



- [The Emergence of Sustainable Development](#)
- [Concrete Industry Sounds Off About Sound](#)
- [Tech Tip: Mitigate Sound at the Tire/Pavement Interface](#)
- [Technical Publications Provide Sound Mitigation Techniques](#)
- [International Tour Shows Concrete Quiet, Durable](#)
- [Literature Showcase: Featured Products Help Achieve Sustainable Development](#)
- [Concrete Pavement News Digest](#)

## The Emergence of Sustainable Development

*ACPA addresses current, emerging issues*

In an address before the United Nations World Commission on Environment and Development, Norwegian Prime Minister Gro Harlem Brundtland cited sustainable development as meeting "the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development is a series of principles that guide building and construction professionals to use the best practices to ensure the least impact on the environment, while also factoring in societal and economic factors.

### Why is it Important?

Sustainability is "on the radar scope" of a growing number of federal and state agencies, as well as the general public. This means more attention and increasing demand for all types of construction - including highways, roadways, and airports - to incorporate principles of sustainable development.

### What Does it Mean to the Concrete Pavement Industry?

Sustainability, if approached correctly, represents a tremendous opportunity for the concrete pavement industry and the companies that comprise it. One reason for this is that concrete has some inherent environmental benefits, including:

- **Durability** resulting in greater longevity, and in turn, fewer construction/reconstruction cycles. Not only does this reduce road-user delays, but also reduces the amount of natural resources used in construction.
- **Reflectance**, which not only reduces energy requirements for lighting and helps control global warming, but also enhances visibility and provides a sense of security and safety in otherwise poorly-lit areas.

- **Environmental efficacy** through the use of industrial waste and by-products, including fly ash (a by-product of coal-burning power plants), blast furnace slag (a byproduct of the steel industry) and silica fume (from micro-electronic "chip" and component production).
- **Natural resource conservation** ... As noted above, concrete pavement construction requires fewer natural resources and less energy for lighting. Concrete pavements also help reduce fuel consumption, an increasingly important issue in the trucking industry, as well as among consumers.
- **Recyclability and re-use** ... Concrete pavement is recyclable and re-usable, which not only can be crushed and re-used on-site for new pavements, but also can be used for other applications including storm water containment, management, and drainage.
- **Safety and security** ... resulting from the decreased hydroplaning potential, less road splash and spray, better nighttime visibility, and improved stopping distances.

These are just a few of the benefits of concrete pavements, which contribute to sustainable development.

#### **What Now ... and What's Next?**

ACPA and its affiliated Chapter/State paving organizations are exploring even more features of concrete pavements to focus on key environmental, societal, and economic benefits.

ACPA is moving quickly and effectively to investigate and communicate to stakeholder groups the realities of issues, such as sound related to tire/pavement interaction; improved air quality; storm water management through the use of pervious pavements; friction; skid resistance; and a range of other current and emerging pavement surface characteristic issues.

## **Concrete Pavement Industry Sounds Off on Sound**

*Research Shows Concrete is Safe, Durable ... and Quiet*

Sound can be a concern to people living near a heavily trafficked highway, ... but it's also a concern shared by agencies and industry.

A truly objective analysis of sound would consider factors such as engine and exhaust stack sound, but the issue recently has focused on sound at the tire/pavement interface, and in particular asphalt (especially open-graded friction course or OGFC) and concrete pavements.

This article shows that the tire/pavement sound levels between well-designed and constructed concrete and OGFC are minor. Studies have shown only slight - barely perceptible - differences between tire/pavement sound levels of concrete and asphalt pavements.

