavement Markings and the Retroreflection TE-29 project by providing administrative and technical services.

Project Managers

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Project Coordinator

Peter J. Hatzi, HTA-31, (202) 366-8036

Status

Pavement Marking Retroreflectivity

A contract was issued in September 1993 for the construction of pavement marking reflectometers. Acceptance testing was completed in September 1995.

Four vans are equipped with the Laserlux system for measuring pavement marking retroreflectivity (nighttime visibility). They are available to State and local highway agencies upon request to demonstrate the technology in a two-day workshop. The demonstration workshop will help State and local highway agencies identify and determine when pavement markings have reached the end of their useful life and need to be refurbished.

Sign Retroreflectivity

A contract was issued in September 1994 to design and build a mobile sign retroreflectometer. A prototype was built and is being showcased to the highway community at national conferences.

TE-37 Advanced Technology Patrol Car

Description

This project will conduct testing and evaluation, and will showcase on a nationwide basis, various state-of-the-practice technologies in the field applicable to highway safety. Texas Transportation Institute began a project a few years ago which they named Technocar 2000 (TC2000). They took a DPS patrol car (1991 Camaro) and outfitted it with certain technologies identified as having showed particular application to traffic records collection in the field while strengthening officer safety. The TC2000 project tested a pen system computer interfaced with an in-vehicle printer, a global positioning system, and radio communication equipment for out-of-vehicle data collection. An interface with magnetic stripe and bar code technologies was also a component of the pen system.

This testing and evaluation effort will build upon the results of the TC2000 project and the experiences of others across the nation by identifying and demonstrating already successful technologies while evaluating various state-of-the-practice technologies in the field. Examples of the types of technologies to be evaluated and demonstrated are listed below.

- Global Positioning
- GIS
- Magnetic Striping
- Advanced Video Systems
- Biometric Identification
- Voice Recognition
- Digital Camera and Pen-based Computer Systems
- Bar Coding Systems
- Smart Tags
- Speed Detection Systems
- Map Matching
- Vision Recognition
- Heads-Up Display Systems

These and other applicable technologies will be placed in a police vehicle, made operational, in-service tested by at least two Texas enforcement agencies, and showcased around the country through FY 97.

Project Manager

David Smith, HTA-31, (202) 366-6614

Status

Two police package vehicles have been purchased and are currently being equipped with components of the technology listed in the above description. Once completed, the vehicles will be tested and evaluated in service, with officers from both a State and local Texas enforcement agency.

Texas DPS Trooper using pen-based clipboard computer with Advanced Technology Patrol Vehicle.

Motor Carrier Safety

This technology group promotes the benefits of new safety-related technology to the motor carrier industry. Three current issues are involved;

- Communicate effectively with a large, diverse motor carrier industry.
- Train police officers to collect quality truck accident data.
- Train law enforcement officers and judges on new blood alcohol concentration standards.

Future technologies will address brake systems and their inspection, driver impairment technology, hazardous material education, and accident analysis.

AP-78 Effective Transfer of Information to Motor Carriers' Customers

Description

This project will determine and demonstrate the most effective ways to provide education, technical assistance, and other technology transfer services to motor carriers. This includes identifying the market, reviewing and evaluating current technical assistance materials, and developing effective means of informing motor carriers of new regulations, innovative safety management techniques, and productivity issues. These new techniques will serve as communication models for future technology transfer.

Background

The Office of Motor Carriers must reach a broad range of clients with its new technology. There are more than 220,000 truck and bus companies in the United States, ranging from owner-operators to large national carriers. Because of the size and diversity of the motor carrier industry and in light of limited Federal resources, the Office of Motor Carriers must identify highly effective technology transfer methods to reach the diverse motor carrier community.

To test the models that have been developed, the project will either (1) identify and undertake the most effective means of transferring tested fatigue countermeasure technologies, or (2) develop effective communication methods regarding Mandatory Alcohol Testing Requirements for Commercial Motor Carriers.

Project Manager

David Longo, HTA-20, (202) 366-0456

Project Coordinator

David Smith, HTA-31, (202) 366-6614

Status

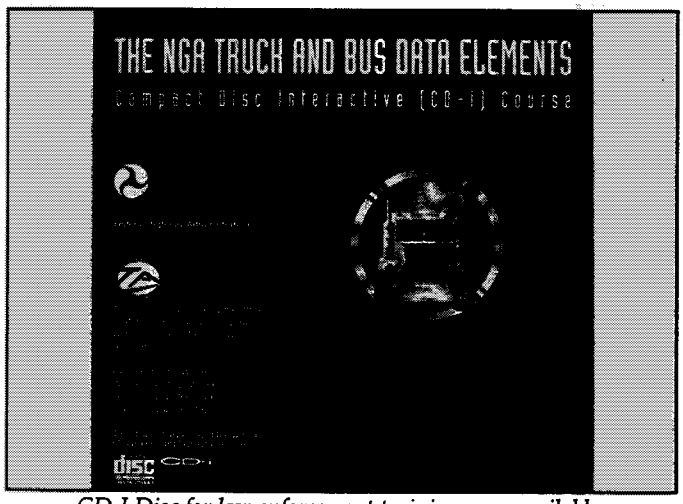
A professional communications firm was contracted and the work described in this contract is near completion. However, additional research is desirable, and may extend this project's completion date.

AP-88 Training for National Governors' Association Data Elements

Description

In response to a national Statewide study conducted by the National Governors'Association, the Federal Government has identified 22 common truck data elements to be collected with accident data. This project will train the law enforcement community to collect quality truck accident data in a uniform manner. Two packages will be developed that address the need for improved accident data relating to trucks:

1. Develop materials for a Train-the-Trainer course and conduct pilots to provide resource individuals in police academies and within the FHWA Motor Carrier Divisions.



