CONCRETE PAVEMENT
CPTP
TECHNOLOGY PROGRAM

Concrete Pavement Technology Update

www.fhwa.dot.gov/pavement/concrete

Scan Team Co-Chair, Danny Dawood, PennDOT (right), thanking Belgian host André Jasienski of FEBELCEM.

The Concrete Pavement Technology Program

CPTP is an integrated, national effort to improve the long-term performance and cost-effectiveness of concrete pavements by implementing improved methods of design, construction, and rehabilitation and new technology. Visit www.fhwa.dot.gov/pavement/concrete for more information.

About CPTP Updates

The CPTP Update is one facet of CPTP's technology transfer and implementation effort. Updates present new products and research findings that emerge from CPTP studies. To place your name on the mailing list, call (202-347-6944), fax (202-347-6938), or e-mail (dblumenthal@woodwardcom.com).

In This Update

U.S.Department of Transportation
Federal Highway Administration

Celebrating 50 Years 1956 50th 2006 Eisenhower Interstate System

Quest for Long-Life Concrete Pavements

U.S. Experts Learn Canadian and European Approaches

In May 2006, a team of 13 concrete pavement and concrete materials specialists from the United States visited Canada, Germany, Austria, Belgium, The Netherlands, and the United Kingdom to identify successful design approaches, material requirements, construction practices, and maintenance strategies for long-life concrete pavements. The scan tour was sponsored by the American Association of State Highway and Transportation Officials, Federal Highway Administration (FHWA), and National Cooperative Highway Research Program. The team included experts and leaders from FHWA, State departments of transportation, academia, and industry. The following activities were conducted:

- Canada—meetings in Toronto with the staff of the Ontario and Quebec Ministries of Transport and the Cement Association of Canada, as well as a visit to Highway 407 in Toronto.
- Germany—meetings at the German Cement Works Association (VDZ), Dusseldorf; the Federal Highway Research Institute (BASt), Bergisch Gladbach; and the Technical University of Munich, Munich. A site visit was also made to a continuously reinforced concrete test section south of Frankfurt.
- Austria—meetings at the Association of the Austrian Cement Industry, Vienna, jointly organized with the Austrian Federal Ministry of Transport; visits to several concrete pavement roadways; and a presentation on the NanoCem consortium in Europe.
- Belgium—meetings in Brussels, organized by FEBELCEM (the Federation of the Belgian Cement Industry), with the Ministry of Equipment and Transport of the Walloon Region and the Infrastructure Agency of the Ministry of the Flemish Community; also, site visits to several concrete pavement projects.
- The Netherlands—meetings with staff of the CROW Technology Center (national information and technology platform for infrastructure, traffic, transport, and public space) and Dutch consultants and site visits to several concrete pavement projects.
- The United Kingdom—meetings at Britpave (British In-situ Concrete Paving Association) and TRL, the Transport Research Laboratory.

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Typical “super-single” tridem axles in use in European countries visited.

Exposed aggregate surface on an Austrian motorway pavement.

The scan tour confirmed that well-designed and well-constructed concrete pavements (both CRCP and JPCP) continue to be important pavement types in the countries visited. Concrete pavements in the European countries visited are designated as long-life and are designed for 30 or more years of low-maintenance service life. The European countries visited are responding aggressively to pavement–tire noise issues in urban areas, and the exposed aggregate surface is the texture of choice in Germany, Austria, Belgium, and The Netherlands. A two-lift concrete placement is used to obtain the exposed aggregate surface. In the UK, the use of an asphalt-based wearing surface is mandated for highway concrete pavements. Also, Germany and Austria have successfully implemented the use of catalog designs for their jointed plain concrete pavements. Germany requires use of a geo-fabric as a separator layer between cement-treated base and the concrete pavement, while the use of an asphalt concrete interlayer is required in Austria. Belgium primarily uses continuously reinforced pavements.