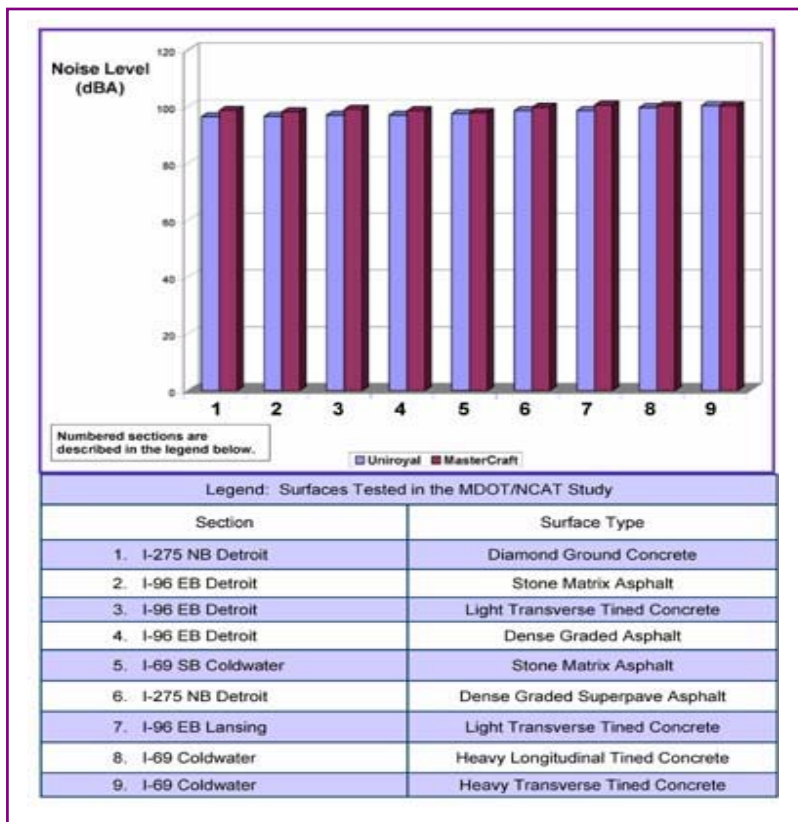
### Pass-by or close proximity?

At the center of the tire/pavement sound controversy are the testing methodologies.

The more conventional and widely accepted method for measuring sound on highways and roadways is the "statistical pass-by method" (SPB), which measures sound where it would most likely be heard by receptors and provides readings useful for environmental impact analysis.

The "close-proximity" (CPX) method, measures sound at the tire/pavement interface and is well suited for investigations of road surface influence on traffic noise, but does not provide a measurement useful for environmental-impact analysis. Furthermore, this method is not used with tires designed for heavy vehicles.

It is known that road-surface sound emission characteristics depend on the tire used, including whether the tire is for light or heavy vehicles. The results obtained with this method, therefore, best describe conditions when sound from light vehicles constitute



the major part of traffic sound (<10% trucks). The CPX method, which is **not** the standard measuring method recommended by the Federal Highway Administration (FHWA) for sound levels along highways for environmental analysis, involves placing a receiver (microphone) near the tire on a trailer being pulled along at highway speeds.

A recent study (Ref. 1) on sound at the tire/pavement interface conducted by the National Center for Asphalt Technology (NCAT) for the Michigan DOT (MDOT) demonstrated that concrete pavements that

are textured with a surface that minimizes sound generation are just as quiet as asphalt pavements, and resulted in the decision by MDOT not to overlay the concrete pavement.

The diamond-ground concrete section was the quietest of both asphalt and concrete sections, based on tests performed.

A few heavily-textured concrete sections increased the concrete pavement sound average, obscuring the quiet concrete section results.

The heavy textures on the concrete sections were mandated by the Michigan DOT and the FHWA for skid resistance and public user safety. Even so, the sound at the tire/pavement interface of nearly all of the sections were within about 3 decibels (dBA) of each other. These research findings show concrete is quiet. Figure 1 (right) shows the results in greater detail.

### Performance, Durability Questions

Just as the differences between the SPB of the CPX methods have been called into question, so too have a number of characteristics about open-graded asphalt pavements.

According to the Rubberized Asphalt Concrete Technology Center (**Ref. 2**), a technology center formed to promote the use of crumb rubber from scrap tires in roadway rehabilitation projects, "it is generally not feasible to require RAC [rubber asphalt concrete] in patches or utility cut repairs." Also, there are reports that question the merits of the sound features as a whole.

The National Cooperative Highway Research Program (NCHRP), in a report (**Ref. 3**) published by the Transportation Research Board, stated that sound reductions of open-graded asphalt pavements "seem to decline with surface age and in approximately 5 to 7 years, much of the noise benefit has diminished."

There also are concerns about environmental and safety issues. **MSW Management** magazine (**Ref. 4**), in a recent article, cited concerns about "air emission, worker safety, and recyclability of crumb rubber asphalt." The article further states that "doubts still remain about life expectancy, recyclability, emission safety related to the production and construction of asphalt pavement, and the application techniques for different climates."

### Policies Guide the Way

A wide range of research substantiates that concrete pavements generally provide superior skid resistance and durability. Research also shows that well-designed and constructed concrete pavements can be as quiet-or quieter-than asphalt. There are also stated policies that generally advise a common sense approach to address sound, emphasizing a balanced approach that does not trade off safety or performance.