CD-I Disc for law enforcement training now available.

2. Develop training programs and provide necessary technical assistance to train State and local police agencies in the proper procedures for collecting National Governors' Association truck accident data elements.

These two packages will be developed into computer-assisted, self-taught training courses.

Background

While medium and heavy trucks are involved in fewer accidents per travel mile than are other types of vehicles, they still pose a substantial problem. Current truck accident data collection methods do not provide adequate information for analysis of truck accidents on a consistent basis. There is also a need to promote the benefits of collecting common truck data elements with accident data. Improved data collection results in better accident investigation.

Project Manager

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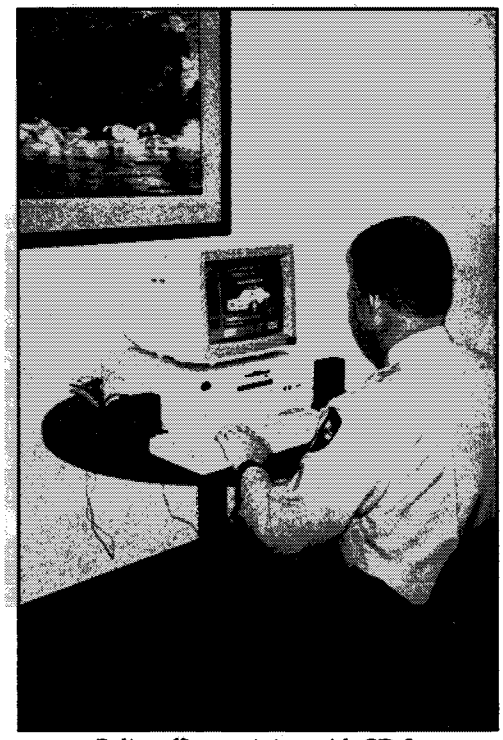

Police officer training with CD-I.

Project Coordinator

David Smith, HTA-31, (202) 366-6614

Status

A professional firm has been contracted for both phases of this initiative. The Train-the Trainer course has been developed and piloted, and training sessions have been conducted in five FHWA regions.

For the second effort, Compact Disc-Interactive (CD-I) technology has been selected. The disks have been completed with a sufficient quantity pressed and delivered to all FHWA Motor Carrier Divisions; additional discs are available to qualified agencies.

Publications

National Governors' Association Truck Accident Data Collection Program, Officers Manual (FHWA-SA-92-035). National Governors' Association Truck Accident Data Collection Program, Instructor's Manual (FHWA-SA-92-036).

Pedestrians and Bicycles

The pedestrians and bicycles group works to reduce pedestrian-motor vehicle accidents by initiating and expanding community-based pedestrian safety programs, advocating implementation of multidisciplined pedestrian/bicycle safety countermeasures, and increasing public awareness of pedestrian/bicycle issues through marketing strategies. The major activity in this group is to develop a Social Marketing Plan to implement the revised Walk Alert Program. Future activities will be directed toward establishing a clearinghouse for pedestrian/bicycle information and activities and implementing the Walk Alert Social Marketing Plan at the State and local level.

AP-18 Application of Pedestrian Safety Programs

Description

This is a joint FHWA/National Highway Traffic Safety Administration (NHTSA) project designed to increase nationwide application of comprehensive, community-based pedestrian safety programs within State and local governments. AP-18 is aimed at community policymakers and stresses a "4E" approach: Education, Engineering, Enforcement, and EMS.

The "Walk Alert" program will be marketed as the model program. This project will promote the benefits of such programs to key Federal, State, and local managers. Technical assistance will be available to those who undertake such efforts. Limited funding will be provided for start-up costs and evaluations. Products to be developed include training materials and tools for implementing community-based pedestrian safety programs. Also sought are new partnerships in the private sector advocacy.

Project Managers

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Project Coordinator

Vince Nowakowski, HTA-31, (202) 366-8037

Status

Through an interagency agreement with the office of Personnel and Management, the HWA has contracted to develop a Walk Alert Marketing Plan. This plan will define an overall strategy for increasing the number of pedestrian safety programs that use the Walk Alert Guide and describe and develop the marketing materials required to achieve this increase. Some of the materials to be developed include:

- A Pedestrian Safety Road Show. This will be an instructor-led marketing/training presentation on how pedestrian safety programs can improve the quality of life in a community and the steps needed to implement such a program.

- A Marketing Video and Brochure.
- A Resource Road Map (an annotated catalog of pedestrian safety training and program resources).

The Pedestrian Safety Road Show will be pilot-tested in five communities of different sizes to determine its effectiveness in convincing a local community to implement a comprehensive pedestrian safety program. The pilot tests are planned to begin in February 1996.

Traffic Control

The purpose of the traffic control technology group is to reduce traffic congestion by encouraging users to adopt and implement advanced technologies, innovative concepts, and systems for traffic control. A major current project involves a large-scale, hands-on demonstration of leading-edge technologies in traffic control equipment and software used at intersections.

DP-93 Traffic Control Equipment and Software

Description

This is a two- to two-and-one-half-day workshop on (and hands-on demonstration of) recently developed electronic traffic control equipment and software used at intersections. The project includes controllers, detectors, communications, pre-emption, test equipment, conflict monitors, closed-loop/distributed systems, centralized control systems, hybrid control systems, and other peripherals found in National Electrical Manufacturers' Association (NEMA) and Type 170 cabinets.

Twenty-five manufacturers and vendors are providing technology to be displayed in a 48-foot tractor/semitrailer that will tour the States and local jurisdictions over the next 2 years. The presentation will emphasize the benefits of adopting and implementing more reliable and powerful traffic control systems to reduce urban congestion.

