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Special Issue: Technical Tips and Techniques

Ease of placement, little to no maintenance, and repairability are among the many features of concrete pavements. This issue of **CONCRETE PAVEMENT PROGRESS** explores some basic and advanced tips and techniques for ensuring the quality of concrete pavements.

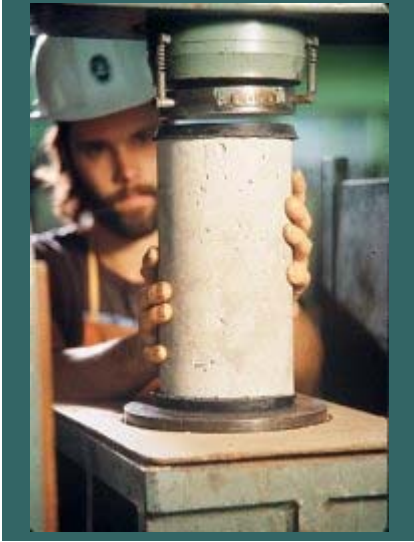
This issue includes articles that are based on the most frequently-asked or recently-asked technical inquiries to ACPA's staff of world-class technical experts.

Keys to Handling Concrete Cylinder Specimens

Compressive strength testing is the most common quality attribute measured on paving projects today. However, poor strength results are often not an indication of pavement quality, but rather testing quality.

Improper fabrication handling, storage, and testing of concrete cylinders is found to contribute to low strength in a majority of strength investigations. It is essential to employ trained testing personnel that are able to properly follow these strength-testing standard procedures for field-made, laboratory-cured cylinders:

- Sample concrete in two increments after discharging some from the chute or truck.
- Transport sample to field curing location where it will remain for first day.
- Remix the sample concrete to ensure homogeneity.
- Add concrete to cylinder molds that conform to standards. Also, rod the concrete in three layers and tap sides of the mold to close rod holes.
- Finish top smooth and level with mold.
- If necessary, move cylinders immediately after molding; support the cylinder bottoms.
- Field-cure cylinders at 60 to 80 °F (15 to 27 °C) and protect from loss of moisture.
- Gently transport day-old cylinders to the laboratory.
- De-mold cylinders and promptly place in 70 to 76 °F (21 to 24 °C) moist curing environment.
- Maintain water on cylinder surfaces at all times.
- Before testing, cap cylinders with 5000-psi (34.5-MPa) capping material-make caps flat, true and no greater than 3/16 in. (5 mm) thick. Or, use optional unbonded caps.
- Wait at least two hours for sulfur caps to harden (unbonded caps do not require a delay).
- Measure cylinder diameter and check cap quality, including alignment.
- Using calibrated testing machine, center cylinder in testing head and load using proper loading rate.
- Observe break pattern (vertical cracks through the cap indicate improper load distribution).



Poor strength results are often not an indication of pavement quality, but testing quality.

Nearly all deficiencies in handling and testing cylinders will lower measured strength.

One common error resulting in low cylinder strengths is leaving cylinders in extreme temperatures (at the sampling or paving site) before water-bath curing in the laboratory. Studies have shown that the temperature during the first 24 hours after a concrete cylinder is made has a very dramatic effect on the strength of the cylinder.

Other common errors include: leaving cylinders for extra days of field-curing; allowing cylinders to fall, tip over or bounce during transportation; delaying moist-curing in the lab; and testing with improperly made and aligned caps.

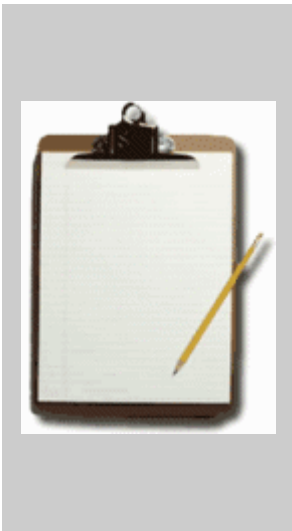
For more information about concrete cylinders, refer to "Construction Specification Guideline for Concrete Streets," ACPA catalog number IS119P. To order IS119P, visit www.pavement.com; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.

[Feedback: Share your thoughts on this article](#)

Checklist for Suspicions of Low Strength Concrete

Low concrete strength test results, whether compressive or flexural strength tests, can indicate more than just low strength. Deficient testing equipment or operator error is often the culprit.

