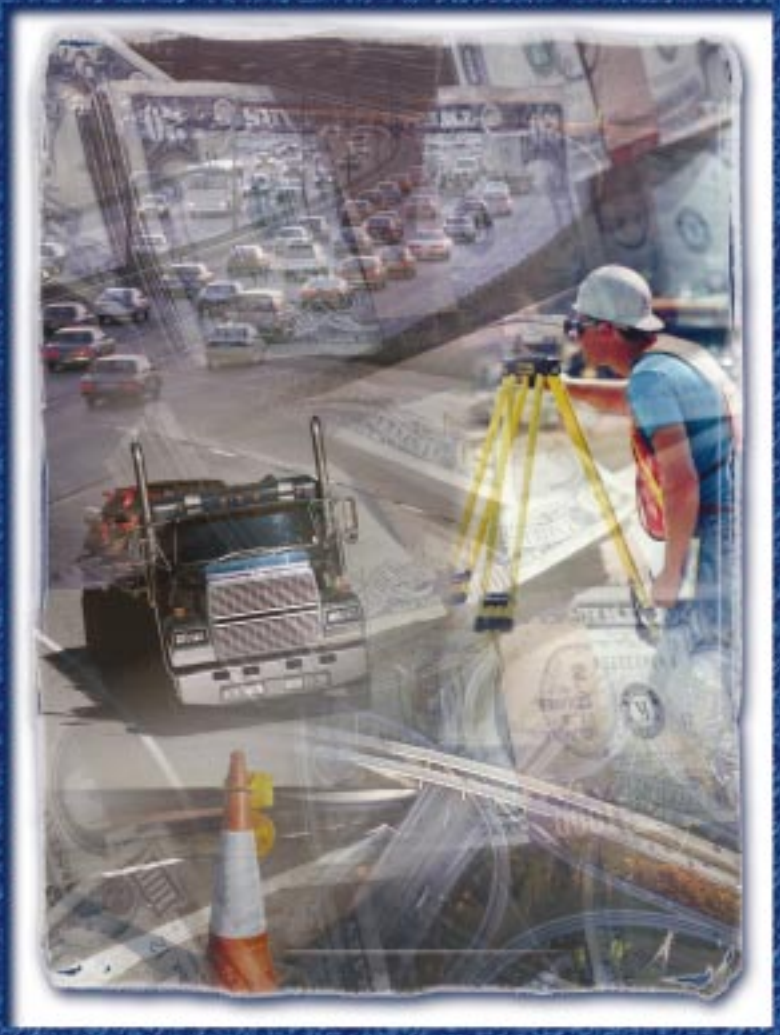

An Investment Benefiting America's Highways:

The Long Term Pavement Performance Program

U.S. Department of Transportation

Federal Highway Administration

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The Long Term Pavement Performance Program

More than a decade ago, the States, the Federal Government, and the Canadian Provinces invested in a 20-year pavement research program. Dubbed the Long Term Pavement Performance (LTPP) program, its primary goal is to provide data and products that extend pavement life at a reasonable cost. What's the value of this research? Why is pavement so important?

Roads (and, by necessity, the pavements on those roads) are critical to our Nation's economic well-being. Without them, commerce would come to a standstill. And no amount of electronic wizardry will help when a pavement fails. As U.S. Secretary of Transportation Norman Y. Mineta has pointed out, "Inadequate infrastructure is one of the chief threats to a thriving economy." And pavement is at the heart of our Nation's highway infrastructure.

Just think about it. Pavements carry all kinds of vehicular traffic for commerce and recreation. And they must do so in every type of climate imaginable, in all kinds of soil conditions, and with locally available materials. Pavements must be environmentally friendly and sustainable. They must be smooth, quiet, skid-free, drainable, and plowable. They must be constructed quickly and repaired quickly.

How can the States design and build roads that address all of these concerns? Only by understanding how and why pavements perform as they do. That's where LTPP comes in. LTPP gathers and processes data describing the structure, service conditions, and performance of more than 2,300 pavement test sections in all the States, the District of Columbia, and in 10 Canadian Provinces. Then, in order to derive further benefit from these data, LTPP's analysis effort takes the raw data collected from the 2,300 test sections and converts it into useable information. Some of these analysis efforts have led to the development of products—practical tools that help highway engineers and managers in their day-to-day activities.

Is LTPP still important today?

Traffic volume has increased 68 percent between 1980 and 1997. Capacity due to new roads has only grown 4 percent during the same time period. As a Nation, we need to understand how to build more long-lived and cost-effective roads to meet this rapidly growing demand.