Project Manager

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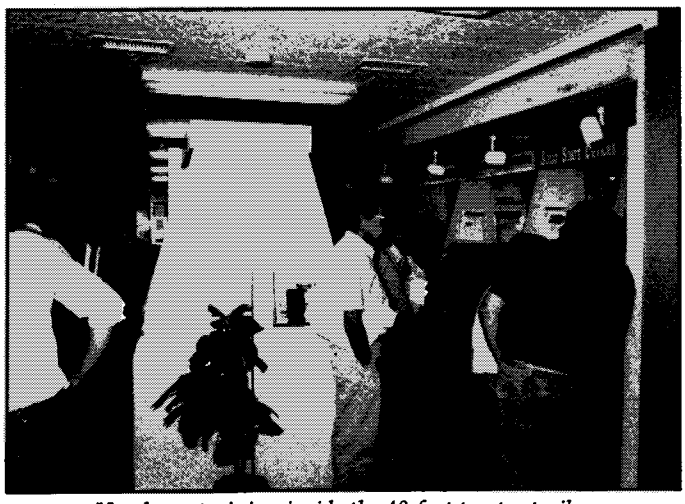

Hands-on training inside the 48-foot tractor trailer.

Status

The project was announced in January 1993, and for the past year, has been presented to managers, traffic engineers, and traffic signal technicians from city, county, and State transportation agencies representing 49 States, Puerto Rico, and the District of Columbia. These jurisdictions control the majority of the nation's signalized intersections, many of which are expected to improve based on the information presented in this demonstration project. The presentation has also been given to representatives from equipment manufacturers that supply about 85 percent of the traffic control technology in the U.S. Initial response from participants has been overwhelmingly positive. The Executive Summary has been particularly beneficial to top managers and the hands-on demonstrations are extremely effective as a technology transfer technique. More than 100 requests for DP-93 have been received to date. Interested Statesmay contact the FHWA Division or Region office. As technology advances, the project will be updated to remain current with state-of-the-art, commercially available equipment and software. Presentations are planned until the summer of 1996.

DP-105 Advanced Corridor Management Technologies

Description

Through use of a workshop and hands-on simulator, this demonstration project will provide a comprehensive approach consisting of various components of an Advanced Corridor Management System. These components include ramp and freeway mainline control, surveillance and detection, driver information systems, automatic vehicle identification, incident management, electronic toll collection, etc. FHWA formed public/private partnerships with industry to demonstrate and display available Corridor Management Technologies in a cooperative effort. Hardware and software products will be showcased in a highly-visible mobile workshop in the form of a large, customized tractor-trailer combination with expandable sides. It will consist of a 2- to 3-day presentation and hands-on demonstration covering various Advanced Corridor Management Technologies. The workshop will be coordinated with the hands-on portion of the demonstration project so that each participant will have the opportunity to use a terminal to simulate the Corridor Management Techniques/Technologies as they are being presented in the workshop. The simulation will emulate actual operation of a system and will enable the user to execute simulated commands and algorithms in a controlled environment.

Project Manager

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Status

Under a cooperative agreement between FHWA and Caltrans, a Work Order to Caltrans has been executed. California Polytechnic State University (Cal Poly) will actually perform the work under contract with Caltrans. That contract is expected to be in place in September 1995 at which time Cal Poly will begin the design, installation, and integration of the software and hardware into the trailer that will be used for DP-105. The tractor has been delivered and a contract for the acquisition and expansion of the trailer is anticipated to be in place no later than December 1995. Approximately 30 vendors have been lined up to provide hardware and software for demonstration in the trailer. Nearly 20 of the vendors have been visited by FHWA. The purposes of the visits are: 1) to gain a better understanding of the technologies the vendors will be supplying, and 2) to develop plans to both implement the technologies on the trailer and describe the technologies in the curriculum. Development of the curriculum will begin in September 1995 and will be performed primarily in-house by FHWA with input from the vendors, Cal Poly, and the proposed presenters. The staff would consist of a lead presenter, an assistant presenter, a systems engineer who will maintain the computer and electrical systems on the trailer, and a driver. Pilot presentations for DP-105 are projected for October 1996 with a national tour to begin in November 1996.

AP-56 Transient Protection, Grounding, and Shielding of Electronic Traffic Control

Description

This project has developed guidelinesfor technicians engaged in installation and electrical protection of traffic control hardware. A 2-day training course was developed for engineers and technicians. Course materials include certification requirements for International Municipal Signal Association (IMSA) and National Institute for the Certification of Engineering Technicians (NICET) technician training.

Project Manager

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Contact

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Status

The contract with the National Academy of Sciences – subcontracted with Georgia Tech – is complete. The National Highway Institute (NHI) has undertaken the final task of updating the audiovisual materials. The training course will be offered through NHI beginning in FY 96.

TE-26 Loop Detector Tester Field Tests

Description

An improved method for testing loop detectors in place has been developed under FHWA sponsorship through the Small Business Innovation Research Program. The digital test instrument not only diagnoses faulty inductive loop detector (ILD) systems quickly, but can also be used in acceptance testing of new ILD systems and can help with preventive maintenance.

Because of a unique digital signal processing technique for making measurements and displaying and interpreting the results, this portable, hand-held instrument has a measurement accuracy of 0.02 percent. The instrument can measure loop inductance, quality factor (a measure of efficiency), and resistance. It does so at frequencies from 10 to 100 kHz, thereby covering the operating frequency range of all commercial loop detector electronics. The instrument can also measure the operating frequency of the loop and its detector electronics after they have been connected, which has not been possible before. The capability of measuring the inductance change caused by a variety of vehicles (such as bicycles or high-bed trucks) as they cross the loop allows the required sensitivity of the detector to be accurately adjusted.