The long-life concrete pavement scan team tentatively identified the following items as having the greatest impact for improving pavement design and construction practices in the United States:

- Two-lift concrete placement—to be pursued in combination with exposed aggregate surfaces for noise reduction and/or the use of lower quality aggregates and recycled concrete in the bottom course for economic and environmental needs.
- Design features catalog—based on theoretical analysis, laboratory investigations, field observations, and expert input.
- Construction of high-quality foundations—renewed focus on foundation materials, thickness, compaction, and alternative foundation types.
- Well-developed concrete mixtures—use of combined aggregate gradations that result in a dense, durable concrete matrix that exhibits low paste at the surface; and consideration of cement characteristics for constructability and economics.
- Geotextile interlayer between the cement treated base and the concrete surface layer—use of a thick geotextile fabric to minimize slab stresses due to curling and warping and as a replacement for asphalt concrete interlayers for unbonded concrete overlays.
- Exposed aggregate surfacings—use of high-quality, durable aggregates in the top course of the concrete slab, but after additional investigations to determine the levels of reduction in noise that can be achieved.

The final report on the scan trip findings is expected to be available during early 2007. The highlights and findings of the scan trip were discussed at the International Conference on Long-Life Concrete Pavements, held in Chicago, Illinois, October 25 to 27, 2006.

Scan team touring at the accelerated load testing facility at the Transport Research Laboratory (TRL).

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Update on CPTP Project Reports

The Concrete Pavement Technology Program continues to produce various reports under each of its six focus areas (design, materials, construction, repair and rehabilitation, user satisfaction, and technology transfer). Recent additions to the CPTP library, listed below, may be accessed at www.fhwa.dot.gov/pavement/concrete. A complete project listing of CPTP reports and products is also available at the Web site.

Tests or Standards to Identify Compatible Combinations of Individually Acceptable Concrete Materials

- Technical Report (Volume II – Test Protocol) (FHWA-HRT-06-080)
- Technical Brief (FHWA-HRT-06-082)

Computer-Based Guidelines for Concrete Pavements

- Volume I: Project Summary (FHWA-HRT-04-121)
- Volume II: Design and Construction Guidelines and HIPERPAV II User's Manual (FHWA-HRT-04-122)
- Volume III: Technical Appendices (FHWA-HRT-04-127)

Guide for Curing of Portland Cement Concrete Pavements

- Technical Report (FHWA-RD-02-099)
- Technical Brief (FHWA-IF-06-003)

Achieving a High Level of Smoothness in Concrete Pavements Without Sacrificing Long-Term Performance

- Technical Report (FHWA-HRT-05-068)
- Technical Brief (FHWA-HRT-05-069)

Long-Term Plan for Concrete Pavement Research and Technology—The Concrete Pavement Road Map

- Volume I, Background and Summary (FHWA-HRT-05-052)
- Volume II, Tracks (FHWA-HRT-05-053)
- Technical Brief (FHWA-HRT-05-074)

High Performance Concrete Pavements

- Summary of FHWA's Test and Evaluation Project Series (FHWA-IF-06-031)
- Project Summary (FWHA-IF-06-032)

TechBrief: Use of Magnetic Tomography Technology to Evaluate Dowel Bar Placement (FHWA-IF-06-002)

TechBrief: Maturity Testing for Concrete Pavement Applications (FHWA-IF-06-004)

TechBrief: Concrete Pavement Rehabilitation and Preservation Treatments (FHWA-IF-06-005)

In addition, several publications and documents will be completed within the coming months and should be available from FHWA shortly thereafter. These reports, which are all based on CPTP projects or CPTP-related disciplines, include the following:

- Use of Magnetic Tomography to Evaluate Dowel Placement
- Development and Implementation of a Performance-Related Specification (I-65 TN)
- Construction and Preliminary Monitoring of the Georgetown, Texas Precast Prestressed Concrete Pavement
- Construction of the California Precast Prestressed Concrete Pavement Demonstration Project
- Use of Precast Slabs for Full-Depth Repair
- Best Practices for Concrete Consolidation for Slipform Paving (Technical Brief)
- Conventional Fast-Track Pavement Rehabilitation (Technical Brief)
- Guidance for Evaluating Dowel Bar Alignment (Technical Brief)
- Best Practices for Thin Bonded Whitetopping (Technical Brief)

Tommy Beatty, director of FHWA's Office of Pavement Technology, recently retired from a distinguished 35-year career with the agency. Beatty has been a strong supporter of the Concrete Pavement Technology Program. As he commented in a Focus interview, "This program is an excellent example of a public–private partnership. The CPTP has produced numerous technologies that will make a significant impact on the transportation program."

CPTP staff and colleagues applaud Tommy's service and wish him a rewarding retirement.