Fabrication, handling, and storage of specimens can also have an impact on concrete strength tests. Here is a checklist to follow if low concrete strengths are suspected:



A quick checklist can indicate if low concrete strength is an issue.

- 1. Verify the testing equipment** - Check the accuracy of the testing equipment by validating it against other equipment. Also compare personnel fabricating the specimens and operating the testing equipment.
- 2. Test additional specimens** - Make sure that specimens are handled according to ASTM C 31, which outlines standard procedures that should be followed when making and curing both cylinder and beam specimens in the field.
- 3. Test the in-situ concrete** - If all of the beams or cylinders are suspect, take at least 3 cores from the pavement according to ASTM C 42. Test the cores to determine the mean in-field compressive strength. If the mean compressive strength is at least 85 percent* of the specified target strength, and no one core is less than 75 percent of the specified target strength, the concrete is adequate and can be left in place. Whether a pay reduction is required for the subplot depends upon the specification.

What about how well the cores correlate with each other?

If the mean of the core strengths is 85% of the mean cylinder strength, ACI would recommend all core strengths should be within one standard deviation of the mean. Standard deviation usually ends up around 550 psi (if there are less than 3 cores taken from the pavement, use 550 psi, otherwise it should be calculated for the set of 3 or more cores).

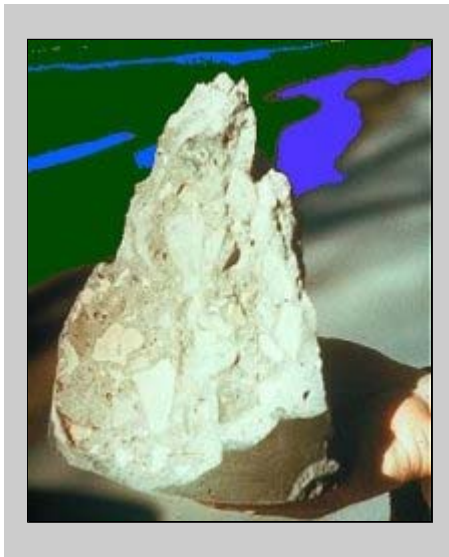
If the cores are all within 550 psi (plus or minus) of the mean, then it shows consistent concrete was mixed, delivered, placed, finished, and cured on the jobsite.

If, however, one of the core's strength is less than one standard deviation from the mean, then the concrete might be questionable in that lot.



Examples of concrete cores prior to testing. (Photo: PCA)

ASTM C 39 "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens" also has some guidance on the precision of the compressive strength test method. Section 10 states that the precision of the test itself (which includes the variance of the concrete used in the specimens) ranges from 6.6% to 9.5%. This means using the same mix and same conditions during the test might generate results that are up to 10% different.



Typical conical-shaped section of concrete after cylinder testing. (Photo: PCA)

For additional information, see ACPA publication IS119P, "Construction Specification for Concrete Streets & Local Roads," which has a more detailed explanation of strength testing criteria.

To order ACPA publications, visit www.pavement.com; call toll-free 1-800-868-6733; or fax requests to 847-966-9666. For additional information, contact [Jerry Voigt](mailto:Jerry.Voigt@acpa.org) at 847-966-2272.

*The American Concrete Institute 318 states that the compressive strength of cores taken from concrete pavement is normally around 85 percent of the cylinder compressive strength (of the same concrete mix). This is due primarily to different curing conditions (lab/water curing vs. field/in-situ curing). This means the average (mean) strength of all the cores taken from a particular project should be around 85% of the average of all the corresponding cylinder strengths.

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Understanding Sawed Joints and Dowel Bar Alignment



The key to saw cutting joints in pavements with dowel bars is doing it right the first time.

A concern shared by contractors and owners is how to accurately saw joints relative to the dowel bars.

The tolerance for sawing transverse joints (the allowable deviation of the saw cut from the center of the dowel) varies by owner and project.

A joint that is sawed up to three inches either way from the center of the dowel, however, will have minimal effect on pavement performance.

The reason for this is that the effective embedment length required is approximately six inches.

Because there is no simple solution to fixing incorrectly sawed joints, the proper approach is to correctly do the job the first time. Here are a few tips:

- Firmly stake the dowel baskets (if used) and correctly mark the dowel location for both baskets and dowel bar inserter placement.
- Make marks accurate and easy to locate by the sawing crew.

