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**Mission:**  
To support research  
and educational pro-  
grams that will in-  
crease professionalism  
and quality in the  
concrete industry



## Pervious Concrete Performance in Freeze-Thaw Environments

This article, by Norbert Delatte with Cleveland State University, is excerpted from an article that will appear in the Fall 2008 edition of Concrete InFocus.

### INTRODUCTION

Portland Cement Pervious Concrete (PCPC) is a material of increasing interest for parking lots and other applications. PCPC typically consists of coarse aggregates, Portland cement, water, and various admixtures. Similar materials are used for cement-stabilized drainage layers in highway and airport pavements. In a research project funded by the Ready Mixed Concrete (RMC) Research & Education Foundation, in-service PCPC pavements were inspected

in the field, and cores were removed in order to investigate properties in the laboratory. Field evaluation methods included visual inspection, two surface infiltration measurements, and indirect transmission ultrasonic pulse velocity (UPV). Laboratory testing methods included void ratio, unit weight, compressive strength, splitting tensile strength, hydraulic conductivity (sometimes referred to as permeability), and direct transmission UPV. Because it is compacted on the surface with screeds or rollers, PCPC generally has higher strength, lower void ratio, and lower permeability at the surface than at the bottom. Therefore,

the properties of the top and bottom parts of the core samples were compared. Generally, the PCPC installations evaluated under this research project have performed well in freeze-thaw environments with little maintenance required. No visual indicators of freeze-thaw damage were observed. With the exception of some installations where the pore

ous concrete pavement system will allow water to flow through, and will not become saturated. This is important, because the damage due to freezing and thawing is likely to occur mainly when the pavement is saturated, and these conditions can be avoided.

With proper attention to design, mixtures and construction, it is possible to make wider use of pervious concrete throughout the U.S. It is important to be careful in locating pervious concrete pavements so that soil from landscaping and other debris does not clog them.

### REFERENCES

1. Delatte, N., Miller, D., and Mrkajic, A. (2007) *Field Performance Investigation on Parking Lot and Roadway Pavements: Final Report*, RMC Research & Education Foundation, December 1, 2007
2. Miller, Dan (2007) *Field Performance of PCPC Pavements in Severe Freeze-Thaw Environments*, MSCE Thesis, Cleveland State University, December 2007.
3. Mrkajic, Aleksandar (2007) *Investigation and Evaluation of PCPC using Non-Destructive Testing and Laboratory Evaluation of Field Samples*, MSCE Thesis, Cleveland State University, December 2007.
4. National Ready Mixed Concrete Association (2004) *Freeze-Thaw Resistance of Pervious Concrete*, May, 2004.

structure was unintentionally sealed during construction with wet mixtures or over compaction, nearly all sites showed fair to good infiltration capability based on drain time measurements.

### RECOMMENDATIONS

It is necessary to use care during construction to avoid sealing off the surface. The National Ready Mixed Concrete Association recommends the use of certified contractors and has developed a Pervious Concrete Contractor Certification Program, the text of which was also funded by the RMC Research & Education Foundation.

A properly designed pervi-



Cleveland State University pervious concrete pavement demonstration site – construction techniques.



### Did you know:

- Although many Foundation projects take one to two years or more to complete, interim reports are often available from the Foundation's website at [www.rmc-foundation.org](http://www.rmc-foundation.org)

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# Legacy

The Newsletter of the RMC Research & Education Foundation

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## From the Chairman

Welcome to the August edition of *Legacy*. This summer, many communities around the country continue to clean up from a variety of weather-related disasters including tornadoes and floods and the continued threat of a hurricane in the Atlantic or Gulf Coast will loom until the end of the hurricane season in November. As these communities rebuild, we offer to them the findings of our Hurricane Katrina study, which could be applied to those areas ravaged by other weather-related disasters. An article on how the Hurricane Katrina report may assist these communities is featured below.

As tight economic times put the squeeze on businesses, it is important to remember that the resources available from the RMC Research & Education Foundation can help support the industry through challenging times. A list of the Foundation's resources, many of which are available for free from the Foundation website at [www.rmc-foundation.org](http://www.rmc-foundation.org), as well as an article on the many ways they are helping to buoy the industry, are detailed on page two.

