LTPP at Year Five

NEIL F. HAWKS

The Strategic Highway Research Program's Long-Term Pavement Performance program is nearing a time of transition. April 1992 will mark five years of effort by the LTPP research team and cooperating highway agencies to get the LTPP studies under way. These two groups have been the agents of a new beginning for pavement research in the United States and around the world. In June 1992, day-to-day management of the LTPP program will be transferred from the National Research Council to the Federal Highway Administration. Under FHWA management, with advice from the Research Council, the program will complete the remaining 15 years of research to provide data critical to improving the performance of roads. At the approach of the end of this first phase, it is well to look at what has been achieved.

LTPP is among the largest pavement performance research efforts undertaken. Data are being gathered on the performance of a variety of in-service pavement types in a wide range of climate, traffic, and subgrade conditions. The specific objectives of the LTPP program are to

1. Evaluate existing design methods.
2. Develop improved design methodologies and strategies for the rehabilitation of existing pavements.
3. Develop improved design equations for new and reconstructed pavements.
4. Determine the effects of loading, environment, material properties and variability, construction quality, and maintenance levels on pavement distress and performance.
5. Determine the effects of specific design features on pavement performance.
6. Establish a national long-term pavement performance data base to support SHRP objectives and future needs.

Neil F. Hawks is Program Manager, Long-Term Pavement Performance, Strategic Highway Research Program, National Research Council, Washington, D.C.

National Pavement Performance Data Base

The creation of the National Pavement Performance Data Base is the first step toward achievement of the first five objectives. SHRP is gathering data for this data base through a number of carefully designed studies of in-service pavements. The studies have been designed to produce data of the type and range needed to satisfy the first five objectives.

The creation of the data base is complex, both technically and logistically. The data must be reliable; variability must be quantified; and the data must be collected through standardized, repeatable methods. Because data on actual, in-service roads are needed for the full range of climate, soil, and traffic conditions found in North America, the LTPP experiments require extensive coordination with highway agencies throughout the United States and Canada.

LTPP Experiments

The LTPP experiments are classified into two groups: General Pavement Studies (GPS) and Specific Pavement Studies (SPS).

The GPS program is focused on existing pavements. The designs under study are those most commonly used in the United States and Canada. The individual test sites have been selected to provide a wide range of values for the key study variables and significant co-variates.

The SPS program requires specially constructed test sections. They will yield needed information about the cost-effectiveness of specific pavement design factors. Under this program, SHRP is exploring options for construction of new pavements, the application of maintenance treatments to existing pavements, and the rehabilitation of distressed pavements.

GPS

The 10 General Pavement Studies are identified in Table 1. State and provincial highway agencies nominated more than 3,000 highway projects as candidate test sites. In December 1988, 780 test sections were finally selected for inclusion in the studies. (See Figure 1 for the constructed GPS sites.) These test sections offer the best possible range of pavement design attributes, materials, traffic, and climatic conditions available for major roadways in North America. Each of these pavement sections will be

GPS

TABLE 1 GENERAL PAVEMENT STUDIES

GPS-1	Asphalt Concrete on Granular Base
GPS-2	Asphalt Concrete on Bound Base
GPS-3	Jointed Plain Concrete
GPS-4	Jointed Reinforced Concrete
GPS-5	Continuously Reinforced Concrete
GPS-6A	Existing Asphalt Concrete Overlay on Asphalt Concrete
GPS-6B	New Asphalt Concrete Overlay on Asphalt Concrete
GPS-7A	Existing Asphalt Concrete Overlay on Jointed Concrete Pavements
GPS-7B	New Asphalt Concrete Overlay on Portland Cement Concrete Pavement
GPS-9	Unbonded Portland Cement Concrete Overlays of Portland Cement Concrete Pavement