Federal and state transportation agencies, through policies and official positions, have generally acknowledged the relatively small amount of sound reduction associated with surface type and have urged specifiers not to trade off safety.

In its synthesis 268, the NCHRP reported: "It is the official policy of the FHWA, and in the opinion of the American Association of State Highway Officials, that a small



**Research has shown that diamond ground concrete pavements are at least as quiet as asphalt pavements.**

amount of noise reduction is not worth sacrificing safety and durability. This means that the practicing highway design engineer must try to find a 'happy medium' between noise control and maintaining a high level of safety."

FHWA's environmental policy (**Ref. 5**) also states that "unless definite knowledge is available on the pavement type and condition and its noise generating characteristics, no adjustments should be made for pavement type in the prediction of highway traffic noise levels...The use of specific pavement types or surface textures must not be considered as a noise abatement measure."

With solid policies and research firmly in place, it raises the question why surface texture continues to be a subject of debate, particularly when the proposed solutions require so much maintenance and repair.

### **Safety over Sound**

ACPA's concern is that this issue of sound at the tire/pavement interface detracts from the fundamental issue of safety, which is a top priority of the U.S. Department of Transportation (DOT), the U.S. Congress, state departments of transportation, and other stakeholders, including the American Concrete Pavement Association.

Safety should be a key part of any discussion about highways and roadway construction or rehabilitation. The reason is simple. The U.S. DOT estimates 43,000 people die on the nation's highways each year, with 13,000 of those deaths attributable to road conditions. There are also an estimated 1,200 work zone fatalities and 40,000 injuries per year in construction work zones, which is why the concrete pavement industry is so committed to "getting in, doing it right, getting out ... and staying out."

The practice of overlaying concrete pavements with materials that require frequent maintenance and repairs raises serious concerns, particularly when there are so many questions about long term performance characteristics, including those related to sound abatement.

The bottom line is it's time to put the tire/pavement noise issue in proper perspective ... and turn up the volume on the issue of building safer, more durable highways and roadways.

### **References/Endnotes**

- (1) "Tire/Pavement Noise Study" for Michigan Department of Transportation, conducted by the National Center for Asphalt Technology, October 2002.
- (2) Rubberized Asphalt Concrete Technology Center website's "Frequently-Asked Questions." The Rubberized Asphalt Concrete Technology Center, a cooperative effort by the County of Los Angeles, County of Sacramento, and the California Integrated Waste Management Board.
- (3) "Relationship Between Pavement Surface Texture and Highway Traffic Noise: A Synthesis of Highway Practice," (NCHRP Synthesis 268), Transportation Research Board, National Research Council, published by National Academy Press, Washington, DC, 1998.
- (4) "Manufacturing and Utilizing Crumb Rubber from Recycled Tires," MSW Management: The Journal for Municipal Solid Waste Management Professionals, by Nongnard Sunthonpagasit and H. Lanier Hickman Jr., November/December 2003.
- (5) "Highway Traffic Noise Abatement Policy and Guidance," June 1995, Federal Highway Administration, Washington, DC. View the full policy at <http://www.fhwa.dot.gov/environment/polguid.pdf>.

## Technical Tip

# Mitigate Sound at the Tire/Pavement Interface

Given the challenges of addressing concerns about sound at the tire/pavement interface, what options exist to address the issue? In terms of concrete pavement construction or rehabilitation, there are two effective means of mitigating sound at the tire/pavement interface - proper texturing or diamond grinding.

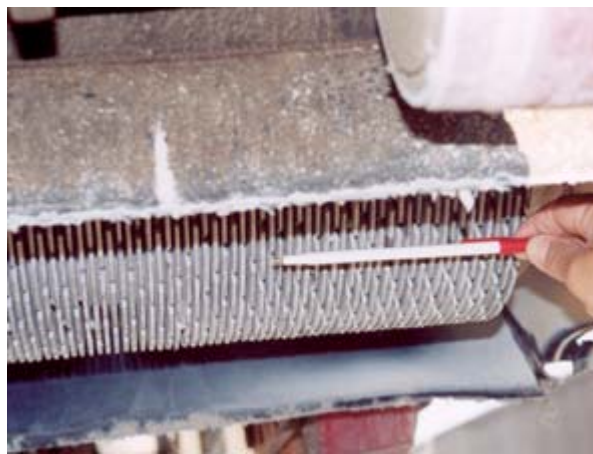
Recent research shows that improved texturing - such as longitudinal tining - reduces sound levels. Research conducted by Marquette University (**Ref. 1**) measured noise, texture and friction at 57 test sites in Colorado, Iowa, Michigan, Minnesota, North Dakota and Wisconsin.