Other factors to consider include:

- The staking operation must firmly anchor the basket to the base material by the use of both high and low anchor points. The high anchors prevent tipping and the low anchors prevent shoving of the basket.
- The type and frequency of the anchors is dependent on the base type used and varies from simple pins driven into granular material to ramset anchors for stabilized bases. If the anchors are incorrect for the base material type, the basket may shove during paving, causing misaligned dowels.

Dowel bars are a design element that impacts long-term pavement performance. Aside from pavement thickness, dowel bars are typically the most important structural feature.

Dowel bars facilitate load transfer at the joints and minimize faulting, corner cracking, and the potential of transverse cracking. Since the late-1980's when state agencies began using dowel bars regularly in their designs, the number of roadways in the United States with the classic 'thump' ride from faulting has diminished.

Repairing Misaligned Saw Cuts

Fixing an incorrectly sawed joint depends how far off the saw cut is from the correct location.



Dowel bars are a design element that impact long-term pavement performance and can be retrofit into undoweled pavements.

If the saw cut is several feet away from the correct location, the best option is to retrofit dowel bars along the joint. This will re-establish the joint in a new location. To avoid affecting joint spacing, don't just establish the first cut and base all the others on measurement. Make sure to check the alignment markers at each joint.

If the saw cut is in close to the dowels, there are two options. Immobilize the joint through stitching and then saw cut and retrofit dowels at a different location. However, the pavement will likely have cracked at the saw cut because of restrained drying shrinkage and temperature movement. Sawing a new joint and retrofitting dowels does not guarantee that the pavement will then crack at the desired location. The second option is to install full-depth repairs at the incorrect saw cut location. Although expensive, this is a proven technique, particularly if only a few joints are affected.

One of the most problematic locations for mismatched saw cuts has been on curves. The saw cut should always be perpendicular to the dowel bars themselves. On curved sections, this means that the saw cut location must always be indexed to the actual dowel bar locations rather than a measurement, since the inside and outside radii are different. Paint marks or colored nail heads are simple but effective ways to identify the center of dowel baskets for correct sawing.

Dowel Bar Alignment Tolerances

Dowel bar placement tolerances are not well defined, as evidenced by the substantial differences allowed by various state departments of transportation.

The most stringent specification requires vertical and horizontal alignment to be within 1/8 inch per foot of dowel bar length; the least stringent requires only 3/8 inch per foot. The current ACPA recommendation suggests a value of 3/8 inch per foot, or 3 percent.

A long standing problem in establishing tolerances is that there is a lack of substantial research that correlates pavement performance with misaligned bars. There is some question about whether a single misaligned dowel can immobilize a joint or simply caused localized deterioration (a crack or spall).

Ongoing Research

If one bar is not the problem, how many misaligned bars, as well as what degree of misalignment, will lock up the joint? Finding answers and ultimately establishing reasonable tolerances requires both theoretical (analytical) and practical approaches.

To find answers, ACPA is evaluating a number of in-service pavements with a magnetic imaging tomography scan unit. ERES Consultants, a pavement consulting and research firm, is conducting a detailed, nationwide survey of 10 to 12 pavements to establish the as-built dowel bar alignment tolerances of these sections. The pavements showing significant alignment problems are also being surveyed to identify distresses that could be related to any possible misaligned bars. Although this research is not intended to develop tolerance limits, it will help determine what works. A subsequent research project will yield recommended tolerances based on detailed analysis.

[Feedback: Share your thoughts on this article](#)

ACPA Offers Special Rate for Annual Convention

The American Concrete Pavement Association is offering a special 2004 Annual Convention registration rate exclusively to public officials and first-time attendees from industry.

Announced by Rolland Johns, Chairman of the 2004 ACPA Board of Directors, the special rate is offered as a way of highlighting the wealth of information disseminated during the three-day event. The discount is applicable to the full convention registration, he said.

"We're pleased to offer this special rate to public officials and first-time attendees from the industry," he said. "The convention is the industry's best venue for networking, discussing current issues, and learning more about the latest in concrete pavement research and technology," said ACPA President/CEO Val Riva.

Among the highlights of the convention is the very popular Tech Day on Friday, December 3. This event begins with a general technical session and is followed by concurrent sessions throughout the day. Research findings, updates on research projects, technical tips, troubleshooting, technical casebook examples, and other technical and technology transfer ideas are also discussed throughout the day.