Project Manager

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Contact

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Status

The manufacturer of the device has completed prototype development and the instrument is now in production. The loop test instrument is being field-tested under actual operating conditions in California, Florida, Idaho, Ohio, and South Dakota. If the field tests are successful, information on the test instrument will be disseminated to State and local agencies. A test and evaluation report has been written, entitled Inductive Loop Tester - ILT II Summary Report, Publication No. FHWA-SA-94-077.

Traffic Management

The current focus of the traffic management technology group is to implement new and emerging technology in traffic simulation and demand management. Seven of the major initiatives in this area include:

- Integrated traffic management systems.
- Communication technology in traffic control systems.
- Traffic network simulation.
- Equipment and software for computerized traffic control systems and Intelligent Vehicle-Highway Systems (IVHS).
- Research in traffic demand management to relieve traffic congestion.
- Highway incident management.
- Geographical Information Systems (GIS) and video imaging applications.

DP-85 Geographical Information System/Video Imagery Applications

This 2-day demonstration project introduces State and local transportation agencies to Geographical Information Systems (GISs) and video imagery systems with the following six activities:

- Demonstrate state-of-the-art GISs and video imagery systems. This includes hands-on classroom demonstrations of GIS software and workstations, laser videodisc software and workstations, and a videologging van equipped with a shuttered video camera to record images directly onto laser videodiscs.

- Demonstrate specific transportation-related applications of GISs and video imagery technology. Applications include planning, environment, pavement management, highway safety and traffic operations, R-O-W, and bridge inventory.

- Demonstrate the benefits of integrating laser videodisc files to a GIS.

- Present information on video imagery equipment operation, cost, accuracy, durability, and maintenance. Two laser videodisc viewing stations will highlight the Connecticut Department of Transportation Photolog Laser Videodisc Viewing Station and Roadview III, which is used by the Wisconsin, Iowa, South Dakota, and Minnesota Departments of Transportation.

- Present information on Global Positioning Systems (GPSs), an activity that includes defining GPSs and discussing their use within a GIS.

- Present information on the costs and benefits (as well as the potential problems) associated with implementing GISs. Items to be discussed include types of available GISs, sources for obtaining digitized maps, data sources, and the steps to implement a GIS – from developing an information system plan to updating and maintenance strategies.

Project Manager

Vincent Nowakowski, HTA-31, (202) 366-8037

Status

Formal presentations of DP-85 began in March 1992. Through September 1995, DP-85 has been presented to over 60 State and local transportation agencies.

DP-85 officially ends in November 1995 with a final presentation in Boston, Massachusetts to the Massachusetts Highway Department. A summary report on DP-85 is being prepared. It will address the following: description of the workshop, number of presentations, audiences(s) reached, lessons learned, strengths and weaknesses of the workshop, and recommendations for future workshop activities in the area of data sharing and integration. This report should be ready for distribution by February 1996.

DP-86 Incident Management Workshop

(Relieving Traffic Congestion Through Incident Management)

Description

This workshop demonstrates the concepts and techniques of Incident Management. It is designed to reach individuals from different disciplines and agencies, such as police, fire, highway, and emergency response, who respond to incidents on freeways and surface streets. The presentations and workshop discussions are also of great interest to towing and special equipment operators, private traffic reporting services, private service patrol operators, and the media. The workshop focuses on safety, the operational efficiency of responding agencies, and the institutional and administrative barriers that hinder interagency cooperation. The workshop is tailored to the needs of each location where it is presented. There are ten workshop modules:

1. Introduction.
2. Overview of Incidents and Incident Management.
3. Communications/Operations Center.
4. Motorist Information.
5. Detection and Verification.

6. Response and Clearance.

7. Site Management.

8. Funding and Administrative Options.

9. Intelligent Vehicle-Highway Systems and Advancing Technologies.

10. Closing: The Next Step.

The DP-86 workshop has been presented primarily as a 2-day workshop. A 1-day version is also now available. It is designed for individuals who perform some type of supervisory capacity in dealing with incidents. Short presentations are followed by full group discussions as well as small group break-out sessions. The closing workshop exercise has participants develop a list of issues and short-range activities that can be pursued to improve the managed response to incidents. The 2-day workshop can be more general in nature and cover more topics. The 1-day workshop is more focused on specific issues such as communications, response plans, and organizational structure.

Project Manager

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Status

Formal presentations of the Incident Management workshop began in April 1992. Forty-nine workshops have been presented to approximately 2000 participants through FY95. Workshops will be extended into 1996. Interested States should contact the project manager or the State FHWA Division office.

Publications

Freeway Incident Management Handbook, July 1991 (FHWA-SA-91-056).

Framework for Developing Incident Management Systems, Washington State Transportation Center (TRAC), Seattle, WA, August 1991.

Incident Management, (Report and Executive Summary) prepared for Trucking Research Institute by Cambridge Systematics, Inc., October 1990.

Incident Command System for Law Enforcement, Massachusetts State Police, 1991.

Northern Virginia Freeway Management Team Operating Manual, (A Regional Plan for Traffic Management on Northern Virginia Freeways), prepared for Virginia Department of Transportation by JHK & Associates, April 1990.

Incident Response Guide (Office Reference and Field Reference), prepared for Washington State Transportation Commission, Department of Transportation, by Washington StateTransportation Center (TRAC), September 1991.

Freeway Incident Management, Operational Guidelines, prepared for Florida Department of Transportation by Frederick R. Harris, Inc., April 1991.

Videotapes

Open Roads: A Look at Freeway Incident Management (19 minutes), 1991.

Incident Management Systems: Safety and Efficiency for All of Us, Washington State Department of Transportation (16 minutes), 1991.

