Answers on a Fast Track

Accelerated Pavement Testing in the United States

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Interest in accelerated pavement testing is growing in the United States. A number of organizations are now performing or initiating programs for testing pavements under simulated traffic conditions for relatively brief periods. The Transportation Research Board has formed the Task Force on Full-Scale and Accelerated Pavement Testing to evaluate current approaches and recommend future actions, paying particular attention to integrating these actions into strategic pavement research at both the national and local levels.

Accelerated pavement testing is intended to address one of the fundamental problems facing the pavement community: evaluating and predicting pavement performance. Performance evaluation for a given pavement alternative or innovation in real time involves either a delay of 10 to 40 years, representative of typical design periods, or the use of a short design period (1 to 5 years) and the extrapolation of results to longer periods, which may confirm or disprove the short-term findings.

As an alternative to the real-time approach, the accelerated pavement testing process increases the load conditions (frequency, magnitude, or both) so that the expected design traffic of 10 to 40 years' duration can be applied to pavement test sections in weeks or months. The trend is to use mechanical systems to cost-effectively apply accelerated loading to test pavements. A brief overview of the status of accelerated pavement testing throughout the world and the direction it is taking in the United States will demonstrate the benefits of this research technology to pavement design and rehabilitation. A National Cooperative Highway Research Program Synthesis of Highway Practice, *Application of Full-Scale Accelerated Pavement Testing*, is being prepared to provide detailed information on this subject, as part of NCHRP Project 20-5, Topic 26-07 (see sidebar).

Development of Accelerated Pavement Testing

Pavement performance studies generally have involved full-scale test sections as portions of the existing highway network, specially constructed test roads or tracks, or fixed (laboratory) test sections. On existing highway sections loading occurs under actual traffic; on test roads or tracks the loading is usually specially generated traffic with controlled loads. On fixed test sections, loading usually involves automated mechanical systems.

Existing highways and test roads or tracks continue to play a significant role in the improvement of pavement technology. The American Association of State Highway Officials Road Test conducted from 1958 to 1961 probably has had the greatest impact on pavement design and analysis in the United States to date. The Long-Term Pavement Performance Program instituted under the Strategic Highway Research Program is expected to have an even greater impact. Another full-scale pavement test that promises significant long-term contributions is the Minnesota Department of Transportation Mn/Road Project being conducted in conjunction with the University of Minnesota. This project on Interstate 94 northwest of Minneapolis relies on actual highway traffic for load application through a route-diversion procedure; it also includes a separate test loop for low-volume traffic. The Federal Highway Administration has developed the WesTrack controlled-traffic test track near Carson City, Nevada, to assist in the development of improved performance-related specifications. The facility has been in operation since March 1996.

Fixed-location (laboratory) test facilities have been used by numerous agencies because loading can be accelerated under controlled conditions, usually at a reasonable cost. Examples of early efforts in this area in the United States include the series of tests carried out by the U.S. Army Corps of Engineers at the Waterways Experiment Station in Vicksburg, Mississippi, using aircraft gears; and the circular test track at Washington State University in Pullman. Several facilities are now in use internationally, some of which are listed in Table 1.

Mobile automated loading systems have become popular during the past 25 years because they allow either field testing on existing networks or controlled testing under laboratory conditions. The Heavy Vehicle Simulator was developed in South Africa by the Council for Scientific and Industrial Research in the late 1960s and early 1970s to enable this flexibility after initial consideration of a fixed-location test track. A similar rationale was later used in the development of the Australian Accelerated Load Facility which has been owned and operated by AARB Transport Research, Ltd. (formerly the Australian Road Research Board) since 1984. Building on the success of these technologies, the recently developed Texas Mobile Load Simulator is also designed to test in-service pavements.

Regardless of the approach, the advantage of accelerated pavement testing lies in the ability to evaluate traffic load effects on pavements in a short time. Although the costs of accelerated pavement testing programs are relatively high, the cost for each load repetition is generally low. Benefit-cost ratios are estimated to be as high as 10 to 1 for both the Heavy Vehicle Simulator in South Africa and the Accelerated Load Facility in Australia, making accelerated pavement testing a very effective research tool. The most commonly mentioned disadvantage of this technology is the fact that environmental effects on a typical pavement with a 10- to 40-year design life are not reflected during the accelerated testing. Several accelerated pavement testing programs, domestic and international, however, have or are evaluating ways to incorporate these effects.

NEVADA AUTOMOTIVE TEST CENTER

Driverless truck circles WesTrack accelerated pavement testing facility 21 hours each day near Carson City, Nevada, guided by special electronic wiring embedded in asphalt pavement.

