Paving the Gap—Implementing Research in Asphalt Pavements

W. A. PHANG

W. A. Phang, head, Pavement Research, R&D Division, Ministry of Transportation and Communications, Downsview, Ontario, Canada.

What Does Implementation Mean?

First, implementation may be considered improved understanding of the behavior of materials and structures, which in turn can lead to solutions to problems, the creation of more effective policies, and the making of better decisions.

An example of this kind of implementation of research is the recent consideration of the policy for specifying the use of "high-stability" mixes. These mixes, intended to resist rutting by high-pressure truck tires, contain a very high percentage of crushed coarse and fine aggregate (not gravel and natural sand), thus raising the costs of crushing and transportation and increasing mix cost by more than 15 percent. On routes with heavy truck traffic, high-stability mixes were intended to be used in all layers, even in deep-strength and full-depth asphalt designs.

Published research (in fact, one of the papers presented at this conference) shows that rutting due to lateral flow caused by high-pressure tires is concentrated 40 to 50 mm below the pavement surface, and that the forces causing this flow taper off markedly at depths below 100 mm. This research also shows significant horizontal shear movement between the bottom of the surface course and the first binder course. Investigations of double-track rutting sites (which manifest rutting damage from high-pressure truck tires) in Ontario have shown repeatedly that second binder course layers have remained unaffected, verifying the theoretical analysis and laboratory test results that have been reported.

Because the results of this research are now known, setting the policy of where to specify high-stability mixes will implement these findings by requiring use only in the surface and upper binder courses. Because a few hundred miles of pavement are affected by this policy decision, it can be said that improved understanding through research has led to significant savings. For example, one 50-mm lift of two-lane pavement costs $50,000/km and if 200 km are involved, then a 15 percent saving would amount to about $1.5 million.

Second, implementation means the incorporation of findings in a methodology or system. In his opening address, Carl Monismith, the conference chairman, discussed the implementation of the pavement research reported at five previous international conferences. He described how, during the 25-year span of these conferences, research had been incorporated step-by-step into mechanistic pavement design methods, using multilayer elastic, viscoplastic, viscoelastic theory, and finite element computer programs. This theme was repeated by keynote speakers, and theme lecturers Steve Brown and Dick Barksdale showed how research reported at this 6th conference fitted into mechanistic pavement design systems and therefore could be implemented.

"The payoff that must come from research will be facilitated if implementation of findings can be expedited."

Over the years, findings from earlier research have been used as the foundation for more complex research, leading in recent years to the wide acceptance of mechanistic pavement design and the development of the AASHTO Design Method incorporating these principles. Similarly, examination of evaluation and monitoring, quality assurance, construction, and management reveals that previous research has been used as the foundation for today's practices and today's systems.

Third, implementation means the incorporation of findings into methods of testing to provide the materials behavior parameters needed in mechanistic design, in materials specifications, in codes of practice, in manuals, and in guidelines. These are the reference documents used by practicing engineers in their day-to-day operations. These are the "bridges" by which research findings are translated into beneficial actions.

Finally, implementation means the direct use of findings, for example, as criteria for the design of mixes to resist the effects of aging, or for processes such as the recycling of asphalt pavement (a whole industry is based on findings of research in recycling), or for the design of equipment. (A paper presented at this conference, for example, describes a new design for compaction equipment for asphalt pavement based on the concept of relative rigidity.)

Incentives for Implementation

Clearly, research presented in this conference series may already have been implemented. Findings that are implemented quickly and with vigor are those that increase productivity, effectiveness, and reliability; improve quality of service and safety; or decrease costs in either the short or the long term. Benefits from implementation must offset the costs of translating research findings into marketable products.

Disincentives for Implementation

Like seeds cast upon stony ground, some research findings do not grow or thrive because they are too fragmented or are not sufficiently comprehensive to build on. In addition, the supporting evidence may not be convincing enough or perhaps it is too short term, or the findings may lack credibility because of unrealistic claims. Researchers should always review their findings to determine if there are roadblocks to implementation and then determine what is needed to eliminate those disincentives.

"Findings that are implemented quickly and with vigor are those that increase productivity, effectiveness, and reliability; improve quality of service and safety; or decrease costs in either the short or the long term."