ACPA's Chairman also announced a special Tech Day package exclusively for public officials. The special one-day package includes a full day of technical presentations on Friday, December 3, as well as a free ticket to the ACPA dinner and awards gala that night. The cost of the package is discounted 30 percent for public officials. For additional information, visit ACPA's website at www.pavement.com, or call [Maryann Beckman](mailto:Maryann.Beckman@acpa.org) at 847-966-2272.

Here are 30 more reasons to attend the ACPA Annual Convention

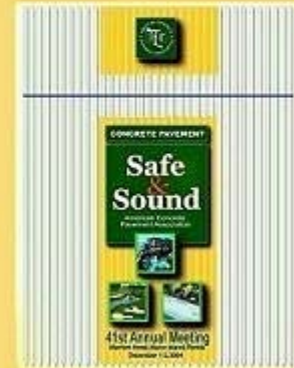
Call today to
save 30%

There's one place where people gather to talk about the latest developments in concrete paving -- the ACPA Annual Convention.

This year, we're presenting our popular Tech Day (on Friday, December 3). If you're an agency official, consultant, or in the business of highway, airport, and roadway construction, you won't want to miss it.

Register today for the ACPA Annual Convention. Use this coupon to save 30% off the registration price. For more information, call Maryann Beckman or Polina Demidova at 847-966-2272. Or, visit the ACPA website at www.pavement.com.

Offer valid only for federal, state, county, and municipal government employees, as well as industry officials whose companies have not registered for the convention previously. Not valid with other promotional offers.



Top 10 Causes & Solutions for Pulled Joint Sealants

Joint and crack sealants will minimize the infiltration of water and incompressibles into the joint or crack for anywhere from eight to 25 years before typically needing replacement. The performance of the sealant depends primarily on the sealant material (hot-pour, silicone, or preformed neoprene), but it is also affected by the installation procedure(s), traffic, climate, etc.

One early distress that might be seen in a joint sealant is where the sealant is not bonded with or touching the sidewalls of the joint. This can result in the sealant being picked up or pulled out when traffic, particularly high-speed traffic such as aircraft or highway vehicles, crosses the joint.

The top ten most common causes and of this sealant problem and possible solutions are:

- 1. Cause:** Opened to traffic too soon after application.
Solution: Delay opening.
- 2. Cause:** High ambient temperature.
Solution: Seal in cooler temperatures.
- 3. Cause:** Excessive sealant application.
Solution: Apply flush with surface or with specified recess.
- 4. Cause:** Sealant too soft for climate.
Solution: Use stiffer sealant.
- 5. Cause:** Sealant tacky.
Solution: Use a de-tackifier or blotter to reduce initial tack.



A few simple steps will assist with proper placement or replacement of joint sealants.

6. Cause: Overheated or underheated sealant.

Solution: Install at correct temperature, verify temperature gauges on melter.

7. Cause: Sealant contaminated with solvent or heat transfer oil from tank leak.

Solution: Discard affected sealant; repair or replace defective parts and re-seal.

8. Cause: Joint faces contaminated with old, incompatible sealant or lubricant/adhesive (may also cause bleeding).

Solution: Re-clean joint (i.e. sandblast) to remove old sealant.

9. Cause: Preformed sealant installed too high in joint.

Solution: Use required recess.

10. Cause: Preformed sealant not sized correctly for slab size, joint opening, and/or temperature variation.

Solution: Use correct compression sealant size.

For more information on sealants, refer to "Joint and Crack Sealing and Repair for Concrete Pavement" (ACPA catalog number TB012P). To order ACPA publications, visit www.pavement.com. For more information, contact [Steve Waalkes](mailto:Steve.Waalkes@acpa.org) at 847-966-2272.

[Feedback: Share your thoughts on this article](#)

Repairing a Rained-On Pavement



Knowing what to do about a rained-on concrete is the key to a long-lasting pavement, such as this 103-year-old street -- the nation's first portland cement concrete roadway in Bellefontaine, Ohio. (Photo courtesy: Ohio Ready Mixed Concrete Association)

If a rain event occurs before a concrete pavement has hardened sufficiently, remedial measures may be necessary, but the pavement does not normally require removal and replacement.

Less invasive and less costly techniques can be used to restore the pavement to a good-as-new condition.

The primary method to repair a rain-damaged concrete surface is diamond grinding. Areas where water diluted the surface paste should be ground to remove the weak surface layer.

As long as minimum thickness requirements are still met after grinding, no structural deficiencies are introduced by this corrective measure.

