R&T UPDATE
Concrete Pavement Research & Technology

SEVENTH INTERNATIONAL CONFERENCE ON CONCRETE PAVEMENTS

The 7th International Conference on Concrete Pavements drew 360 pavement engineers and technicians to Orlando, Florida on September 9-13, 2001. The event, organized by the International Society for Concrete Pavement, builds upon the legacy of previous international conferences organized by Purdue University and held in the United States about every four years.

Attendance at this conference almost doubled from the previous 1997 conference in Indianapolis, Indiana. About half of the participants were from outside the U.S. as 33 countries were represented. In total, 71 technical papers were written and delivered by authors from 15 different countries.

ACPA's President and CEO Val Riva delivered the keynote address to kick-off the conference. He noted the significant technical achievements that were reported at the conference. He urged the attendees to continue with research and technology to make concrete roads safer, last longer, and be more cost competitive. ACPA was joined by 13 other groups, including the American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA), Transportation Research Board (TRB) and Innovative Pavement Research Foundation (IPRF), in co-sponsoring the conference.

This edition of ACPA's Research and Technology Update summarizes a number of technical papers presented at the 7th International Conference. Nineteen of 71 papers are summarized as space will not allow for more. Copies of the Final Program listing all of the papers are available from ACPA until December 2001. Additionally, complete copies of the papers described in this report are available from ACPA upon request (contact Debbie Howard at 847-966-2272 or email at dhoward@pavement.com).

Development and Calibration of a Mechanistic Design Procedure for Jointed Plain Concrete Pavements — The development of a mechanistically-based design procedure is currently underway in the United States. This work is being conducted through the National Cooperative Highway Research Program (NCHRP) under sponsorship by AASHTO. This paper addresses the key aspects of the design procedure for jointed plain concrete pavements. The basic assumptions used to structurally model the PCC slab, base, subbase, subgrade, and joints are described in this paper. *Authors: Darter, Khazanovich, Snyder, Rao and Hallin.*

Identifying Combinations of Materials That Lead to Premature Deterioration in Concrete Pavements — Premature deterioration of concrete pavements can result from incompatible combinations of materials that were individually acceptable. The likelihood of problems due to incompatibility increases with the complexity of the mix design: the more ingredients, the greater the chance of an undesirable interaction. This paper provides a review of the literature on incompatibility of concrete materials, supplemented by a survey of selected highway officials and paving contractors. Particular emphasis is placed on early stiffening of fresh concrete, early

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cracking of hardened concrete, and inadequate air-void systems. *Authors: Detwiler, Nagi and Bhattacharja.*

Using Maturity Concepts to Determine Strength of Rapid Setting Hydraulic Cement Concrete This paper details the work of the Federal Highway Administration's Mobile Concrete Laboratory during pavement replacement on Interstate 10 near Pomona, California. The objective of the activity was to determine if maturity concepts could be used to predict early strength of Fast-Setting Hydraulic Cement Concrete. Based on this limited investigation, it appears that the maturity method predicts the early age flexural beam strength with a relatively high degree of certainty. Predictions of later age flexural beam strength are less certain. Compressive strength and maturity values correlated well for both early and later ages. *Authors: Mullarky and Wathne*

Concrete Pavement Design: It's More Than a Thickness Design Chart — Many aspects must be considered in developing an adequate concrete pavement design besides the selection of the pavement thickness. This paper examines some of these aspects of design and illustrates them with examples drawn from the author's experience. Among the topics covered are: an understanding of the basis of existing empirical pavement design practices, effect of site conditions, awareness of the basis of design tools and equations, appreciation of the difference between design simplification and actual field complexity, the crucial role of pavement materials, and the impact of construction on pavement performance. *Author: Rollings*

Performance of Arizona's SPS-4 Joint Sealing Experiment — Currently, nearly all state highway agencies require sealing of transverse joints in jointed plain concrete pavement (JPCP). However, despite the conventional wisdom concerning the need to keep transverse joints in concrete pavements well sealed, previous studies on the subject have not demonstrated that JPCP with unsealed joints perform differently in terms of spalling, faulting, roughness, or deflections. Arizona is one of four states that has built and monitored experimental concrete pavement test sections with sealed and unsealed joints. The performance of the concrete pavement test sections and the joint sealants has been monitored since the pavement's construction in 1991. This paper presents the findings from nine years of monitoring of the performance of the pavements and joint sealants at that site. *Authors: Hall, Evans, Crovetti, Correa and Scofield*

Methods for Measuring Application Rate of Liquid Membrane-Forming Curing Compounds on Concrete Pavements — Several methods of measuring application rates of liquid membrane-forming curing compounds were investigated. For non-pigmented compounds, a direct mass determination using sampling coupons appears to be the only plausible method. For white-pigmented compounds, reflectance was found to be a reasonably accurate, field applicable, method. *Author: Poole*

Demonstration of Lightweight Inertial Profilers for Construction Quality Control: Status Report — In 1999, the Federal Highway Administration, in partnership with the industry groups and ten state DOTs, demonstrated the use of lightweight inertial profilers to measure pavement profile for construction quality control and acceptance. This paper summarizes the results of the individual state evaluation reports and makes recommendations concerning inertial profiler operation and calibration as well as proposed construction smoothness specifications based upon inertial profilers. *Authors: Swanlund and Law*

Reconstruction of Urban Intersections Using Portland Cement Concrete Pavement — In 1994, the Washington State Department of Transportation began replacing selected asphalt concrete

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intersections with full depth portland cement concrete pavement (PCCP). This decision was made due to the high visibility of urban intersections and the high rate of rutting that was occurring in a short period of time (eight years or less). The paper summarizes a recent project where three major intersections were reconstructed with full-depth PCCP using accelerated construction techniques. With the use of partial and full road closures, lengthy construction periods are no longer warranted or necessary. *Authors: Uhlmeyer and Pierce*