"The principal product at highway agencies is clearly pavement. We need to design pavements that will last. And we can only do this if we know how to do the job right. And we can't do that without the kind of information that LTPP gives us."

—Francis B. Francois, Attorney and Consultant; Former Executive Director of the American Association of State Highway and Transportation Officials (AASHTO)

"LTPP data contains information that is not available anywhere else in the world. This information is critical to developing specifications for good-performing pavements and is key to developing models that predict future performance."

—E. Dean Carlson, Secretary of the Kansas Department of Transportation; President of the Board of Directors of AASHTO; Former Executive Director of the Federal Highway Administration

"Pavements are an essential part of our Nation's transportation infrastructure. The LTPP program can contribute to a sound, efficient, and properly managed transportation infrastructure system. In turn, increasing efficiencies can lead to reductions in transportation expenditures."

—Ray Mellen, Manager, Community Programs and Field Affairs, Automobile Club of Southern California

What is the current investment in LTPP?

The total national investment in LTPP from 1987 to 2001 is approximately $187 million. In addition, partici-

LTPP is a valuable research program for everybody in America—those who use our roads directly and those who are the beneficiaries of travel on our roadway systems. Whether it is for moving people, whether it is for moving goods, whether it is to support local activities or national trade and tourism—whatever it is—the quality of our pavements is integral to the quality of life in America and to the success of our economy. LTPP is a major contributor toward assuring that we will have good pavements into the 21st century.

—Francis B. Francois, Attorney and Consultant; Former Executive Director of AASHTO

pating States and Canadian Provinces invested approximately $50 million.

What is the value of this investment?

"LTPP is about maximizing our Nation's $17 billion a year investment in roads. If you can take this $17 billion and extend its useful payback period by increasing performance or if you can reduce the investment by some change in the design, the value is immediate and measurable."

—Tom Larson, Former Federal Highway Administrator

"To put in perspective LTPP's value to the Nation's economy and infrastructure, let me give you a little history. The trucking industry's percentage of moving traffic has always been on a direct line with the building of the highways and, ultimately, with the building of the Interstate highway system. Good highways have allowed the trucking industry to provide fast, reliable, and inexpensive transportation to our customers. This, in turn, has given us the best transportation system in the world. By making highway improvements, we will increase our competitiveness in the world economy because our products will get to market even more quickly and cheaply. Improvements are absolutely necessary."

—John M. Smith, President and CEO, CRST International, Inc.

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—Francis B. Francois, Attorney and Consultant; Former Executive Director of AASHTO

What are the benefits of LTPP to date?

"LTPP provides answers to all kinds of questions about our Nation's roadways—how to improve them, how to make them safer, how to rehabilitate them more cost-effectively. Through the products and procedures developed over the past several years, LTPP has helped many, many highway agencies."

—Michael Darter, Research, ERES Consultants/ ARA, Inc.; Adjunct Professor of Civil Engineering, University of Illinois, Urbana-Champaign

"The States expect to get useable products out of LTPP. And I think that is occurring more and more."

—Francis B. Francois, Attorney and Consultant; Former Executive Director of AASHTO

Specific products that LTPP has developed and the benefits derived from them today include:

FWD Calibration Procedures

In 1999, $5.5 billion[1] in Federal highway funds were spent on pavement rehabilitation and resurfacing. To make good decisions about pavement rehabilitation, State departments of transportation (DOTs) need extensive data on the structural condition of pavement.

To measure the structural condition of a pavement, most pavement engineers rely on falling-weight deflectometer (FWD) technology. FWDs "thump" the pavement and record information about its structure and integrity. But like all sophisticated tools, the FWD must be properly calibrated and used. If it is not, measurements will be inaccurate. Inaccuracy wastes dollars.

So, in the late 1980s, LTPP developed FWD calibration procedures and subsequently launched four FWD calibration centers in cooperation with State DOTs. LTPP's FWD calibration procedures are the only nationally accepted means of verifying that FWD information is accurate.

Are these calibration centers a good investment for the States that run them? According to Gary Hoffman, PennDOT's chief engineer, "Pennsylvania's FWD calibration center has proved to be an excellent investment. With how much we spend each year on rehabil-

[1] *Highway Statistics, 1999*, FHWA.

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itating our roads, we really need the most accurate data we can get. Having the calibration center assures us of that."