Grinding can commence when the pavement has reached the strength specified for opening to construction traffic.

The only instance requiring repair other than diamond grinding for a rained-on pavement is when severely eroded edges cannot be corrected prior to the concrete hardening.

Where pavement lanes, concrete shoulders, or curb and gutter are to be constructed adjacent to the eroded edges, a new existing edge can be created by making a full-depth saw cut parallel to the planned pavement edge and a sufficient distance in from the edge to remove all unsatisfactory concrete.

Where there is no adjacent concrete section, it may be necessary to remove all or a portion of a lane and reconstruct it.

If a portion of a lane width is to be removed, make a full-depth saw cut parallel to the planned edge and a minimum of 2 feet from it. Drill holes and install tiebars using an expanding grout or epoxy.

Rain is not detrimental to the quality of concrete pavement if appropriate action is taken to protect and correct the unhardened concrete pavement.

Prior planning and immediate action are mandatory to minimize the effects of rain.

Diamond grinding is the primary remedial technique for a rained-on concrete surface.



A diamond-grinding machine is used for removing the non-durable surface, re-texturing the pavement, and smoothing out the ride.

[Feedback: Share your thoughts about this article](#)

Would you like to submit a technical question for consideration in a future issue of CONCRETE PAVEMENT PROGRESS?

Send an e-mail to [ACPA](#) or call [Bill Davenport](#) or [James Martinez](#) at 847-966-2272.

[Read more about repairing rained-on pavements](#)

Read more about repairing rained-on pavements. For more information about rained-on pavements, consult ACPA's latest R&T Update, "How to Handle Rained-On Concrete Pavements."

It provides more information on how to prevent and repair rain damage to freshly-placed concrete pavements. Diamond grinding is highlighted as the primary remedial technique for a rained-on concrete surface. Click [here](#) to download the publication free of charge. For more information, contact [Steve Waalkes](#), P.E., At 847-966-2272.



To order ACPA publications, go to the ACPA website, www.pavement.com; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.



ACPA Product Showcase

Joint and Crack Sealing and Repair for Concrete Pavement



TB012P

This technical publication (TB012P) provides all the specifics about sealing and resealing concrete pavement joints.

The 32-page bulletin is the ideal resource for engineers who want information on sealant function, materials, evaluation and repair. It also covers special considerations for resealing cracks, cross-stitching and load-transfer restoration for joints.

The cost of this publication is \$14.50. To order TB012P, access <http://www.pavement.com/ecommerce/main.html>; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.

Construction Specification for Concrete Streets & Local Roads

The 24-page information sheet (IS119P) has detailed explanation of strength testing criteria.

It highlights new specification guidelines that provide information and specification language for developing street or local road project specifications, as well as acceptance criteria for smoothness, thickness, and strength.

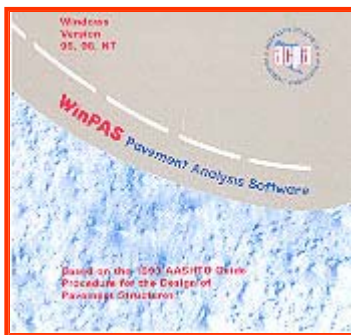
The publication features footnotes, diagrams, and illustrations that provide specific details and list important references for a specification writer. The cost of this publication is \$12.50.

To order IS119P, access <http://www.pavement.com/ecommerce/main.html>; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.



IS119P

WinPAS Software, Simplified Design Guide



MC016.01P

This popular, user-friendly software program (MC016.01P) allows roadway pavement thickness design and evaluation according to the 1993 American Association of State Highway & Transportation Officials (AASHTO) Design Guide for Pavement Structures, including traffic and overlay thickness methods.

A life-cycle cost module allows you to compare alternative designs, as well. The software is compatible with Windows 95, 98, NT, 2000, and XP.

A 94-page manual (MC016P) accompanies the software program.

It explains all factors in the 1993 AASHTO Design Guide for Pavement Structures, including reliability, traffic, soil support, serviceability, and concrete properties. It also includes chapters on overlay thickness design and life-cycle cost analysis.

The cost of this resource is \$495.00 for non-members. To order MC016.01P, access <http://www.pavement.com/ecommerce/main.html>; call toll-free 1-800-868-6733; or fax requests to 847-966-9666.