Pavement Texture Research Enhances Safety

With tining, friction and tire-pavement noise in the finished pavement are significantly influenced by spacing, depth, width, and orientation of the tines. Longitudinal tining is the preferred choice for tined surface in many States.

A variety of construction or rehabilitation techniques have been found to yield pavement textures that have good friction properties without sacrificing too much on tire–pavement noise. These techniques are discussed here briefly as provided by the FHWA technical advisory on surface texture.

CPTP pavement texture efforts lead to enhanced pavement safety as brought forth in FHWA Technical Advisory T 5040.36 (Surface Texture for Asphalt and Concrete Pavements) issued in June 2005. The technical advisory provides state-of-the-practice information on pavement surface texture/friction and guidance on selecting techniques that will provide adequate wet pavement friction and low tire–surface noise. The advisory is consistent with FHWA pavement policy contained in 23 Code of Federal Regulations 626.3 stating, "Pavement shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner."

In 1987, the Permanent International Association of Road Congresses (now called the World Road Association) defined three classes of pavement surface texture. Two classes of surface texture affect wet pavement friction: microtexture, with wavelengths of 1 mm to 0.5 mm (0.00004 to 0.020 in.), and macrotexture, with wavelengths of 0.5 to 50 mm (0.02 to 2.00 in.). The first is generally considered to be a function of the fine aggregate used in a concrete pavement mixture, while the second is related to tining or other concrete finishing operations. A third class, megatexture, with wavelengths of 50 to 500 mm (2 to 20 in.), plays a role in tire–pavement noise.

While the advisory points out that safety is paramount, it notes that tire–surface noise also should be considered and that a safe and low-noise surface is achievable with the proper design considerations. The effect of texture on tire–pavement noise is complex. Macrotexture wavelengths of 2 to 10 mm (0.08 to 0.40 in.) tend to decrease the exterior noise generated at the tire–pavement interface, while increased megatexture of 50 to 500 mm (2 to 20 in.) has been shown to increase interior noise in vehicles. The interaction of the three classes of texture raises the possibility that an optimized texture might provide both a safe and quiet pavement surface. Much of the current research is directed at achieving that optimized condition.

While this article focuses primarily on safety issues, a later one will deal more indepth with tire–pavement noise. In fact, Larson, Scofield, and Sorenson (2004) note that because texture has such an effect on both noise and friction, the issues must be considered together to fully address highway users' concerns.

New Construction Texture

Several construction techniques have been found to provide good concrete pavement texture under various conditions:

1. Tining preceded by a burlap drag is an effective method of providing macrotexture to new portland cement concrete pavements. However, spacing, depth, width, and orientation of the tines have a significant influence on both the friction and tire–pavement noise of the completed pavement. In general, narrow, deep grooves rather than wide, shallow grooves, within the limitations given below, are better for minimizing noise.

General recommendations on transverse tine configuration are a width of 3.0±0.5 mm (0.125±0.020 in.) and a maximum depth of 3 mm (0.125 in.) with an average random spacing of 13 mm (0.5 in.) or 26 mm (1.0 in.). The advisory provides typical random spacings that will yield the suggested averages.

For longitudinal tining the same width and depth recommendations apply (3 mm [0.125 in.]) wide by 3 mm [0.125 in.] deep) while a straight, uniform spacing of 19 mm (0.75 in.) has been shown to provide adequate handling characteristics for small vehicles and motorcycles. Longitudinal tining is the preferred choice for tined surface in many States.

2. Exposed coarse aggregate in the pavement surface is sometimes an effective means of providing an acceptable, lower noise texture. In this case, texture depth, aggregate size, and aggregate durability greatly affect the friction, noise, and longevity of the pavement surface. Exposed aggregate

surfaces typically are constructed in two layers with the top layer having fine and coarse aggregates that are wear-and-polish resistant with a minimum of 25 percent of the fine aggregate being siliceous material. This is the preferred method for surface texture in many European countries.

3. An alternative for surfaces where the design speed is 80 km/h (50 mi/h) or greater may be a broom or artificial turf finish of the fresh concrete surface, provided adequate safety performance has been demonstrated. Either method typically results in striations of 1.5 to 3 mm (0.063 to 0.125 in.) in depth.

4. Diamond grooving is also an effective method of imparting macrotexture to a new concrete surface. Again, spacing, depth, width, and orientation of the grooves have a significant influence on the friction and noise characteristics of the surface. Suggested configurations are the same as those given above for transverse and longitudinal tining.