And how important is FWD data? "FWD data," explained Hoffman, "plays a key role in developing our rehabilitation strategy, the design of our rehabilitation, and the resulting life-cycle cost analyses. Indeed, FWD data has become integral to our pavement design process."

1998 Rigid Pavement Design Procedure and Spreadsheet

Getting the design of pavement correct from the start is, at best, a difficult task. Much of what pavement engineers have to work with are formulas and equations that are based on assumptions—assumptions that may or may not reflect the reality of the conditions and useage of the road to be built.

In 1998, research by the National Cooperative Highway Research Program (NCHRP) addressed a component of this issue through the development of improved guidelines for the design of portland cement concrete pavements. However, new guidelines, in and of themselves, are not enough. They need to be validated if engineers are going to use them.

Enter LTPP…LTPP data were used to validate the new guidelines, demonstrating to the States that the guidelines matched real-world problems. The LTPP research team also developed a software tool to further help highway engineers implement the new procedure. The software allows an engineer to tailor the rigid pavement design to the site-specific conditions, materials, traffic, and design details. The resulting design is more cost-effective and reliable.

So why is it so important that the States implement these new guidelines? A comparison of several rigid pavement designs located in different geographic/climatic regions indicates that the 1998 procedure reduces the life-cycle costs of pavement by 30 percent compared to current procedures. This translates into a potential savings of $52 million per year for U.S. highway agencies. The costs of user delay will also be reduced because of fewer highway closures for pavement rehabilitation.

LTPPBind

The Superpave asphalt pavement mix design system has been implemented by most States since its introduction in the mid-1990s. One of the significant improvements of this system over its predecessor (the Marshall asphalt mix design system) is its ability to match the selection of the asphalt binder (cement) with the site-specific climatic conditions.

As with any system, however, there is always room for improvement. Indeed, when the Superpave system was being developed, there was a limited amount of information about pavement temperature. As such, the original Superpave system assumed that the expected low air and pavement temperatures were the same—a conservative assumption.

Why is this significant? Choosing the wrong binder has many implications, not the least of which is cost—not only the cost of construction, but also the costs down the road for maintenance and rehabilitation.

With so many States already investing in the Superpave system, it made sense to see if this issue could be addressed. So researchers used LTPP data to quantify the relationship between air and pavement temperatures and to develop an accurate low pavement temperature prediction model.

This model was then used to develop a software tool —LTPPBind—that allows engineers to accurately select the correct Superpave asphalt binder for their specific regional conditions. LTPPBind has been adopted by AASHTO and is a standard component of the Superpave mix design system used today.

A national comparison of the asphalt binders selected using LTPPBind and those selected using the original Superpave systems indicated an annual construction cost-savings of $50 million for the highway agencies.

Indeed, the Kansas Department of Transportation (KDOT) uses LTPPBind software as an integral part of their pavement design process. "We're using LTPPBind for all our major paving projects in Kansas," explained Lon Ingram, KDOT's chief of materials and research. And although it's too early to determine the specific effects of using LTPPBind, "we believe we're seeing improved performance," continued Ingram.

Pothole Patching

We've all had to deal with potholes. Typically appearing in winter and spring, they are proof that climate and traffic have a significant impact on our roadways.

The idea of having a national pavement database, to me, is probably the most important aspect of LTPP. Not only for what we get out of it today, but for its usefulness in 20, 30 years from now. I think that is just critical.

—E. Dean Carlson, Secretary of the Kansas Department of Transportation; President of the Board of Directors of AASHTO; Former Executive Director of the Federal Highway Administration

Potholes also cost a lot of money—money to pay for their repair, money for vehicle repairs, money in terms of delays.

To deal with the pothole problem, State and local highway agencies have developed pothole-patching techniques that can be accomplished quickly, with minimum disruption to traffic. The downside to these techniques is that quite often they have a very short service life and the pothole reappears, requiring one or more additional repairs.

Which pothole-patching techniques work and which ones don't? That's what a Strategic Highway Research Program (SHRP) project began studying in 1991. When the SHRP research project ended, the LTPP program continued to collect performance data for an additional 5—years. Analysis of the LTPP data has documented that the recommended SHRP pothole repair procedures offer far superior performance and significant improvements in cost-effectiveness over standard pothole repair materials and procedures.

What does this do for the States and local highway agencies? Routine application of the SHRP/LTPP pothole repair materials and procedures will not only save highway agencies' maintenance dollars, but will reduce vehicle damage and accidents caused by potholes.