Using Total Stations for Collision Investigation, Washington State Department of Transportation (15 minutes), 1991.

Incident Management in Virginia, Virginia Transportation Research Council and Virginia Department of Transportation (22 minutes), 1991.

Introduction to Freeway Management (10 minutes); Operational Guidelines for Freeway Management (20 minutes); and Overview for New Team Members (30 minutes). These three programs are on one tape. Florida Department of Transportation, 1991.

For information on availability of these materials, please contact the project manager.

AP-28 Symposium on Integrated Traffic Management Systems

Description

This symposium examines the wide range of issues related to planning, designing, and operating Integrated Traffic Management Systems. The symposium brings together experts in urban freeway and arterial traffic operations from the private and public sectors. The symposium is jointly sponsored by the Transportation Research Board and FHWA.

Background

Most State and local transportation agencies work independently of one another in monitoring traffic activities that guide their decisions to implement traffic control strategies. The resulting strategies are generally uncoordinated and result in projects that have merit but could be greatly improved for the benefit of users. Recently, several States and metropolitan areas have become involved in integrated traffic management systems for planning, design, and operation. With these integrated systems, traffic information is shared among several operating transportation agencies and the operational decisions are made jointly.

Project Manager

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Project Coordinator

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Status

The symposium was first held in June 1992 in Irvine, California and proceedings were distributed. A second symposium was held in Seattle, Washington in May 1995. A third symposium is being planned for Boston, Massachusetts in 1996.

AP-55 Development of Traffic Models Handbook and Training Course

Description

This project will update a 1981 Traffic Models Handbook and develop a training course on the uses of traffic signal optimization and simulation models. Both the handbook and the course will include models developed by FHWA R&D efforts as well as other models in general use by traffic engineers throughout the United States. The course models will be primarily useful in urbanized areas (for example, traffic network simulation or signal optimization models such as TRAF-NETSIM and TRANSYT-7F). Models to increase the effective capacity of two-lane rural roads and isolated intersections will also be covered.

The course will be designed in modules so that it can be tailored to particular audiences. The course will also help students select the best models or procedures for particular types of designs or operations. Intelligent Vehicle-Highway System topics will be briefly delineated, and the relationship between static and dynamic, as well as real-time model usage, will be discussed.

Project Manager

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Project Coordinator

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Status

The contractor has completed the handbook and training course. This course is now available from the National Highway Institute (Course Number 13368).

AP-58 CORFLO Training Course and User Manual

Description

The three objectives of this project are to develop a training course for the TRAF-CORFLO model that simulates the flow of vehicles on a large urban area network containing freeways and arterials, to produce a user-friendly tutorial manual, and to present the training course to transportation agencies on a by-request basis.

Participants are expected to learn how to use the TRAF-CORFLO model and to interpret and understand the results of the simulation.

Project Manager

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Project Coordinator

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Status

The course has been developed and is now available from the National Highway Institute (Course Number 13367).

AP-59 FRESIM Training Course

Description

The objectives of this project are to update the existing freeway traffic simulation (FRESIM) documents, develop a FRESIM training course to teach traffic engineers to effectively use the TRAF-FRESIM model, and to interpret and understand the results of the simulation. In addition, as many as nine presentations of the developed course will be made to transportation agencies on a by-request basis.

Project Manager

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Project Coordinator

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Status

The course has been developed and is now available from the National Highway Institute (Course Number 13366).

AP-65 Traffic Software Users Workshop

Description

The purpose of this project is to conduct a workshop for a cross section of traffic software users to evaluate the utility and effectiveness of traffic simulation and signal optimal software recently developed by FHWA. Participants will be asked to provide critiques of model use prior to the workshop and results of these critiques will be used to guide discussion and help formulate consensus evaluations. Communications on highway-oriented electronic bulletin boards will be assessed for information on model use, and literature reviews will reveal the utility and limitations of particular models. Traffic signal optimization and simulation models, which are in wide use by traffic engineers but were not developed by FHWA, will also be assessed. From this workshop recommendations will be developed for a continuing Federal role in traffic software development, including software to support the Intelligent Vehicle-Highway Systems.

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Status

McTrans, University of Florida, conducted the workshop, which was held in January 1994 in Orlando, Florida. A second workshop was held in November 1994 in Chicago, Illinois and a third workshop was held in July 1995 in Tucson, Arizona.

AP-66 Traffic Control Systems Handbook

Description

The purpose of this project is to update the 1985 edition of the Traffic Control Systems Handbook (FHWA-IP-85-11) and to broaden the handbook to include Intelligent Vehicle-Highway Systems (IVHS) technology and concepts. The handbook is also intended to provide an updated compendium of existing traffic control technology for the advanced designer and user.

The preparation of this Handbook will include a review of existing and evolving technologies (equipment and software) that apply to computerized Traffic Control Systems and IVHS. This Handbook will be used as a basic reference by practicing State and local government engineers to develop and operate Traffic Control Systems; it will also serve as a training aid for experienced traffic engineers.

Project Manager

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Status

A contract to update this Handbook was awarded in September 1992. This work is expected to be completed in Winter 1995/1996. Whereupon it will be distributed to State and local agencies.

AP-80 Telecommuting

Description

This in-house FHWA project has two major activities. First, the transfer of funds to the Office of the Secretary (OST) to help support the Department of Transportation (DOT) "Telecommuting Study" (in the 1991 Appropriations Act); and second, a competitive contract to support the FHWA Telecommuting Pilot Study (Office of Contracts and Procurement). The DOT Telecommuting Study will gather information on the management techniques needed to conduct the FHWA Traffic Operations Program.