5. Diamond grinding may be an effective means of imparting macrotexture to a newly constructed pavement, especially when nonpolishing, large aggregate is used. The FHWA advisory points out that adequate safety performance should be demonstrated. Diamond grinding typically provides grooves that are approximately 3 mm (0.125 in.) wide spaced at 5 to 6 mm (0.20 to 0.25 in.) intervals. Specific groove depth and spacing are dependant on hardness of the aggregate.

6. A burlap drag alone as a means of imparting texture is recommended only where design speeds are less than 81 km/h (50 mi/h). Again, striations of 1.5 to 3 mm (0.063 to 0.125 in.) in depth are typical.

7. Additional methods, sometimes including thin, asphalt-based surface treatments (microsurfacing) or thin, epoxy-bonded layers, are used by various agencies where research has shown those methods to be effective.

Restoration of Texture

Restoration techniques identified to restore lost texture on an aging concrete pavement are diamond grinding, transverse or longitudinal grooving, and the application of thin overlays of either epoxy- or asphalt-based materials. The life of both grinding and grooving techniques is heavily dependent on the polishing resistance of the coarse aggregate used in the original pavement surface. Agencies are encouraged to do their own research on the types of rehabilitation approaches yielding the most benefit.

Other Considerations

Other site-specific factors to consider when evaluating a pavement texturing approach are splash and spray, climate, traffic volume, traffic speed, roadway geometry, the likelihood of conflicting traffic maneuvers, cost, and the presence of noise-sensitive receptors. The FHWA advisory points out that no one treatment will always be the best choice for a wide range of projects and conditions. They encourage local research and the evaluation of the available literature on setting texture requirements and friction thresholds.

In addition, Larson, Scofield, and Sorenson (2005) point out evidence that suggests increased emphasis on texture/friction at sites with higher accident risk could significantly reduce fatalities, injuries, and resulting traffic delays. Such sites include two-lane roads, intersections, curves, work zones, freeway ramps, and sites where frequent erratic traffic movements occur.

Finally, Larson (2005) notes the importance of comparing the friction demand assumed during pavement design with that actually provided on the pavement surface throughout the pavement's service life, especially at known critical sites. He further points out that, although numerous American Association of State Highway and Transportation Officials Guides address various aspects of this issue, the amount of information is so voluminous that computer-supported tools are being developed to help apply the results.

Sources

FHWA Technical Advisory T 5040.36, Surface Texture for Asphalt and Concrete Pavements, June 2005 (www.fhwa.dot.gov/legsregs/directives/techadvs/t504036.htm)

Larson, Roger M., Larry Scofield, and James B. Sorenson. 2004. "Pavement Surface Functional Characteristics." Presented at Fifth Symposium on Pavement Surface Characteristics, Toronto, Canada, June 2004.

Larson, Roger M., Larry Scofield, and James B. Sorenson. 2005. "Providing Durable, Safe, and Quiet Highways." *Proceedings of the 8th International Conference on Concrete Pavements*, Vol. II, pp 500-522, Colorado Springs, CO, August 2005. International Society for Concrete Pavements, Bridgeville, PA (www.concretepavements.com).

Larson, Roger M. 2005. "Using Friction and Texture Data to Reduce Traffic Fatalities, Serious Injuries, and Traffic Delays." Presented at International Conference on Surface Friction Christchurch, New Zealand, May 2005 (www.surfacefriction.org.nz).

CPTP Presentations to AASHTO Subcommittees

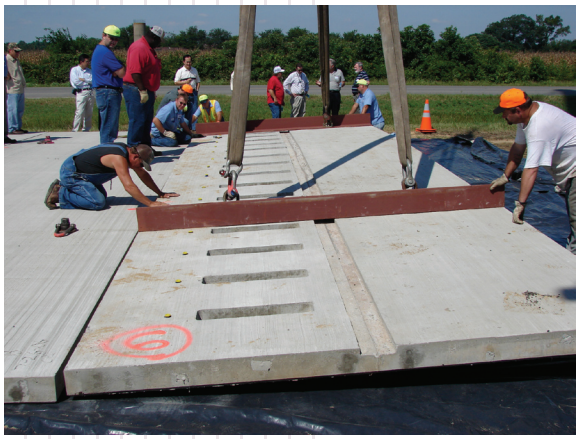
Presentations on the Concrete Pavement Technology Program were featured at several recent AASHTO committee and subcommittee meetings. These presentations were designed to help raise awareness of CPTP and to help disseminate information on products and innovations that are being promoted under the CPTP Task 65 Implementation Contract.