Recent Developments in the United States

In 1984 FHWA acquired the first accelerated loading facility in the United States, installing it at the Turner-Fairbank Highway Research Center, McLean, Virginia, in 1986. Various studies have been performed with this testing device (Figure 1), including field studies in Montana and Wyoming and a demonstration project at the USACE Waterways Experiment Station. The FHWA Accelerated Loading Facility is currently in use for SHRP Superpave™ validation studies at the Turner-Fairbank Center's Pavement Testing Facility; FHWA recently acquired a second

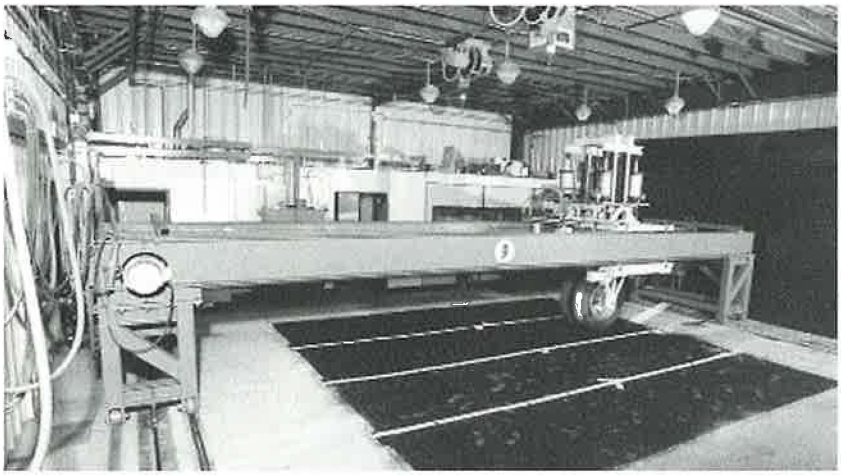
National Cooperative Highway Research Program Project Synthesizes Experience with Full-Scale Accelerated Pavement Testing

For many years pavement engineers have successfully used accelerated, full-scale pavement testing for developing and verifying design procedures and evaluating material performance. Under National Cooperative Highway Research Program Project 20-5, Synthesis Topic 26-07, a synthesis report is being prepared to describe the role of advanced pavement testing in the development of pavement technology. The report will present a review of the capabilities and limitations of the major equipment, facilities, and techniques for advanced pavement testing that are available worldwide, such as loading and pavement configuration, instrumentation, temperature and moisture measurement, analysis procedures, and applications. The synthesis will also contain a summary of how transportation and research agencies have applied advanced pavement testing and applications planned for the future.

The topic consultant is John B. Metcalf, Freeport-McMoRan Professor of Engineering, Louisiana State University, Baton Rouge. The published report is expected to be available in late 1996. For further information contact Sally D. Liff, manager, Synthesis Studies, Transportation Research Board (telephone 202-334-3244); Stephen F. Maher, senior program officer, Research Syntheses, Transportation Research Board (telephone 202-334-3245); or Scott A. Sabol, NCHRP staff engineer, Transportation Research Board (telephone 202-334-3228).

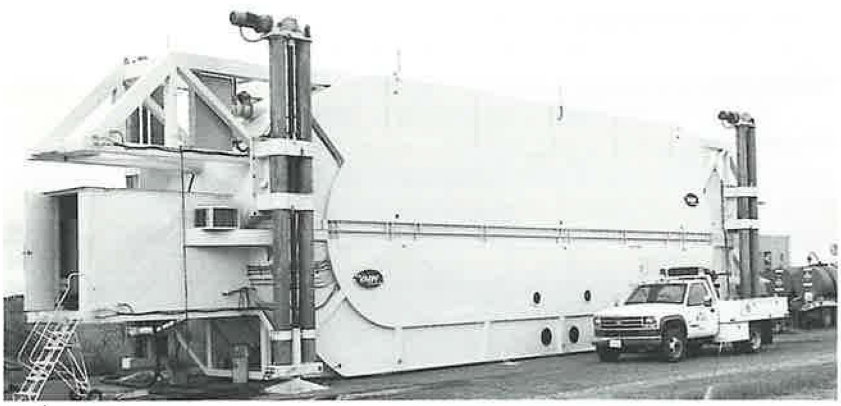
FHWA

FIGURE 1 Federal Highway Administration Accelerated Load Facility, Turner-Fairbank Highway Research Center, McLean, Virginia.



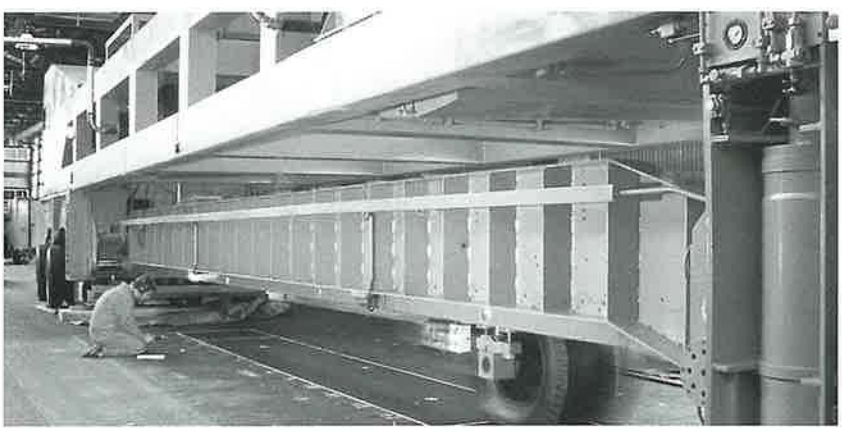
INDIANA DOT

FIGURE 2 Indiana Department of Transportation Accelerated Pavement Testing Facility, Purdue University, West Lafayette.