The FHWA Telecommuting Pilot Study will provide training for telecommuters and their supervisors and will design and implement an evaluation plan. Some technical support will also be required to assist telecommuters and units that participate in this pilot program. The concept of telecommuting involves moving the work to the worker instead of bringing the worker to the work.

Project Manager

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Status

The telecommuting study is complete, and a final report was produced in 1993. A national telecommuting bulletin board system was developed by Tele-Commuter Resources, Inc.

AP-121 Advanced Traffic Controller Training Course and Video

Description

This project includes recent developments in microprocessor-based traffic controller systems as a follow-up to original efforts. This contract also includes presentations at several regional seminars prior to offering State-by-State presentations to local agencies. It draws upon the knowledge of a panel of technical experts (users and manufacturers) to assure a balanced treatment of the subject. The Local agency presentations will be an optional task in the contract, and there will be an opportunity for National Highway Institute participation. The result is expected to elevate the knowledge base of user agencies, which will translate into more effective operation and maintenance of traffic control equipment on a national level.

Background

In the mid-1980s, the Office of Implementation developed and presented three training courses on microprocessor-based traffic controllers. They are NEMA TS 1 Standards, 170 Controller Assemblies, and a combination course containing both NEMA and 170 Controller technologies. As new technology becomes available, it will be incorporated into the training materials.

Project Manager

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Status

The contract was awarded in September 1993. Course presentations were held in Washington, D.C. and Norfolk, Virginia. An additional

presentation will be held in Newington, Connecticut in early December 1995. Richmond, Virginia is planning to host a presentation in early 1996.

AP-123 Wide Area Incident Management Expert System

Description

This project will develop an expert system to enable operations center personnel to better assist on-site responders to multiple incidents in an urban corridor of freeways and arterial streets. The GIS-based "expert system" provides an information database and prompts control center personnel, reminding them of important details such as the notification and coordination of various agencies or specific actions that must be taken.

Project Manager

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Status

The expert system is being developed through a Work Order with the Virginia Department of Transportation. Work began in the fall of 1993 and completion is expected in late 1995. The expert system will be demonstrated at the TRB Annual Meeting in January 1996.

AP-153 Freeway Management Handbook Update

Description

The original Freeway Management Handbook is a four-volume document that was published in 1983. This will be a major revision and not merely an "update." The intent is to make the new Handbook modular in nature so that individual chapters can be updated as needed in this rapidly changing arena. In addition to a "paper" Handbook, Alternative publishing methods such as diskette and CD-ROM , will also be explored.

Project Manager

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Status

The contract was awarded in August 1995. Sites have been selected for the case studies. The Handbook is anticipated for delivery in March 1997.

AP-155 Expanded Traffic Software Multi-Media Package and Guidance for Selecting Traffic Software

Description

This project will develop a multimedia package to provide traffic engineers and city planners with an automated means of selecting and appropriately using FHWA computerized traffic simulation models. This tool, which will operate on a commercially-available desktop multimedia platform, will allow a traffic engineer to identify local traffic issues using a knowledge acquisition process, determine the appropriate traffic simulation model based on expert system criteria, and provide a detailed overview of the traffic model using a multimedia presentation. The final product will be distributed nationwide on large format media such as CD-ROM and will be made available over the Internet.

Project Manager

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Status

Work on this project was completed in September 1995 and the multimedia package is expected to be distributed in FY96.

AP-164 Managing Incidents and Access on Surface Streets

Description

This project will focus on how existing and advanced technologies—together with enhanced access control—can be employed to reduce incidents and improve traffic operations on the surface street system. This project will:

- Investigate the potential of using ATMS, ATIS, and APTS technologies to better control movements in and out of driveways and side streets.
- Identify the strategies that can best manage access and reduce incidents on surface streets.
- Develop a manual on access management that describes "best practices" for developing and implementing comprehensive access management programs.
- Produce brochures, videos, multimedia presentations, etc. that will help practioners, decision-makers, business persons, developers, and the general public understand the process for and the potential benefits of access and incident management on surface streets.

- Co-sponsor national conferences on access management in 1996 and 1998.

Project Manager

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Status

A procurement request to prepare a comprehensive access management manual will be developed in early 1996. A technical working group will be established and will meet periodically in order to guide this effort. Plans are being made for the second National Access Management to be held in Vail, Colorado on August 11-14, 1996.

TE-41 Airborne Platform for Traffic Management

Description

This project will evaluate the use of the Rafael Observation Balloon System (OBS) as a low-cost, transportable system for use in observing a road system to facilitate congestion management, incident detection and management, and signal system fine-tuning. The OBS will be purchased and tested by the Delaware Department of Transportation. During the test period, the Delaware DOT will be loaned a payload with infrared capabilities (FLIR) for a one-month evaluation. Infrared equipment will be useful in search and rescue missions, as well as other enforcement and emergency services operations.

Project Manager

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Status

Test and evaluation of the OBS is ongoing. The final project report on testing and evaluation of the OBS is expected to be available in 1996.

Motor Carrier Operations

This technology group promotes the use of advanced technologies to facilitate safe and efficient movement of goods by the motor carrier industry both nationally and internationally. The primary audiences for demonstration and application projects are:

- The motor carrier industry.
- Safety and weight enforcement officers.
- Truck drivers.

The technologies addressed will assist the trucking industry in transporting its goods more efficiently through pre-clearance and automated credential verification, and will assist enforcement officials in identifying trucks and truck drivers who are operating in violation of motor carrier safety regulations.

DP-111 Advanced Motor Carrier Operations Technologies

Description

Numerous technological advances have been made in recent years that will facilitate the movement of goods both nationally and internationally, while improving the operational safety of automobiles and trucks travelling together in the traffic stream. Many of these developments are aimed at improving safety while eliminating carrier delays through electronic automation of inspections, weighing, toll collections, and credential purchases.