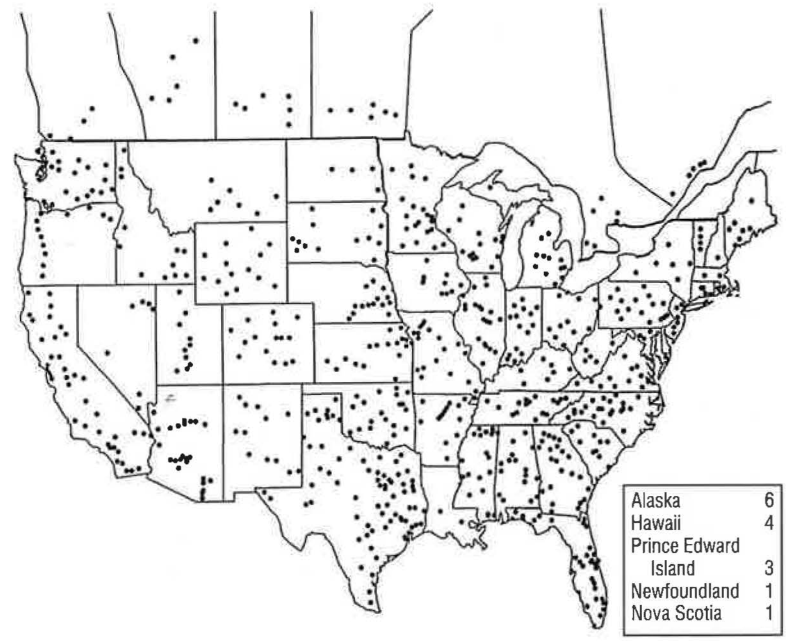

FIGURE 1 Location of constructed GPS sites.

SHRP

studied closely for 20 years to determine why some pavements fail and others do not.

A first, or inventory, round of data collection, coordinated by SHRP's four regional offices, was completed in 1990 to verify that the design and construction of these sections matched agency records. Each GPS site was drilled and samples were taken for later laboratory testing. Before the drilling and sampling began, the LTPP research team created its own set of standard procedures and field tests. This ensures that all samples collected by SHRP's four drilling and sampling contractors, or by state and provincial highway agencies, are obtained and handled according to the same rigorous standards. These guidelines will be published in 1992 in the *SHRP-LTPP Guide for Field Material Sampling, Handling, and Testing*.

The planned materials testing program for GPS matches the scale of the sampling program. Carefully selected commercial laboratories will take more than two years to complete testing. Before it is over, 93,000 separate tests will have been run, each in strict accord with the *SHRP-LTPP Guide for Laboratory Materials Handling and Testing Manual* and a rigorous quality assurance/quality control program that will allow future researchers to use LTPP test data with confidence.

Field-performance monitoring of the test sections is also under way. The longitudinal and transverse profiles, skid resistance, deflection under load, and pavement distress of each 500-foot-long test section are monitored periodically in strict accord with SHRP standards. These standards, contained in SHRP test manuals, will be published to show highway engineers and researchers how these data were acquired.

The commitment from states and provinces for the collection of traffic data is even more extensive than that for the field and laboratory testing programs. Traffic data are essential to pavement design and critical to monitoring the performance of the GPS sections. The states and provinces are providing long-term, site-specific traffic data for each of these widely dispersed test sites. By analyzing traffic data along with performance measures, materials test results, and climatic data, researchers will be able to identify the crucial factors affecting pavement performance, quantify their impact, and improve accuracy and reliability of existing design procedures.

Under GPS research for LTPP studies, the standard pavement designs of the past 20 years are being evaluated. This research will yield a great deal of information on how to improve those standard designs, but little about their limitations. Information is lacking on new design procedures for integrating structural and mixture design, methods for unifying pavement design and maintenance into a single engineering system, or generating pavement rehabilitation strategies that cost-effectively address specific pavement deterioration problems. To remedy these shortcomings, special test sections, constructed to rigorous specifications that control key performance variables, are needed. The SPS program provides these sections.