Investigation of the Optimum Time for Cutting Joints in Concrete Roads — This paper describes an investigation of the optimum time for cutting joints in concrete pavements with a normal surface and with exposed aggregate. The results from the laboratory test show differences in the earliest cutting times for a normal surface and for a surface with exposed aggregate. For a normal surface the concrete is sufficiently strong to begin cutting without causing external damage at a compressive strength around 950 psi, while an exposed aggregate surface must reach about 1,300 psi. *Author: Lofsjogard*

Using Fiber-Reinforced Polymer Load Transfer Devices in Jointed Concrete Pavements — In this paper, the use of Glass Fiber-Reinforced Polymers (GFRP) as load transfer devices is investigated and some material characteristics and design guidelines are introduced. Falling Weight Deflectometer testing was conducted after one year of service and showed that GFRP dowels produced 30% higher deflections compared to steel, however the load transfer efficiencies for GFRP dowels remained excellent. The increased diameter and reduced stiffness of the GFRP dowels results in lower dowel bar bearing stresses. *Authors: Shalaby and Murison*

Investigation of Dowel Bar Retrofitting on PCC Pavement Responses — Dowel bar retrofit (DBR) has been successfully used to improve load transfer at transverse joints on many projects. In this study, finite element analysis was used to evaluate variables such as PCC thickness, temperature gradient, and subgrade support on DBR response. Discontinuities were modeled solely with aggregate interlock as well as in combination with dowels. In both cases, load transfer efficiency and the critical slab tensile stresses were computed to examine the immediate theoretical benefits. *Authors: Hiller and Buch*

A Framework for Repair and Rehabilitation Treatment Selection for Portland Cement Concrete Pavements — State highway agencies must maintain pavements in an optimum manner. Consequently, an increased interest has developed in finding effective means to select treatments within the overall framework of a strategy development process. A process for selecting rehabilitation strategies is described in this report along with systematic decision criteria to optimize the incorporation of a variety of repair methods to address a particular situation. *Authors: Zollinger, Smith and Tayabji*

An Evaluation of Retrofit Load Transfer Materials and Dowel Bar Configurations — In 1994, the Minnesota Department of Transportation (MnDOT) constructed experimental test sections of retrofit load transfer across transverse cracks in concrete pavement to evaluate retrofit load transfer and the effects of different dowel lengths and configurations, and patching materials on performance. After 6 years, the LTE has remained above 80% for all of the test sections, there have been no visible failures of the repairs and very little additional faulting has occurred in any of the configurations, although several repairs exhibited plastic shrinkage cracks and bond failures along the vertical faces of the slots. *Authors: Rettner and Snyder*

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Performance and Repair of UTW Pavements — This paper presents the results of studies dealing with ultra-thin whitetopping pavement performance reviews and repair and rehabilitation experiences. The paper includes detailed performance descriptions of several existing UTW pavements in Georgia and Tennessee and the UTW repair and rehabilitation projects conducted at the Federal Highway Administration's Pavement Testing Facility and in several states. The most commonly used repair method for UTW pavements are panel removal and replacement, which has been demonstrated as an effective method for UTW repair. *Authors: Wu, Tayabji, Sheehan and Sherwood*

The Ultrathin Whitetopping Option — In 1994, Iowa built 11.6 km (7.2 miles) of ultrathin whitetopping on a segment of Iowa Highway 21. Some 41 sections of pavement including three overlay depths, four joint patterns, three surface preparations, and fiber usage were constructed. Deflection testing, visual surveys, coring, and direct shear testing have continued over the seven years. The methods employed in the rehabilitation and success of each technique are also discussed. *Author: Cable*

The "Systems" Approach to Concrete Pavements — The performance of concrete pavements is influenced by the series of processes that takes place during a project. This paper reviews the processes that have a major influence on the long-term performance of concrete pavements, and suggests a "systems" approach to help assure due consideration of the interaction among these critical processes. *Author: Forster*

Use of Nondestructive Testing for Concrete Pavements — The Federal Highway Administration (FHWA) has promoted the use of nondestructive testing techniques for over 20 years in an effort to reduce the cost and time of construction quality control. Many of the available nondestructive techniques, however, are still under-utilized by state highway agencies. This paper presents FHWA's experience with two nondestructive test methods that show great promise for application in concrete pavement construction: maturity and impact-echo. This paper includes a brief discussion of background and theory, as well as a detailed discussion of case studies. *Authors: Crawford and Wathne*

Status of High-Performance Concrete Pavements Constructed Under FHWA's TE-30 Program Since 1996, twenty-two concrete pavement projects incorporating innovative design and construction concepts have been constructed by participating state highway agencies under the Federal Highway Administration's High Performance Concrete Pavement program. These innovative concepts, ranging from the use of trapezoidal cross sections to alternative dowel bar materials to fiber-reinforced concrete, all share the same goal of providing long-lasting, economical PCC pavements that meet the specific performance requirements of their particular application. This paper introduces the different projects included in the program, and summarizes the various design and construction innovations currently being investigated in those projects. It also highlights some preliminary findings from selected projects. *Authors: Smith and Swanlund*

The Ohio HPCP Joint Sealant Experiment — This paper describes the design and construction of the Ohio U.S. 50 test pavement, a project intended to evaluate concrete pavement performance in connection with various sealant types and joint configurations in the wet-freeze climatic zone. Unsealed transverse joints are also included in the experimental factorial. Monitoring activities are discussed and the sealant performance to date is summarized. *Authors: Ioannides, Sander and Minkarah*

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