The goal of Demonstration Project No. 111 is to demonstrate new technologies and programs that enhance motor carrier safety and productivity. The mechanism for this demonstration will be a mobile exhibit housed in an expandable trailer. Equipment obtained on loan from vendors will be displayed in a hands-on format and kiosks containing product, service, and program information will be provided in the trailer. Short presentations and workshops will be presented to address the technological and institutional barriers that hinder the implementation and use of new technologies. The primary target audiences of DP 111 are the enforcement community, the trucking industry, and truck drivers. The demonstration will be taken to truck shows, national and regional conferences and symposiums, and to sites in States across the country where safety and weight enforcement agency personnel can be reached.

Project Manager

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Status

Construction should be completed early in the summer of 1996. Public/private partnerships are being explored for purposes of acquiring a tractor. Equipment vendors are being contacted togauge their project participation. Vendor participation will consist of equipment loans and provision of product and service information for the kiosks in the trailer. The kiosks will also have information about Federal and State safety and enforcement programs of interest to the motor carrier community. Pilot presentations for DP-111 are anticipated in late 1996.

AP-126 Operational Practices for Automated Truck Enforcement Facilities

Description

Technological advances made in the last ten tears in traffic monitoring and increased emphasis on highway safety for truck traffic have created the need to determine more effective ways to monitor and inspect commercial motor vehicles. Commercial Vehicle Monitoring (CVM) facilities provide the means for monitoring commercial vehicle traffic and enforcing safety regulations. Due to limitations on both funds and available space for roadway expansion, careful consideration must be given to the function and design of CVM facilities. A study was undertaken to investigate successful practices in designing a new facility or in retrofitting or upgrading an existing facility. A questionnaire was distributed to all 50 States to determine the state-of-the-practice in CVM facility design and operation. The study report presents the issues that need to be considered when designing or upgrading a CVM facility, and provides a checklist of critical factors, consideration for facility components, and typical facility layouts.

Project Manager

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Status

The draft project report was completed in June 1995 and presented to a project panel for review. The final report will be published in the fall of 1995.

Technology Assessment

One function of the Technology Assessment Branch is to identify and evaluate new products emerging from the highway community's research efforts, and to analyze the various elements of the highway system to determine opportunities for new product development. This is accomplished through work with other FHWA offices, technical specialists, and domestic and international partners.

A current project involves the assessment of hot mix asphalt recycling to identify the state of the practice, market penetration, and institutional or technical barriers to recycling. Other technology assessment efforts evaluate traveler information systems, computer-assisted interactive technology, and robotics. Technology scanning activities continue domestically and internationally among universities, States, and other public and private organizations.

AP-71 Assessment/Motorist Information System

Description

This project, which began in February 1993, provides an evaluation of four Advanced Traveler Information Systems (ATIS) in Washington State. These systems are Flow, Traffic Reporter, Bellevue Smart Traveler, and the proposed Canadian border crossing information system. To accomplish this evaluation, an ATIS taxonomy was developed, and guidelines were established for evaluating ATIS in each of the taxonomy's categories. The classification of systems, including their distinct definitions of success, is complete.

Three related but distinct system goals have been identified as contributing to the overall ATIS goal of increased mobility:

1. Removing individual drivers from congested roads.
2. Reducing individual driver's overall use of roadways.
3. Altering drivers' modes of transportation.

The four ATIS were reviewed and classified in accordance with these goals as a basic framework, with an analysis of the functional elements of message type, technology used, and location of the system. The use of the taxonomy was assessed in terms of its ability to guide effective evaluation of other ATIS projects.

Background

As traveler information systems are developed and used for urban centers in the United States, a need was identified to assess how travelers accepted and used the travel information currently provided through various public and private media (for example, broadcast media, highway advisory radio, telephone hotlines). The results of this effort willhelp urban traffic engineers and officials to design and implement more effective traveler information systems.

Project Manager

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Project Coordinator

Martha M. Soneira, HTA-11, (202) 366-8029

Status

The classification of systems is complete. A draft report, entitled "An Assessment of Washington State Traveler Information Systems Based on a General ATIS Taxonomy," was released in August 1994 for review and comment.

AP-72 Computer-Assisted Interactive Training

Description

The project identified and examined FHWA's experiences with eight computer-assisted interactive applications through staff studies, the Local Technical Assistance Program, and the Federal Lands Highway Program. A detailed discussion of the advantages and disadvantages of the training is presented in a report published April 15, 1993. Recommendations in the report detail how computer-assisted interactive training can enhance FHWA's technology transfer program with its clients. The report identifies areas to be considered when planning the development of new or the modification of existing interactive applications. It also presents detailed descriptions of the newest developments in multimedia-based interactive technologies and evaluates various advantages and disadvantages associated therewith.

Project Manager

Salim Nassif, HTA-11, (202) 366-8026

Status

This project is complete. The resulting report, Assessment of Computer-Assisted Interactive Applications, FHWA-SA-94-040, ahs been printed and is available for distribution. Copies may be obtained from the Report Center.

AP-74 Technology Scanning

Description

This effort will identify and assess technologies developed in State and university laboratories that have the potential for nationwide application. It is anticipated that the high-potential technologies identified will be applied to technology evaluation, promotion, and deployment efforts. Subject areas to be included are asphalt pavements, concrete, structures, environment, safety, and traffic operations. Approximately 20 States or universities will be contacted each year for a 3-year period.

Background

Many States have active research and development programs that produce useful results and products. However, because of the diversity and autonomy of State highway agencies, these results and products are not readily known to other State and local agencies. This may be true even though the States are interacting on AASHTO-level committees and task forces, because they deal with articulated common needs and problems subject to limited resources and time.