UT-AUSTIN

FIGURE 3 Texas Mobile Load Simulator, Victoria, Texas.



CALTRANS

FIGURE 4 Caltrans Heavy Vehicle Simulator tests pavement at Richmond Field Station, University of California, Berkeley.

Accelerated Loading Facility for this activity and for the evaluation of crumb-rubber-modified asphalt pavements. A third Accelerated Loading Facility was acquired by the Louisiana Department of Transportation for research at the Louisiana Transportation Research Institute in 1994. The equipment will be used initially at a fixed location.

The Mn/Road project, which was initiated in the early 1990s by Minnesota DOT, required a large investment for establishment of two new test roads. The Indiana Department of Transportation facility at Purdue University in West Lafayette (Figure 2), a fixed facility that simulates road conditions, began operation in 1992, and has been productive for a relatively modest investment.

The Texas Department of Transportation embarked on a project to develop equipment for accelerated pavement testing in the early 1990s with the Texas Mobile Load Simulator (Figure 3), which became operational late in 1995. This facility will operate on in-service pavements in Texas.

The California Department of Transportation entered the accelerated pavement testing arena in 1994 with the CAL/APT program, taking delivery of two Heavy Vehicle Simulators from South Africa in 1995 (Figure 4). CAL/APT relies on a collaborative effort between Caltrans, the University of California at Berkeley, Dynatest Consulting, Inc., of Ojai, California, and the South African Council for Scientific and Industrial Research. This collaboration is focused on technology transfer to minimize developmental and learning-curve inefficiencies. The approach has proven effective; CAL/APT began producing results in 1995.

Several accelerated pavement testing programs are associated with strong laboratory test programs and activities such as improved mechanistic pavement analysis. This combination of approaches already has been demonstrated by South Africa to provide significant advances in relatively little time.

Benefits

Accelerated pavement load testing allows for evaluation not only of the economics of capital investment in the pavement structure, but also the user costs of such investment. As competition for tax dollars continues to increase, accelerated pavement testing can yield results that will help make optimal use of funds earmarked for pavements.

The use of accelerated pavement testing enables pavement engineers to rapidly evaluate and compare rehabilitation measures for both flexible and rigid pavements. Prompt evaluation of quality-control measures on newly constructed pavements is also possible as a part of regularly contracted projects. New construction procedures can be assessed quickly as a part of pavement construction or reconstruction, and such assessment can be included in special provisions of regularly contracted proposals.

The advent of accelerated pavement testing improves the feasibility of using materials that are not standard for road construction, such as mixes containing waste materials or modified binders. Pavement costs can be reduced by eliminating unnecessary pavement thickness or improving the structural balance of the design. Layer equivalencies can be developed for new materials such as mixes with rubberized asphalt. Failure that could be caused by unproven designs or unanticipated heavy traffic can more easily be avoided.

An accelerated approach to pavement testing promises greater knowledge and understanding of pavement and material behavior, improvements in design methodologies for new and rehabilitated pavements, and the ability to validate information to both agency and contractor groups as the industry moves in the direction of warrantied pavements.

Future Developments

The U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, is embarking on an accelerated pavement testing program with a heavy vehicle simulator to be delivered in 1996. Other states and agencies in the United States are also planning accelerated pavement testing programs. One ambitious program is the Federal Aviation Administration's planned Accelerated Loading Machine, which can apply full future aircraft gear loads to test sections at a fixed facility.

Accelerated pavement testing is expected to be a catalyst in improving pavement engineering in the United States. Experience elsewhere, such as South Africa and Australia, and innovations within the United States, suggest that the benefits will accrue to both the public and private sectors. As a result the traveling public will enjoy better-performing, more cost-effective and longer-lasting pavements.

TABLE 1
Worldwide Fixed-Location Accelerated Pavement Test Facilities

Country	Organization	Type of Facility	Name of Facility
Denmark	Technical University of Denmark	Linear track	Danish Road Testing Machine
Netherlands	Delft University of Technology	Linear track	LINTRACK
United States	Indiana DOT/Purdue University	Linear track	Accelerated Pavement Testing Facility
France	Laboratoire Central des Ponts et Chaussées	Circular track	Manege á Fatigue Nantes
United Kingdom	Transport Research Laboratory (TRL)	Linear track	Pavement Test Facility (PTF)
New Zealand	University of Canterbury	Circular track	Canterbury Accelerated Pavement Tester Indoor Facility (CAPTIF)
Spain	Road Research Center, Madrid	Linear track	CEDEX Test Track
Mexico	Universidad Nacional Autonoma de Mexico (UNMA)	Circular track	————
Japan	Public Works Research Institute (PWRI)	Linear track	————
Switzerland	Federal Institute of Technology (EPFL)	Linear track	Full-Scale Testing Machine