Among the study's findings:

> Longitudinally tined concrete pavements and an asphalt pavement exhibited the lowest exterior noise.

> One asphalt pavement, and the longitudinally tined and random skew transverse tined (1:6 skew) concrete pavements exhibit the lowest exterior noise.

> When comparing different pavement textures with mean texture depths of about 0.276 in. (0.7 mm), the following exterior noise reductions were observed, compared to a uniform, transversely tined concrete pavement: random transverse, 1 to 3 dBA; random skewed, 4 dBA; longitudinal, 4 to 7 dBA; open textured asphalt, 5 dBA.



**Photo shows close up of diamond grinding blades. Diamond grinding is used to impart a smooth, quiet surface texture on concrete pavements.**

(Random transverse or random skewed means the teeth on the concrete rake are spaced at random intervals.

To mitigate the sound factor, a number of state DOT's have recently shifted away from uniformly spaced transverse tining of concrete pavements. A survey of states by ACPA reveals that nine states have either changed to longitudinal tining or are considering doing so.

As mentioned previously, all pavements produce sound, and equally important, all pavements eventually will need to be resurfaced, restored, or reconstructed. Unfortunately, when pavement rehabilitation is performed prematurely, it represents a huge waste of taxpayer money that



**Operator diamond-grinds a section of concrete pavement used for tire/pavement noise testing in Arizona.**

otherwise could be used to address serious safety and road-user delay issues.



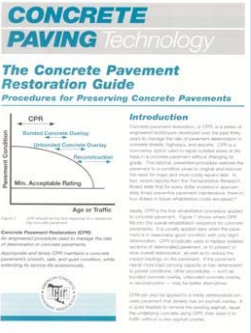
Diamond-grinding of pavements has been shown as an effective means of not only restoring or improving the original surface characteristics of the pavement when constructed, but also reducing sound.

-----

**Reference:** (1) "Noise and Texture on PCC Pavements - Results of a Multi-State Study," David Kuemmel, et al, Marquette University team research for the Wisconsin Department of Transportation, June 2000.

For more information, contact Mike Ayers at 217-621-3438. Would you like to submit a technical question? Send an e-mail to [ACPA](mailto:ACPA) or call [Bill Davenport](mailto:Bill.Davenport@ACPA) or [James Martinez](mailto:James.Martinez@ACPA) at 847-966-2272.

## Read More About Diamond Grinding

|  |   |  |
|--|---|--|
|    |   |    |
| <p><b>"The Longevity and Performance of Diamond-Ground Pavements" (IS522P)</b> Good review of diamond grinding, including an extensive field survey based on performance data on 60 pavement sections in 18 states.</p>            | <p><b>"Diamond Grinding and Concrete Pavement Restoration" (TB008P)</b> - Comprehensive information about diamond grinding concrete pavements covers specs, field operations, and diamond grinding performance.</p> | <p><b>"The Concrete Pavement Restoration Guide" (TB020P)</b> - Covers why and when to perform concrete pavement restoration (CPR). Includes strategies to help plan work on pavements.</p> |
| <p><b>To order ACPA publications, go to the ACPA website,</b><br/> <a href="http://www.pavement.com">www.pavement.com</a>;<br/> <b>call toll-free</b><br/> <b>1-800-868-6733;</b><br/> <b>or fax requests to 847-966-9666.</b></p> |   |  |

## **International Tour Shows Concrete Quiet, Durable** *Exposed aggregate concrete pavements perform better over time, researchers say*

A recently completed international scanning tour focused on pavement texture and quiet pavement technologies in six European countries.

Although most of the pavement surfaces were predominantly asphalt, some of the better performing pavements were exposed aggregate concrete pavements, according to observations made on the tour. There are also durability problems with quiet asphalt pavements and tire/pavement sound levels increase on them as they age, especially compared to exposed aggregate concrete pavements.

This was one of the key findings reported by Kevin McMullen, P.E., Wisconsin Concrete Pavement Association, who cited work done by researchers in the United Kingdom as part of the findings he reported from the scanning tour.