On May 5, 2006, Malcolm Kerley, chief engineer of the Virginia Department of Transportation and a member of the CPTP Task 65 Executive Expert Task Group (ETG), made a presentation to the AASHTO Standing Committee on Highways at the group's technical meeting held in Jekyll Island, Georgia. Kerley focused on the technology transfer components of the program and highlighted two technologies that have generated considerable interest in the pavement community: the MIT Scan device (for measuring the alignment of dowel bars) and precast, prestressed concrete slabs. Under the CPTP program, the MIT Scan device has been loaned to several States for investigation, and the precast, prestressed concrete pavement technology has been demonstrated in three States, with perhaps as many as eight additional demonstrations anticipated over the next 3 years.

At the Subcommittee on Construction's Annual Meeting held in San Juan, Puerto Rico, July 30 – August 3, Tommy Beatty, director of the FHWA's Office of Pavement Technology and a member of the CPTP Executive ETG, included an update on CPTP activities and technology transfer activities related to CPTP in this presentation.

Joe Denault, HNTB Corporation and formerly the chief engineer of the West Virginia Department of Transportation, made a presentation on the CPTP program to the AASHTO Subcommittee on Materials at its annual meeting, August 6 – 11 in Overland Park, Kansas. In his presentation, Denault, who is Chair of the CPTP Task 65 Executive ETG, described the product implementation and technology transfer activities being carried out under CPTP.

Precast Prestressed Pavement Demos Continue



PPCP workshop demo in Sikeston, Missouri. Following completion of the Missouri PPCP project in December 2005, FHWA and MoDOT co-sponsored a national rollout workshop and field demo during August 2006.

As reported in earlier CPTP Updates, FHWA is providing engineering support and funding to State DOTs in a series of demonstration projects that will advance the use of precast prestressed concrete pavement (PPCP) for pavement construction and rehabilitation. The principal benefits of this innovative technology include reduced lane closure times and longer pavement life. Each project has required different design elements, demonstrating the flexibility of the PPCP concept. Since the Texas, California, and Missouri projects reported earlier, a bridge approach application has been completed.

In Iowa, where the DOT is considering the use of PPCP panels to permit rapid replacement of failed bridge approach slabs during short construction windows, a trial bridge approach project was completed on a new bridge on Route 60 near Sheldon. The trial will be monitored during the next few months, and if it is deemed successful, Iowa will adopt the PPCP concept for bridge approaches on heavily trafficked highways. The Iowa bridge and pavement segments meet at a skewed angle, which is typical in many if not most situations. Also, the Iowa DOT elected to place precast panels in each lane separately, thus requiring transverse as well as longitudinal posttensioning onsite. The single-lane panel placement, with subsequent panel placement of the adjacent lane, will be the construction procedure needed in most traffic situations for rehabilitation in existing bridge approach slabs.

To advance the implementation of precast concrete pavement, AASHTO's Technical Implementation Group (TIG) has formed a Lead States Team on Precast Concrete Pavement Panels. The team met recently to outline a work plan and estimated budget, and, pending TIG Oversight Committee approval and funding, execution of the plan will start late in 2006 and continue into 2007. The TIG team has identified several types of precast concrete paving systems that are at various stages of adoption by the transportation community. The team is identifying the uniqueness of each of these systems as well as their commonalities, exploring applications, outlining the benefits that precast panels offer, identifying barriers to implementation, and developing strategies to expedite the adoption process.

For information on FHWA's PPCP demonstration projects, contact Sam Tyson, Office of Pavement Technology: sam.tyson@fhwa.dot.gov

For information on the new AASHTO TIG for implementation of precast technology, contact Timothy J. LaCoss, FHWA New York Division: Timothy.LaCoss@dot.gov

Precast bridge approach demo in Sheldon, Iowa.

ETGs Hold Joint Meeting

A first for CPTP Task 65, Technology Transfer, Deployment, and Delivery, occurred on March 1, 2006, with a joint meeting of the Executive and Engineering Expert Task Groups in Dallas. Sixteen members of the Executive ETG, 17 of the Engineering ETG, 4 guests, and 3 of the Task 65 team attended. Executive ETG Chair Joe Deneault presided. An exchange of technical and management ideas resulted. The ETGs also held separate meetings while in Dallas.