SPS

There are nine Specific Pavement Studies (see Table 2). The first two, SPS-1 and SPS-2, are focused on structural design factors: how designs can be improved to counteract the stresses generated by load and environment. SPS-3 and SPS-4, administered as part of SHRP's Highway Operations research, will provide information about the effectiveness of various pavement maintenance techniques when applied to different pavement designs at various times in their service lives. Under SPS-5, SPS-6, and SPS-7, a wide variety of rehabilitation technologies using both asphalt and concrete are being studied. SPS-8, the study of environmental factors that affect structural design, will isolate distresses caused principally by climatic and geological conditions. This, in turn, will lead to the development of engineering models to counter such distress. SPS-9 serves two functions: to validate the findings of SHRP's asphalt research efforts and to provide the data base necessary to integrate pavement structural design with asphalt materials mixture design. This last item cannot be overemphasized. Mixture design must deliver the engineering properties demanded by the structural design. If these two engineering elements are not integrated, the long-term performance of pavements will always be disappointing.

Each SPS has a unique materials sampling and testing plan and a monitoring plan designed to match the requirements of each study. For the most part, these plans are variations of those employed in GPS, with changes in the frequency of monitoring or the addition of tests to address specific needs not found in GPS. Samples of materials used in SPS test site construction are provided to the SHRP Asphalt and Concrete research teams. Newly developed test methods can be tried on these samples in a situation in which the performance predictions based on those tests will be verified.

Each SPS test site contains 2 to 12 separate test sections. Many of the sites also will contain supplemental test sections where state and provincial highway agencies will be researching materials and techniques of local or regional interest with the same rigor applied to the core SPS sections. Ninety-one such supplemental sections already have been constructed. When fully implemented, SPS will contain a minimum of 1,400 individual test sections.

SPS test sites require special construction and must therefore be completed using the contracting procedures of the state and provincial highway agencies. It is often difficult to find appropriate sites in the construction plans of the highway agencies. The experiment design requirements are rigorous; only a handful of construction projects meet the criteria. To date, all sites for the maintenance studies have been identified, and most have been constructed (see Figure 2). About two-thirds of the rehabilitation studies sites (SPS-5, SPS-6, and SPS-7) have been identified. Approximately 50 percent of the structural studies sites (SPS-1 and SPS-2) have been located. Recruitment for SPS-8 (Environmental Factors) has just begun; no site recruitment for SPS-9

SPS

TABLE 2 SPECIFIC PAVEMENT STUDIES

SPS-1	Strategic Study of Structural Factors for Flexible Pavements
SPS-2	Strategic Study of Structural Factors for Rigid Pavements
SPS-3	Preventive Maintenance Effectiveness of Flexible Pavements
SPS-4	Preventive Maintenance Effectiveness of Rigid Pavements
SPS-5	Rehabilitation of Asphalt Concrete Pavements
SPS-6	Rehabilitation of Jointed Portland Cement Concrete Pavements
SPS-7	Bonded Portland Cement Concrete Overlays of Concrete Pavements
SPS-8	Study of Environmental Effects in the Absence of Heavy Loads
SPS-9	SHRP Asphalt Research Field Verification