LTPP Studies

"I also believe that the series of studies that FHWA has been doing are terribly important. They produce important findings—findings that greatly enhance the capability of a State or a county or a toll agency or a Province to manage their pavements and to make intelligent pavement decisions. In the past, so much of it has been just flying by the seat of the pants. Now there is hard, reliable data out there that is being analyzed and can be utilized. And I think that's what States really want."

—Francis B. Francois, Attorney and Consultant; Former Executive Director of AASHTO

Pennsylvania has gotten a payback from LTPP's studies. PennDOT decided to change its practice of using skewed joints after reviewing the results of an LTPP study. The study analyzed LTPP data to identify what worked and what didn't to control the development of joint faulting.

According to Gary Hoffman, PennDOT's chief engineer, Pennsylvania believes it will be able to save money with the new policy. "We'll be able to reduce costs initially because perpendicular joints are just less expensive than skewed joints," explained Hoffman. "In addition, we'll save money by eliminating construction problems and ensuring that future maintenance is easier to deal with. So not only will we save money initially, but also through the entire life cycle of a pavement project."

What benefits will LTPP yield in the next couple of years?

"The idea of having a national pavement database, to me, is probably the most important aspect of LTPP. Not only for what we get out of it today, but for its usefulness in 20, 30 years from now. I think that is just critical."

—E. Dean Carlson, Secretary of the Kansas Department of Transportation; President of the Board of Directors of AASHTO; Former Executive Director of the Federal Highway Administration

In the more immediate future:

"The LTPP database is providing a wealth of data that is being translated into useable knowledge in products such as the 2002 Design Guide. Indeed, LTPP is providing one of the most important elements in technology development through field validation and calibration. The use of LTPP data helps demonstrate to the user community that the models and technologies being developed really match real-world problems."

—M.W. Witczak, Ph.D., Professor of Civil Engineering, Arizona State University; Professor Emeritus, University of Maryland, College Park

What is the 2002 Design Guide? It's NCHRP Project 1-37A, "Development of the 2002 Guide for the Design of New and Rehabilitated Pavement Structures," intended to replace the current AASHTO *Guide for the Design of Pavement Structures*. Why is it being replaced? The current guide is widely recognized as being inadequate for the design challenges faced by today's highway agencies.

In other words, the "how-to" book on designing pavements is out of date. Given the amount of money spent on highways, it is extremely important that the "how-to" book be as up to date and accurate as possible. Indeed, the developers of the 2002 Design Guide have estimated that the new procedures could result in a pavement rehabilitation savings of $1 billion per year.

Is a future investment needed?

Designing and building roads that last was the top choice cited by motorists when asked about preferred transportation improvements to combat traffic delays.[2] And it's no wonder. Traffic continues to increase, while few new roads are being built. Traffic congestion causes user delays, which, in turn, affect the timely movement of people, goods, and services. The bottom line is that traffic congestion affects our Nation's economic growth and steals valuable time from our citizens.

What does this have to do with LTPP?:

"The LTPP program really revolves around the idea of giving predictability to what we put down on the road. In today's economy, with just-in-time delivery, things simply have to move and move readily. So, things like pavement blowups that can be the result of bad joint practices, or excessive cracking and deflections, or potholes need to be minimized as much as possible. And the whole realm of predictable good behavior of pavements is what minimizes these problems. And that's what LTPP is about."

—Tom Larson, Former Federal Highway Administrator

However, a major change in LTPP's funding occurred in 1998. With the passage of the Transportation Equity Act for the 21st Century (TEA-21), LTPP's budget was effectively reduced by one-third. This level of funding is not sufficient to operate LTPP to its full potential. Recognizing this problem, the State DOTs have chosen to provide a partial solution by using NCHRP funding for LTPP in fiscal years 1999, 2000, and 2001. However, this solution is just a stopgap measure. In order for LTPP to operate at its full potential, a larger investment than is currently being provided by TEA-21 will be required.

Why should this investment be made?

"LTPP is so unique that it has value above what you might be able to calculate. It is almost of an incalculable value because it has required years of effort, probably thousands of people by now that have applied their technical abilities to this, and so it just becomes a research investment that simply has to be carried to a full-term set of findings."

—Tom Larson, Former Federal Highway Administrator

As significant as the 2002 Design Guide is, it only opens the door. With the continued full operation of LTPP, developers of the next generation of pavement design procedures will have information on the impact of pavement drainage, climatic factors, traffic, new pavement design features, rehabilitation strategies, and complete life-cycle performance histories not available today. Without a continued investment in LTPP, we may lose a potential cost-savings of up to $2 billion per year for highway agencies, plus $1.3 billion per year in savings for highway users.