Project Manager

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Status

The contractor has completed visits to 40 States and universities and has identified several technologies that have the potential for application. A final report had been prepared and is being reviewed.

AP-75 Expert Systems for Highway Applications

Description

This project reviewed completed studies on using of expert systems applications in the highway transportation field. A detailed assessment of each application was presented and the users were identified. Recom-

mendations were provided on what applications should be made available to field offices and to State highway and local agencies.

Software programs that were identified as beneficial to the FHWA were obtained and recommended for distribution. One such program, "Expert Signal," was designed for traffic engineers. The program aids in the design of traffic signals for isolated intersections. It was distributed to all FHWA field offices, regional offices, and the Federal Lands Divisions, in addition to 20 other users in the industry.

Project Manager

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Status

An 8-month contract was awarded in late 1992. The project was recently completed and the final report and software has been distributed to the States and FHWA field offices.

AP-76 Asphalt Recycling Assessment

Description

In response to a request from the Pavement Division (HNG-40), OTA has initiated Application Project 76, an assessment of hot mix asphalt (HMA) recycling. This technology assessment project is designed to accomplish four tasks.

- Document the state of the practice and report on the use of recycled HMA.
- Develop a synthesis of the performance and use of recycled HMA.
- Determine if institutional or technical barriers are restraining the use of recycled HMA.
- Provide recommendations for enhanced use of recycled HMA.

The scope of the project includes visits to at least two States in each FHWA region. The States were selected in cooperation with the regional materials engineer to obtain a cross section of those States that regularly

use recycled HMA and those that do not permit or limit the use of recycled HMA.

Background

Demonstration Project 39 showed that asphalt recycling is a viable rehabilitation technique. This effort developed materials, mix design, and construction guidelines for implementing an asphalt recycling project. Based on work accomplished under this project, it was estimated that the use of reclaimed asphalt pavement (RAP) would amount to approximately 15 percent of the total HMA production by the mid-1980s.

Despite having been demonstrated asphalt pavement recycling as a viable technique, the process has not been adopted to the extent originally estimated. No formal follow-up to this technology area has been initiated since Demonstration Project 39.

Currently, there is considerable emphasis on waste management at State, local, and national levels. Ordinances or legislation that mandates the recycling of certain waste products is under consideration or has passed at various government levels.

Project Manager

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Status

A team comprised of the Pavement Division (HNG-40), the Technology Management Division (HTA-10), and the appropriate Regional Pavement and Materials Engineer hascompleted all site visits. A final report has been developed and is in the printing stage. The report should be distributed in November 1995. In addition to this final report, a training course entitled, "Pavement Recycling for State and Local Governments" will be developed under competitive contract. This contract was awarded September 25, 1995 to NCAT at Auburn University. Pilot materials are expected by late summer 1996. While the final report will focus only on hot mix asphalt recycling, the training course would include all aspects of pavement recycling.

Marketing

This area focuses on enriching FHWA's technology transfer process. Since FHWA interacts with many types of customers, both internal and external, a marketing approach helps to improve effective communication with a variety of groups. To this end, a marketing seminar—which includes product and market assessment, communication strategies, and promotional management—has been developed to improve technology transfer skills of highway personnel. Another project that supports FHWA's marketing effort provides customized exhibits for local, national, and international conferences.

AP-25 Marketing Seminar, "Facilitating and Expediting Technology Transfer"

(Now National Highway Institute Course 42015)

Description

The objective of this seminar is to train highway personnel involved in technology transfer to be more effective in facilitating and expediting the process. More timely implementation of cost-effective products and procedures should result by improving the marketing and promotion skills of these personnel.

The seminar defines marketing and discusses strategic tools and techniques to enrich the technology transfer process. Case studies, development of marketing plans, and other exercises expand on the concept of marketing as a customer-oriented process.

1. Anticipate and define customer needs and wants early in the research stages and throughout the technology transfer process.

2. Manage that demand by stimulating customer/partner relationships and interest in focused product development; prioritize technology products and provide resources in personnel and funding.

3. Satisfy that demand by fulfilling measurable expectations and anticipating changing requirements.

Project Manager

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NHI Course Coordinator

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Status

The series of 2-day seminars was completed in October 1993. The course was modified to a 1-day format, eliminating FHWA-specific references and concentrating on marketing concepts and tools as they apply to highway technology transfer and applications.

The pilot course was conducted in Madison, Wisconsin, followed by four courses in Region 3. Two more 1-day courses were held in Salt Lake City, Utah and Denver, Colorado. Reservations are being accepted to schedule the 1-day seminar in other locations across the United States. Individuals should contact their training officers to schedule attendance.

AP-87 Technical Exhibits

Description

With the increased emphasis on marketing and strengthening the relationship between its partners and clients, the FHWA has developed exhibits that highlight the technologies and projects being developed and promoted by the FHWA. The topics available for display include European asphalt technology, asphalt and concrete technology, bridge protection devices, traffic, safety, and IVHS, as well as other FHWA Research and Development projects and Office of Technology Applications' activities.

Project Manager

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Status

Exhibit panels and graphics are available to FHWA field offices. Notebooks containing a photo display of all exhibit materials and suggested layouts are available upon request. Using these exhibit materials at conferences or meetings is a cost-effective means to promote current technical programs. By requesting only those graphics and panels needed, a unique exhibit configuration can serve the specific conference/meeting requirements.

A contractor has been hired to inventory, design, layout, transport, assemble and disassemble exhibit materials, and provide storage for exhibits within the U.S. To date, there have been more than 800 exhibits, including displays at CONEXPO '93 Conference, the Pacific Rim TransTech Conference, and at the 1993 and 1994 AASHTO and TRB meetings.

Technology Transfer Aids

Research and Technology Exhibit for future loan.

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