Significant Technical Developments

Nevertheless, during the last 10 years, significant technical developments have advanced pavement research inplementation to a striking degree. The most remarkable of these developments is the growth of hot-mix recycling of asphalt pavements. Research in this area had been sporadic before the early 1970s; however, the need for recycling was spurred by rapidly escalating prices of asphalt cements. By the mid-1980s, more than 50 percent of asphalt mixes in rehabilitation works in Ontario contained recycled asphalt pavement materials.

Cold-milling equipment introduced in the late 1970s revolutionized rehabilitation by making it possible to partially remove one or more layers of old asphalt pavement before placing new or recycled mixes. Cold milling is now a feature of almost all rehabilitation jobs.

Last but not least is the use of the microcomputer in all facets of highway engineering. Microcomputers make it possible for the engineer to use mechanistic design methods in a practical sense. Microcomputers make it possible to develop greater management efficiency, effectiveness, and productivity in operating highway agencies. Microcomputers make it possible, through automation, to carry out many functions not previously performed because of costly, labor-intensive requirements.

Expediting Implementation

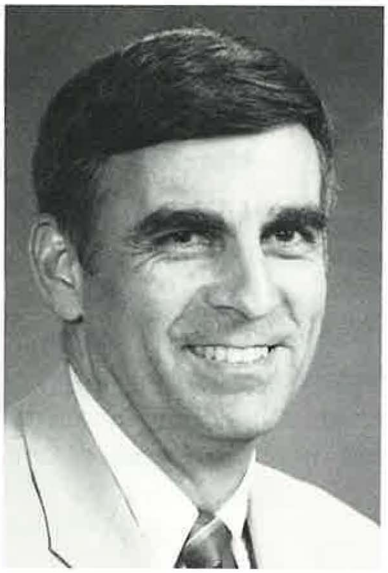
The payoff that must come from research will be facilitated if implementation of findings can be expedited. Because research efforts are carried out independently in many locations around the world, and the results are scattered across time and space, a national or international body is needed to direct attention to problems, seen and foreseen, to direct effort in the disciplines most required for the resolution of these problems, and to provide a forum for the presentation and discussion of developments leading to implementation. Such a body would encourage production and dissemination of model codes of practice, manuals, specifications, and test methods. Highway agencies would be able to build or adopt their own versions based on these models.

Conclusion

Using the term implementation in the widest sense provides a perspective against which to assess the payoff of research findings presented at this conference series. The conclusion is that the benefits are visible, that they have significantly influenced the practice of highway engineering in the last decade, and that the foundation has been laid for "paving the gap."

The University's Role in Pavement Research Implementation

JON A. EPPS



Jon A. Epps, dean, College of Engineering, University of Nevada-Reno, Reno, Nevada.

"Paving the gap" between the researcher and the practitioner refers to the transfer of usable knowledge between these groups. "Implementation of research to practice" is a more conventional statement of the focus of this session at the 6th International Conference on the Structural Design of Asphalt Pavements.

Of all existing institutions in the United States, the universities are in the best position to implement pavement-related research. But successful implementation requires a cooperative effort among researchers and practitioners. Thus an examination of the organizations within universities and those in association with funding agencies is presented here, and the general requirements of the research-implementor are discussed along with the need to establish a reward system for researchers and practitioners.

University Mission

Legislation associated with establishing Land Grant Universities in the United States clearly states the mission as (a) teaching, (b) research, and (c) public service. The most important activity of public service is continuing education. Clearly, the major universities in the United States are charged with "paving the gap"; they have responsibilities in research as well as implementation through their teaching and continuing-education programs.

At present about 6 out of the 16 western states in the United States have comprehensive programs that satisfy their mission statements as applied to their programs in pavement design, construction, rehabilitation, and maintenance. Shortages of staff, equipment, space, and a failure to recognize the importance of transportation account for this relatively low percentage. Because of these recognized constraints, western universities will more than likely develop regional transportation and pavement programs.

Organizational Structure

General

A typical university research organizational structure is shown in Figure 1. A majority of the outstanding pavement researchers in the United States are