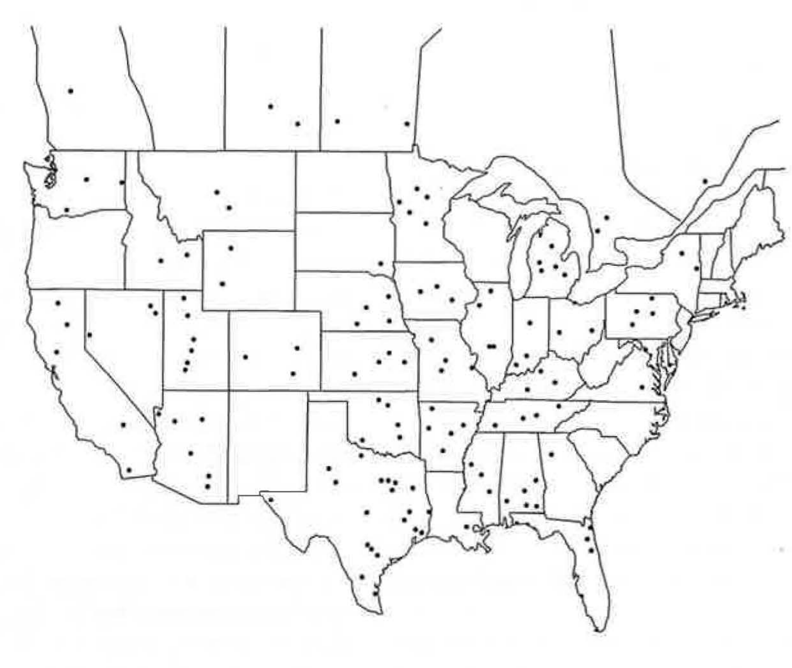

FIGURE 2 Location of constructed SPS sites.

SHRP

(Asphalt Research Verification) has occurred. Current plans project that SPS construction will be completed by the end of 1993. State and provincial support for LTPP is illustrated by their willingness to set aside scarce highway construction dollars for building SPS sites.

International LTPP

Nations around the world are developing related long-term pavement performance studies. Although each of these studies is designed to meet national objectives, the nations involved recognize that cooperative action will strengthen all the studies and accelerate the exchange of research findings. Using the SHRP LTPP studies as a focal point, studies have been initiated in Australia, Austria, Brazil, Denmark, Finland, France, Japan, The Netherlands, Norway, Sweden, and the United Kingdom. Other nations are considering starting cooperative studies. To foster international information exchange, the data from these studies will be stored in the LTPP data base, which is maintained by the Transportation Research Board. Results from related research studies conducted worldwide will be available from a single source. The similarity of data-collection procedures will also permit each of the cooperating nations to interpret how the research results of all of the studies pertain to their own national conditions.

Where Does This Lead?

Hundreds of test sections, thousands of tests, a massive data base, and international cooperation do not guarantee the success of LTPP. Researchers must sift and analyze the data before LTPP's objectives will be realized. This work must begin early, so that flaws in the studies or biases in the data can be identified and corrected early, and so that the benefits of LTPP can reach engineering practice as soon as possible.

Such work is already under way. SHRP is sponsoring three early analysis projects; another is being sponsored by the Canadian SHRP; and the Transport and Road Research Laboratory in the United Kingdom is also sponsoring one. FHWA has funded two separate studies, which should provide substantive early results. The SHRP-sponsored studies are expected to provide distress-specific pavement performance models that will continue the introduction of mechanistic elements into pavement design, which began with the 1986 revision of the *AASHTO Guide for the Structural Design of Pavements*. These studies also will quantify the effectiveness of mainte-

continued on page 32

SHRP's Pavement Performance Data Base

SHRP has developed the world's largest and most comprehensive pavement performance data base. SHRP's Information Management System (IMS) is a centralized source for pavement performance data collected from the Long-Term Pavement Performance research. During the next two years, SHRP will release data to the public twice a year, in January and July. The information is readily available through the Transportation Research Board.

Each release of data will provide pavement designers and analysts with the latest high-quality data on in-service pavement sections. Researchers can use the information to evaluate existing pavement design methods; determine the effects of loading, the environment, materials properties and variability, construction quality, and maintenance requirements; develop improved design methods and strategies for the rehabilitation of existing pavements; and complete a host of other highway research tasks.

The latest release is available only from the LTPP-IMS data base administrator, Penny Passikoff. Significant new information in inventory, materials testing, and monitoring is available. The data are maintained on a Dec MicroVAX 3900 running VMS. The data are available on a variety of media, including hard copy. Cost for the data varies; the handling cost of $75.00 is waived for LTPP participants.

