A2F01: Committee on Portland Cement Concrete Pavement Construction
Chairman: James D. Grove

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JAMES D. GROVE, *Iowa Department of Transportation*
SANFORD P. LAHUE, *American Concrete Pavement Association*

More than 100 years ago in the small town of Bellefontaine, Ohio, city officials decided to build an experimental section of concrete street. Thus began the portland cement concrete (PCC) pavement industry. Concrete pavements have since helped transform our society from agricultural to industrial, and from rural to urban.

20TH-CENTURY DEVELOPMENTS

During the 20th century, the PCC paving industry has seen many new design concepts, as well as innovations in construction techniques and productivity that have enhanced competitiveness and quality. Halfway through the century, concrete pavements were used in the construction of the U.S. Interstate system, the greatest public works project in history. At about the same time, the advent of the slipform paver revolutionized and mechanized PCC pavement construction by eliminating the need for conventional side forms. Slipform paving resulted in higher productivity, better overall quality, and better-riding pavements. As the 21st century approaches, the slipform paver with modern computer controls still stands as the greatest paradigm shift in paving, and serves as the foundation for advances in the new millennium.

Other significant 20th-century innovations include the autograder, which gave the slipform paver a uniform subgrade to build upon; high-production central and ready-mix plants; new cements; admixtures that enhanced strength and durability; and research that solved incompatibility problems. In addition, the engineering concept of concrete pavement restoration, introduced in the 1970s, has extended the performance of PCC pavements well beyond their design life. It was also at midcentury that paving contractors began experimenting with sawed concrete joints. Previously, joints had been formed in the plastic concrete with jointing tools. These hand-formed joints had often resulted in a rough ride. Sawed joints improved ride quality and soon became a standard construction method.

The concrete pavement industry today is built on partnerships with the public sector at the federal, state, and local levels. At the inception of the federal-aid highway program in 1916, the Portland Cement Association (PCA) was formed to initiate these important partnerships. PCA represented industry's input to the highway pavement community until 1963, when the American Concrete Pavement Association (ACPA) was formed, and a 36-year partnership with the Transportation Research Board (TRB), the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), the Federal Aviation Administration (FAA), and other major specifying agencies began.

During the 20th century, the future of concrete pavement construction was defined by research and development activities. The principal stakeholders within the industry, from

both the public and private sectors, met frequently to forecast research needs for the future. The record shows clearly that concrete pavement construction procedures at the end of the millennium are the products of research.

RECENT ACTIVITIES

At the turn of the millennium, the concrete paving industry faces new research needs and priorities, as well as new dynamics in research funding for concrete pavements. In the post-Interstate era, research and innovation must be focused on preserving, rehabilitating, and enhancing the existing system. Only through a forward-looking and cooperative effort will concrete pavements be able to meet the changing needs and expectations of tomorrow's stakeholders, who, while becoming increasingly dependent on the nation's transportation system, have also become more aware and less tolerant of delays, performance problems, and the expense of poorly constructed and maintained pavements.

During 1997–1998, representatives of state departments of transportation (DOTs), FHWA, TRB, academia, consultants, contractors, PCA, ACPA, and local ACPA chapters formed a task group to create a blueprint for the future of concrete pavement research. The group examined the expectations of today's transportation users and translated anticipated future needs into five distinct goals:

- Discerning the best of today's practices;
- Reducing initial costs without compromising concrete pavement performance;
- Reducing user delays and public inconvenience associated with concrete pavement construction and maintenance;
- Developing cost-competitive pavement options for all paving applications; and
- Increasing the certainty that concrete pavements will achieve design expectations.

At the same time that this blueprint for the future was being developed, other events were taking place that will have an impact on concrete pavement construction in the new millennium.

First, the Innovative Pavement Research Foundation (IPRF) was founded in 1997 as a nonprofit organization to create a new generation of PCC pavements. The Board of Directors of IPRF includes public and private officials involved in concrete pavement construction. The foundation's principal activities include applied research, field test and evaluation, development of user-friendly materials, and training and education to facilitate adoption of the best and most innovative practices in the concrete pavement industry. The tasks of IPRF that will impact concrete pavement construction in the 21st century include the following:

- Pilot studies in traffic management optimization for the reconstruction of urban freeways;
- Examination of the impact of texturing and surface treatment on reducing wet-weather accidents;
- Development of tests or standards for identifying compatible combinations of individually acceptable concrete materials;
- Determination of the costs and benefits of various components of concrete pavements; and
- Field trials of concrete pavement products and process technologies.

Second, the U.S. Congress passed the Transportation Equity Act for the 21st Century (TEA-21), which was signed into law in June 1998. This landmark legislation provides $175 billion ($165 billion in guaranteed funding) to address the critical needs of America's highways. The bill includes a provision for $30 million in funding for applied research and development in concrete pavement.

Third, as a natural extension of the research blueprint, an action plan was created. This plan describes more than 70 activities addressing critical needs of the concrete pavement industry for the new millennium. The plan has served as a basis for fine tuning of the research blueprint.

Fourth, following on the research blueprint, the action plan for applied research, and the funding provided by TEA-21, a cooperative agreement was signed between FHWA and IPRF in March 1999. This 5-year agreement reflects the common interests of the private and public sectors—industry (IPRF), the federal government (FHWA), individual state DOTs, the transportation research community (TRB), and academia—in applied concrete pavement research. The agreement is unique in focusing on programs instead of projects.