"As a summary assessment, I'd like to say that I think LTPP has been a tremendous program for the country. To me, it is very, very important that LTPP continues even beyond its intended life right now and that its funding be increased. I think it's that valuable."

—M.W. Witczak, Ph.D., Professor of Civil Engineering, Arizona State University; Professor Emeritus, University of Maryland, College Park

"LTPP is probably the best research investment anyone could devise and it's getting better all the time."

—Tom Larson, Former Federal Highway Administrator

[2] *Moving Ahead, The American Public Speaks on Roadways and Transportation in Communities,* FHWA, 2001.

E. Dean Carlson was appointed secretary of the Kansas Department of Transportation (DOT) on January 9, 1995. Carlson has more than four decades of experience in the field of transportation. He retired in 1994 as executive director of FHWA. His 36-year career with FHWA included many positions in various Regional Offices, as well as at Headquarters in Washington, D.C. Carlson is currently president of the Board of Directors of AASHTO. He is also a member of the Executive Committee of the Transportation Research Board and a member of the Board of Advisors for the Eno Transportation Foundation. In 2001, Carlson was made a member of the National Academy of Engineering.

Michael Darter has been involved in pavement engineering throughout his entire 35-year career and is an internationally recognized authority in highway and airport pavements. He worked for several years for Utah DOT prior to receiving his Ph.D. in Civil Engineering. Darter has also served as professor of Civil Engineering at the University of Illinois for more than 20 years. He currently is head of the pavement research group at ERES Consultants, a division of Applied Research Associates, Inc.

Francis B. Francois retired on February 1, 1999 as executive director of the American Association of State Highway and Transportation Officials (AASHTO), a position he had held since August 1980. Since his retirement from AASHTO, Francois has engaged in a limited transportation consulting practice, concentrating on transportation policy, programs, and research. He is currently chair of the National Steering Committee on Transportation Operations, formed in 1999 by the Institute of Transportation Engineers and the Federal Highway Administration (FHWA) to help lead a national dialogue on improving the operations and management of the Nation's surface transportation system. A member of several panels at the Transportation Research Board, he served for 18 years as a member of its Executive Committee. He is a co-founder of the Intelligent Transportation Society of America and was the second chairman of its Board of Directors of which he is now an honorary life member. In 1999, Francois was made a member of the National Academy of Engineering.

Thomas D. Larson, former Federal Highway Administrator, came to FHWA after a distinguished career as a researcher, a professor of Civil Engineering, and an administrator at the Pennsylvania State University. He was Pennsylvania's Secretary of Transportation for 8 years. Larson was an active leader in both AASHTO and the Transportation Research Board.

Ray Mellen manages community programs and field affairs for the Automobile Club of Southern California. Prior to joining the Automobile Club, Mellen was the first Traffic Operations Engineer for the City of Irvine in Orange County, California. He also served as a consulting engineer in private practice where he performed various transportation planning and engineering studies in several southwestern cities. Hired as a transportation engineer for the Automobile Club, Mellen assisted in the club's efforts toward developing effective traffic and transportation engineering management programs. He served as technical advisor to various county, regional government, and community organizations, and continues to represent the club on a statewide committee responsible for developing standards for all traffic signs, signals, and highway markings in California.

John M. Smith is president and chief executive officer (CEO) of CRST International, Inc. He is also chairman and CEO of CRST International subsidiaries Malone Freight Lines, Inc.; CRST, Inc.; and Three I Truck Line. An active member of the trucking industry, Smith has served as president of the Interstate Truckload Carriers Conference and is known nationwide for his efforts to promote highway safety. He currently serves on the Board of Directors of the Interstate Truckload Carriers Conference and on the Executive Board of the American Trucking Association, and he is a member of the Iowa Motor Truck Association.

M.W. Witczak was appointed professor of Civil Engineering at Arizona State University on July 1, 1999. From August 1973 through June 1999, Witczak served on the faculty of the University of Maryland, College Park, where from 1981 to 1985, he was chairman of the Civil Engineering Department. During 1986 through 1996, Witczak also was concurrently affiliated with PCS/Law Engineering and served as vice president of Law Engineering until May 1996. Witczak is an internationally recognized expert in the area of highway and airfield pavements. In July 1999, he was appointed professor emeritus at the University of Maryland.

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—Tom Larson, Former Federal Highway Administrator

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