Concrete Pavement News Digest



Airport Seminar to Highlight Pavement Bases and Smoothness ... ACPA's Airport Pavement Design Seminar will feature the latest information about drainable and stabilized bases, as well as airfield pavement smoothness criteria ...

The seminar is scheduled for October 5-7 in Skokie, Ill. With only 12 seats remaining, ACPA is urging those interested in the seminar to register as soon as possible. Topics covered in the seminar reflect the latest research on these topics.

The seminar is geared toward construction and project managers with some but not extensive experience in concrete pavements.

Seminar topics will include:

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



The cost of the seminar is \$650 for ACPA members, government employees, and state aviation officials; \$875 for non-members (other than government or aviation officials). For more information and a brochure, visit ACPA's website at www.pavement.com. To register, contact [Polina Demidova](mailto:Polina.Demidova@acpa.org) at 847-966-2272. If you have questions about the seminar, contact [Jim Lafrenz](mailto:Jim.Lafrenz@acpa.org) at 202-842-1010.

ACPA Calls for Papers ... ACPA is calling for papers on ultrathin whitetopping (UTW) and thin whitetopping techniques for the International Conference on Best Practices for Ultrathin and Thin Whitetopping to be held on April 13 - 15 in Denver.

The conference is geared toward engineers and construction professionals, including federal, state, and municipal engineers, consulting engineers, contractors, materials suppliers, and members of academia.



Suggested topics include:

- >>> Selecting the right projects for UTW and thin whitetopping.
- >>> Pavement analysis and design.
- >>> Construction.
- >>> Concrete materials for UTW and thin whitetopping.
- >>> Pavement performance.
- >>> Jointing patterns.
- >>> Whitetopping repair and rehabilitation.

New and emerging topics are also acceptable. Papers will be selected based on near-term applicability to practice. The presentations should include the most comprehensive coverage of UTW and thin whitetopping ... ACPA, the Federal Highway Administration, and the Colorado DOT, are co-sponsoring the conference ... For more information, contact [Shiraz Tayabji](mailto:Shiraz.Tayabji@acpa.org) at 410-997-0400.

Coal Ash Association Announces Workshops ... The American Coal Ash Association (ACAA) scheduled a series of workshops covering the use of coal and fly ash in concrete pavement.

The workshops, themed Coal Combustion Products Partnership (C2P2), will provide contractors, engineers, state transportation officials, and other transportation professionals with information about the benefits of using coal ash in highway construction. Added sessions will cover structural fills, controlled low strength materials, and road base products.



Dates and locations for the workshops are:

- >>> September 14 - Las Vegas
- >>> September 16 - Austin, Texas
- >>> September 30 - San Juan, Puerto Rico
- >>> November 16 - Atlanta
- >>> November 18 - Louisville

ACAA is co-sponsoring the workshop with the Federal Highway Administration, the Environmental Protection Administration, the Recycled Materials Resource Center, DOE and the Utility Solid Waste Activities Group.

For more information, visit <http://www.epa.gov/epaoswer/osw/conserves/c2p2/>, or contact the ACAA at 720-870-7897.

Research Board Calls for Abstracts on Pavement Preservation ... The Transportation Research Board's (TRB) Task Force on Roadway Pavement Preservation is seeking abstracts for a pavement preservation workshop.



TRB is looking for topics that cover the successful implementation of roadway pavement preservation techniques. The deadline to submit abstracts is October 1. Go to www.trb.org/conferences/preservation/ for more information.



Zeller Appointed Executive Director ... The Concrete Paving Association of Minnesota's (CPAM) Board of Directors appointed Matt Zeller, P.E., as the new Executive Director of CPAM ... Zeller was previously the Director of Engineering Services for CPAM ... The appointment was effective August 28 ... For more information, contact CPAM offices at 763-561-0402.



Zeller

ACPA Invites Transportation Professionals to Hospitality Event



Transportation officials from the public sector and ACPA members attending the AASHTO annual meeting are invited to ACPA's Annual Ice Cream Social hospitality event on September 19 between 7 - 9 p.m. at the Philadelphia Marriott Downtown.



American Concrete Pavement Association

The event provides members, staff, and affiliates the opportunity to meet with federal and state transportation officials in an informal setting. The ice cream social will be held during the American Association of State Highway and Transportation Officials' 2004 Annual Meeting, September 17 - 21, in Philadelphia.

ACPA also reminds members and affiliates to visit ACPA's booth (#200) during AASHTO's trade fair on September 19 - 20.

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.

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