Finally, under the cooperative agreement between FHWA and IPRF, a Concrete Pavement Research Committee, administered by TRB, was formed and funded. The committee, which includes representatives from state DOTs, industry, FHWA, academia, and IPRF, will meet periodically to examine new findings and identify priorities for future research in concrete pavement. The committee's recommendations will form the development of the annual research and technology agenda for IPRF and FHWA into the 21st century.

FUTURE PRIORITIES

There is no doubt that the funding and structure needed to advance concrete pavement technology into the new millennium are in place. It would be a grave mistake, however, to advance such a progressive and dynamic innovation and research program into the next century without input from users—the traveling public. In May 1996, a report of the National Quality Initiative (NQI), titled *National Highway User Survey*, was issued. The NQI Steering Committee (made up of representatives from FHWA, AASHTO, and several national trade associations) commissioned this survey, which was funded by FHWA, to determine the general public's satisfaction with the nation's highway system and identify their priorities for highway improvement.

The survey was developed and conducted by Coopers & Lybrand and Opinion Research Corporation in cooperation with the NQI Steering Committee. Households throughout the United States were sampled; the sampling process was based on a random digit-sampling frame. With regard to overall satisfaction with the highway system, 50 percent of respondents said they were satisfied, 34 percent were neutral, and 16 percent were totally dissatisfied. More than 50 percent expressed satisfaction with the major characteristics of the highway system. The respondents identified the three most important characteristics of the system as follows:

- Priority 1, safety—Respondents were most concerned about wet-weather pavement conditions.
- Priority 2, pavement condition—Respondents expressed a desire for a quiet, smooth ride and a durable pavement.

- Priority 3, traffic flow—Only 29 percent of respondents were satisfied with levels of construction delays and congestion.

On the basis of a discriminate analysis of the survey results, however, pavement condition ranked as the number one priority. Improved quality of the roadway surface is the factor most likely to significantly increase public satisfaction with the highway system.

LOOKING TO THE 21st CENTURY

As the 20th century comes to an end, substantial information, administrative structure, and funding exist with which to build an innovative concrete pavement program for at least the first decade of the new millennium. The challenges for the 21st century are substantial. More and heavier trucks can be expected as demand for just-in-time delivery increases, and implementation of the North American Free Trade Agreement continues. Miles traveled by users will increase each year, and their patience with delays will decrease. The following observations about the future can also be made:

- More attention will be given to preserving, rehabilitating, and enhancing the existing system.
- Funding for applied research in concrete pavement is secure into the first decade of the new millennium.
- The partnership among all stakeholders will achieve a new level of cooperation through IPRF, the cooperative agreement between IPRF and FHWA, and the inclusive institutional structure of TRB.
- As personnel turnover and retirement rates increase, more emphasis will be placed on education and training.
- There will be growing interest in innovative financing, whereby the public and private sectors join to advance projects.
- Users will be less forgiving in their support of highways if delays and performance are not addressed. The traveling public is tired of orange barrels.

The research and innovative technology currently being funded and considered serve as the basis for a vision of the concrete pavement construction process in the new millennium, at least during the first decade. The following developments can be anticipated:

- More courses on basic principles and best practices for concrete pavement construction will be created.
- Basic standards will be developed for describing the interaction between tire and pavement during wet weather, leading ultimately to a reduction in wet-weather accidents.
- New concepts in mix designs (high-density mixes) will result in improved durability and performance.
- High-performance concrete pavement that will last for 50 years or more will be constructed. A current project in Minnesota involves pavement that has been designed to last 60 years.
- There are strong indications that microwave curing systems, along with laser or infrared guidance systems, will be used on all slipform pavers, offering the potential for more-durable and smoother pavements.

- Fast-track mixes will be used to reduce the exposure time of the traveling public and workers in construction zones.
- Incentives will increasingly be used for construction characteristics such as ride, water-cement ratio, strength, and thickness.
- Contraction joints will be sawed and sealed in a one-pass operation.
- Rapid and nondestructive testing will accelerate the acceptance process, thus improving cash flow.
- The slow, often unreliable making of concrete beans and cylinders for acceptance will be eliminated and replaced by nondestructive methods.
- Greater use will be made of performance-based specifications (with incentives), placing more responsibility for quality control on the contractor.
- Sections of urban freeways either will be reconstructed or rehabilitated in a 55-hour weekend window.
- The first one-pass-in-place reconstruction equipment will be developed and used in a pilot project in the United States.
- Real-time material testing criteria will permit use by traffic as well as acceptance and payment for concrete pavement construction on the same day the pavement is placed.
- Precast concrete panels will be used for rapid repairs.
- Ride measurements will be made directly behind the slipform paver.
- The use of warranties for concrete pavement will be explored in more detail. Caution will be required in the concurrent use of performance-based specifications and incentives.
- Water-cement ratio will be used increasingly for quality control and acceptance of concrete for pavements.
- The concrete pavement restoration process will be streamlined so that a-mile-a-day restoration will be common practice.
- Users' concerns about the construction process will be solicited more frequently.

While other developments can be expected, the above list represents an educated look forward at PCC pavement construction in the new millennium.