Presentations

- Tommy Beatty, Director, FHWA Office of Pavement Technology, reviewed the FHWA pavement program with a focus on CPTP. He described recent activities and reviewed funding under the SAFETEA-LU initiative, where $4.1 million per year is provided for portland cement concrete pavement research over the next 4 years.
- Gary Henderson, Director, FHWA Office of Infrastructure Research and Development, described Turner-Fairbank Highway Research Center activities with special attention to the Concrete Pavement Roadmap for which a management structure is being established.
- Sam Tyson, FHWA Office of Pavement Technology, described the CPTP vision and accomplishments with slides and a handout.
- Tom Cackler, Director of the National Center for Concrete Pavement Technology (NCCPT), gave an overview of the new Center, its mission and goals, advisory boards, and focus areas: mix analysis, surface characteristics, long-life pavements, concrete overlays, and equipment innovation.

Engineering ETG Action Items

- Develop Techbriefs on concrete consolidation, fast-track rehabilitation, and other CPTP subjects as needed.
- Decide how to target the contractor industry for implementation of new technologies.
- Encourage support of State attendance at the International Conference on Long-Life Pavements conference in Chicago in October 2006.

Executive ETG Action Items

- Prepare interim guidance on dowel bar alignment tolerances and measurement.
- Prepare a CPTP presentation for the next meeting of the AASHTO Standing Committee on Highways.
- Add an "Implementation Issues" section to all future technical briefs.

Progress on Alkali–Silica Reactivity

An ASR Benchmarking workshop was held in June 2006 as part of FHWA's effort to develop a comprehensive ASR Development and Deployment Program. The need for the workshop was born out of the recently enacted SAFETEA-LU, which, in Section 5203 (e), established funding of $10 million over 4 years for the development and deployment of techniques to prevent and mitigate alkali–silica reactivity.

The workshop gathered input from 74 experts and stakeholders regarding the state of ASR technology and the challenges ahead. Academia, industry, State DOTs, FHWA, and other government agencies were represented. The workshop was focused on four topics:

1. ASR test methods and identification techniques.

2. ASR prevention in new construction and current specifications.

3. ASR mitigation in existing concrete.

4. Nationwide inventory of ASR-affected structures and pavements.

The workshop report, including recommendations, and information on FHWA's ASR Program are now available: www.fhwa.dot.gov/pavement/concrete/asr.cfm

For more information, contact Gina Ahlstrom (gina.ahlstrom@dot.gov or 202-366-4612).

Best of Research and Practice

International Conference on Long-Life Pavements

Reconstructing with CRCP—Chicago. Photo: Scott Humphreys, Concrete Reinforcing Steel Institute

Concrete pavement researchers from around the world gathered in Chicago to exchange research findings and implementation lessons with promise for extending the life of concrete pavements. The October 2006 conference was part of CPTP's technology transfer activities and was co-sponsored by nine other national and State organizations (American Association of State Highway and Transportation Officials, American Concrete Pavement Association, Concrete Reinforcing Steel Institute, Illinois Chapter—ACPA, Illinois Department of Transportation, International Society for Concrete Pavements, National Concrete Pavement Technology Center, Portland Cement Association, Transportation Research Board). The conference presenters addressed a wide range of issues, for example:

- Practices extending the life of concrete where pavements are subject to extreme freeze–thaw stresses (e.g., the northern States, Canada, and Belgium) and where pavements are subject to high volumes of heavy loads, such as in New South Wales, on U.S. Air Force runways, and on urban expressways.
- Rehabilitation methods that reduce closure times including full-depth precast panels in Ontario and Michigan, an innovative three-dimensional design process for fitting curved, precast slabs, and the experimental use of fast-setting hydraulic concrete in California.
- Use of the new mechanistic–empirical design guide to project the relative effects of climate, heavy truck loadings, and subgrade on pavement life, and a State plan to make use of the guide practicable via a design catalog.
- The value of performance-related specifications in achieving higher quality construction for longer pavement life.

The program also included relevant highlights from the 10th International PIARC Conference, the 2006 International Long-Life Concrete Scan, and the 6th International DUT-Workshop.

For information on the availability of the conference proceedings (CD or print), contact Shiraz Tayabji: stayabji@CTLGroup.com.

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