For more information about the IMS data base, contact Shahed Rowshan, SHRP Project Manager, at (202) 334-3774. To request data, contact Penny Passikoff, TRB Information Management System operator, at (202) 334-3259.

SHRP

SPS-3 site on US-195 near Spokane, Washington, where the effectiveness of four preventive maintenance treatments will be tested, including chip seal overlays, shown here under construction.

large size of some projects leads to a scale that is not practical for walking from one end to the other, especially if the FAR (floor-area ratio) is low. In such cases, two or three nuclei of developments can at least make the subcenters walkable. The term "urban village" has often been used to describe large suburban mixed-use development projects, incorporating a high level of amenities along with higher densities. It is a worthy pedestrian-oriented design strategy to pursue.

Summary

Site planning is a well-accepted part of the development process. Unfortunately, the pedestrian often gets lost in the shuffle of other major decisions. To prevent this, it is necessary to include pedestrian elements at each stage of the planning and design process, from the initial conceptualization of site orientation to the final details for traffic controls. This is the essence of pedestrian-sensitive site planning. It involves integrating pedestrian components into the development process from concept to formal site-plan submission. It means simply remembering that pedestrians are there and that they need to be accounted for in the design process along with buildings, utilities, and automobiles.

References

1. S. A. Smith, K. S. Opiela, and L. L. Impett. *NCHRP Report 294A: Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas.* TRB, National Research Council, Washington, D.C., 1987.
2. *Residential Streets: Objectives, Principles, and Design Considerations.* Urban Land Institute, American Society of Civil Engineers and National Association of Home Builders, Washington, D.C., 1974.
3. *Model Subdivision Regulations*, American Planning Association, Washington, D.C., 1989.

LTPP *continued from page 17*

nance and rehabilitation tactics to control or remedy distress. Improvements to design and maintenance models derived from these findings will reach standard practice in three to five years.

Spin-off Products

The products of data analysis will not be available for a while, but other products generated by LTPP studies soon will reach the implementation stage. Many of the LTPP data-collection and data-management techniques are adaptable to pavement management systems. SHRP-developed non-destructive test equipment calibration and quality assurance procedures are being converted into standards by ASTM and the American Association of State Highway and Transportation Officials. New traffic data collection techniques and new or improved materials test methods will improve the reliability of existing design procedures. LTPP has spurred the development of automated weigh-in-motion and vehicle-classification technology. Research in these areas will aid other sectors of highway engineering such as traffic planning and "smart roads," and there are more research benefits to follow.

None of these spin-off products was high on anyone's list of critical needs. As they are implemented, however, they will stretch scarce highway dollars. By that measure, LTPP has been successful.

The End of the Beginning

The National Research Council's stewardship of LTPP through SHRP has been successful. The period of this stewardship will end in June 1992—leaving 15 years of research to be guided and evaluated. No single organization could provide for all of LTPP's needs; thus it was agreed among AASHTO, FHWA, and the National Research Council to divide the duties. FHWA will assume day-to-day operational management of the studies. The Research Council will retain the advisory role of the SHRP Executive and Pavement Performance Advisory committees through new Transportation Research Board panels. Steps have been taken to achieve the transition from direct National Research Council management to the new arrangement. FHWA has created an independent division to manage the operation of LTPP and appointed Paul Teng, long experienced in pavement research at both the state and federal level, as Division Chief. On his appointment, Teng was loaned to SHRP to learn about the management of LTPP. He will serve as the manager of headquarters operations during his assignment at SHRP. Teng's involvement in all aspects of the program will prepare him for full operational management of LTPP by mid-1992.

With the strong advisory role of the National Research Council through TRB, the commitment to success shown by the member agencies of AASHTO, and the status and independence that the new LTPP division will enjoy at FHWA, the coming transition will mark not only the end of one beginning for LTPP studies, but signal the start of another.