McMullen made the remarks last month during the ACPA Chapter Division semi-annual meeting in Indianapolis. He said the researchers, in a presentation to the tour participants, reported that exposed aggregate concrete pavements feature inherently higher skid resistance and durability, and that within five to six years, also exhibit better acoustical properties.

McMullen said that empirical analysis of pavements in the United Kingdom, Denmark, Netherlands, France, Belgium, and Italy underscore the durability of concrete, as well as the huge potential of diamond grinding for surface texturing and sound mitigation.

ACPA sponsored Kevin McMullen, P.E., Executive Director of the [Wisconsin Concrete Pavement Association](#), to represent ACPA and the concrete pavement industry. John Roberts, Vice President of Pavement Restoration for ACPA and Executive Director, [International Grooving & Grinding Association](#), represented the diamond grinding industry.

In addition to McMullen and Roberts, tour participants included officials from the Federal Highway Administration and state DOT's, as well as representatives from the National Asphalt Pavement Association and the Rubber Pavements Association.

### **ACPA Literature Showcase**

## **Featured Products Help Achieve Sustainable Development**

The concepts of sustainable development (see [article above](#)) may be new to some, but it's a familiar topic to ACPA. The Association has a number of resources dealing with surface characteristics, and environmental issues. Below is a list of technical publications that can help professionals achieve these benefits.

Concrete pavements' surface characteristics provide safety and security through their surface textures, resulting in decreased hydroplaning potential, less road splash and spray, and improved stopping distances.

**"Concrete Pavement Surface Textures" (SR902P)** is a 12-page report that provides the latest information on concrete pavement surface textures for a variety of applications, focusing on **skid resistance** and **noise qualities**. It also includes complete recommendations, including texture dimensions, for the ten most common textures.



The cost of this publication is \$12.00. To order SR902P, access [www.pavement.com](http://www.pavement.com); call toll-free 1-800-868-6733; or fax requests to 847-966-9666.

The durability of concrete pavements result in greater longevity, and in turn, fewer construction/reconstruction cycles. Not only does this reduce road-user delays, but also reduces the amount of natural resources used in construction.

### **"Scale-Resistant Concrete Pavements" (IS117P)**

describes the practices required to design and construct concrete pavements that have excellent **resistance to surface scaling** due to freezing and thawing, and the use of deicing chemicals.



**"Albedo: A Measure of Pavement Surface Reflectance" (RT3.05)** provides background information on albedo and how it used to measure reflectance. It also includes reflectance and cost comparisons between different pavement surfaces. Click [here](#) to download this issue of **Research & Technology Update** for no charge.

**R&T Update** is the transportation-construction industry's only periodical that covers technical and research topics related to concrete pavements. Download past **R&T Updates** for free and view new, monthly issues on the ACPA website, [www.pavement.com](http://www.pavement.com). For more information, contact [Steve](#)

[Waalkes](#) at 847-966-2272.

## **Concrete Pavement News Digest**

**ACPA Announces Fall Airport Pavement Design Seminar ...** ACPA is urging early registration for the popular ACPA [Airport Pavement Design Seminar](#), scheduled for October 5-7 in Skokie, Ill. Limited to only 24 registrants, the seminar typically sells out completely almost immediately after the first announcement. The three-day seminar is geared toward entry-level and project engineers and will include:

- A comparative analysis of the Federal Aviation Administration (FAA), PCA, and military design methods
- An explanation of FAA specifications and design requirements
- Preparation for construction and construction techniques for pavements, concrete mix designs, and adjustments

In addition, the seminar also will feature the newest criteria for stabilized bases and smoothness of airfield pavements. The information is based on recently completed research conducted by the [Innovative Pavement Research Foundation](#).

The seminar is \$650 for ACPA members, FAA employees, and state aviation officials; \$875 for non-members from industry. Click [here](#) for a brochure ... To register, contact [Polina Demidova](#) at 847-966-2272. If you have questions about the seminar, contact [Jim Lafrenz](#) at 202-842-1010.

**ACPA-Sponsored Lab Set to Launch ...** A recently constructed, mobile concrete laboratory is about to be pressed into service, thanks to contributions from ACPA and the affiliated Chapter/States ... The state-of-the-art traveling laboratory was built to study concrete at paving sites and demonstration projects as part of a [16-state pooled fund study](#).

The purpose of the research project, called "Material and Construction Optimization for the Prevention of Premature Pavement Distress in Concrete Pavements," is to evaluate existing and emerging technologies. The study also will review procedures for testing concrete cementitious materials to prevent materials or construction problems, which could lead to premature concrete pavement distress.

The mobile laboratory will make its debut at an event hosted by Iowa State University.

The event, a ribbon cutting ceremony and open house, is scheduled for 2 to 4 p.m., on July 6. From there, the mobile lab will move to a demonstration project in Missouri ... ACPA, ACPA-affiliated Chapter/State associations, and Iowa State University each contributed to the purchase of the quarter-million dollar lab, which includes a truck, 44-foot trailer, and test equipment ... Additional field testing will be done in all [16 contributing states](#) over the next three construction seasons. For more information, contact [Jerry Voigt](#) at 847-966-2272.

**FHWA Releases Concrete Pavement Analysis Software ...** ACPA is distributing a recently released [Federal Highway Administration](#) software tool that evaluates the costs and performance benefits of adding features to a concrete pavement design ...

The software allows contractors, engineers, and consultants to quickly compare costs versus performance trade-offs in selecting different design features during the design process. Professors and students can also use the tool to better understand the concrete pavement design process ... To order a **free** copy, contact [Andy Gieraltowski](#) at 847-966-2272 ... The software tool is a result of research that began under a cooperative agreement between the Innovative Pavement Research Foundation and the FHWA.

**ACPA Releases Newest Issue of R&T Update ...** ACPA released its newest issue of **Research & Technology Update** last week. This issue, titled, "Minimize Wheel Slap: Keep Your Joints Narrow" revisits a study conducted in 1998 that surveyed 10 concrete pavement projects on wheel slap.

The technical periodical reinforces previous observations about wheel slap and provides the latest condition assessment of the 10 subject pavements, as well as two additional ones ... It also provides recommendations on joint widths, sealant quantities, and resealing strategies ... **R&T Update** is the transportation-construction

industry's only periodical that covers technical and research topics related to concrete pavements ... Download past R&T Updates for free and view new, monthly issues on the ACPA website, [www.pavement.com](http://www.pavement.com). For more information, contact [Steve Waalkes](#) at 847-966-2272.

**ACPA Concrete Pavement Progress** is published four times a year and covers current practices and case histories in the concrete pavement industry. ACPA **Concrete Pavement Progress** is distributed free of charge to public officials, ACPA members, executive committee, board of directors, and affiliated chapter/state paving associations.

All rights reserved. Copyright 2004 by the American Concrete Pavement Association. No portion of this publication may be reproduced mechanically or electronically without the expressed written permission of the American Concrete Pavement Association.

**American Concrete Pavement Association**

Washington: 1010 Massachusetts Ave., NW., Suite 200, Washington, DC 20001  
Phone: 202.842.1010 Fax: 202.842-2022  
Chicago: 5420 Old Orchard Road, Suite A100, Skokie, IL 60077  
Phone: 847.966.2272 Fax: 847.966.9970  
Visit our website at [www.pavement.com](http://www.pavement.com)

2004 Chairman, ACPA Board of Directors - Rolland Johns, CEMEX  
2004 Vice-Chairman, ACPA Board of Directors - Dan Keys, Berns Construction Co., Inc.  
ACPA President/CEO - [Valentin J. Riva](#)  
Editor - [Bill Davenport](#)  
Managing Editor - [James Martinez](#)

**ACPA Concrete Pavement Progress** is published four times a year and covers current practices and case histories in the concrete pavement industry. ACPA **Concrete Pavement Progress** is distributed free of charge to public officials, ACPA members, executive committee, board of directors, and affiliated chapter/state paving associations.

All rights reserved. Copyright 2004 by the American Concrete Pavement Association. No portion of this publication may be reproduced mechanically or electronically without the expressed written permission of the American Concrete Pavement Association.

**American Concrete Pavement Association**

Washington: 1010 Massachusetts Ave., NW., Suite 200, Washington, DC 20001  
Phone: 202.842.1010 Fax: 202.842-2022  
Chicago: 5420 Old Orchard Road, Suite A100, Skokie, IL 60077  
Phone: 847.966.2272 Fax: 847.966.9970  
Visit our website at [www.pavement.com](http://www.pavement.com)

2004 Chairman, ACPA Board of Directors - Rolland Johns, CEMEX  
2004 Vice-Chairman, ACPA Board of Directors - Dan Keys, Berns Construction Co., Inc.  
ACPA President/CEO - [Valentin J. Riva](#)  
Editor - [Bill Davenport](#)  
Managing Editor - [James Martinez](#)