Despite the industry's economic slow-down, we are delighted to have so many companies step up to be sponsors of the 4<sup>th</sup> Annual RMC Research & Education Foundation Fundraising Golf Tournament. This year's event promises to be the best yet and with so much early support, it is already a tremendous success. Information on the Golf Tournament and recognition of the sponsors to-date may be found on page three.

This fall, the RMC Research & Education Foundation will have the opportunity to showcase its work as part of two important industry events – the National Ready Mixed Concrete Association's (NRMCA) Board of Directors meeting and their ConcreteWorks conference and expo. These venues will provide the Foundation with the opportunity to highlight its deliverables to make sure our resources are being utilized by as many people as possible. The Foundation's fall Board of Trustees meeting will also take place in September.

Pervious concrete continues to be an extremely popular topic, as evidenced by the many requests the Foundation continues to receive for its "Research Supporting Sustainable Development" CD which features all of the Foundation's pervious deliverables as well as our crushed concrete aggregate report and LEED Guide. Dr. Norbert Delatte with Cleveland State University, the primary researcher for the Foundation's long-term field performance of pervious concrete study, recently wrote an article about the application of this study for NRMCA's *Concrete InFocus* magazine, an excerpt of which appears on page four.

I hope you enjoy this edition of *Legacy* and I thank you for your continued support.

Regards,  
George Gregory  
Chairman



## Katrina Study Findings Applicable to Other Natural Disasters

Mother Nature has wreaked havoc across the country this year with hurricanes, massive floods and tornadoes leaving many people, particularly in the Mid-West, to clean up what's left of their belongings and start over. What's even more daunting is the idea that yet another natural disaster could strike again. However, by strengthening building codes and using

building materials such as concrete that can withstand high winds and the resulting projectile damage as well as flooding, residents of these hard-hit areas can rebuild with

confidence. After Hurricane Katrina struck the Gulf Coast Region in August 2005, the RMC Research & Education Foundation teamed up with the Mississippi Concrete Industries Association to work with Mississippi State University to perform a forensic evaluation of how different building materials withstood high winds, rain and flooding. The findings of this study, which include recommendations for strengthening building codes, may certainly be applied to other regions under threat of similar catastrophic

weather events, such as tornadoes and floods. With the ultimate goal of protecting life and property the next time such a weather disaster looms, it is reasonable that communities struck by severe weather events may want to apply the findings of the Foundation's Katrina study as they rebuild.

The report "Coast in the Eye of the Storm - Hurricane Katrina: August 29, 2005" may be ordered as a hardcopy or on CD by contacting Jennifer LeFevre at 240-485-1151 or at [jlefevre@rmc-foundation.org](mailto:jlefevre@rmc-foundation.org).

### When Times are Tough, the Foundation Offers Resources

Sustainability remains a hot topic as the U. S. and other countries look to address growing concerns regarding energy use and protecting the environment. Companies are turning their attention to decreasing their carbon footprint and increasing their sustainability efforts. In many cases, specifiers are seeking additional information on the environmental and energy saving benefits offered through the use of concrete. Interest in the Foundation's "Research Supporting Sustainable Development" CD continues to be high with over 3,000 copies of the CD requested and high activity on the Foundation's website, including over 1,200 site visits in the two weeks following the release of the revised Pervious Concrete Research Compilation.

The educational offerings funded by the Foundation also help the industry to stay competitive and keep its workforce sharp to ensure the highest efficiency and skill level. The classes and certifications developed with Foundation funding, and offered through NRMCA, include the Effective RMC Supervisor, the RMC Sales Manager Training Course, the Financial Management Course and the Ready Mixed Concrete Plant Manager Certification course. Driver training materials are also available along with many other resources.

Information about these and other programs may be found at [www.rmc-foundation.org](http://www.rmc-foundation.org) or please contact Jennifer LeFevre at 240-485-1151.

## Availability of Foundation Deliverables

**Pervious Studies Compiled by the University of Central Florida** – The studies *Construction and Maintenance Assessment of Pervious Concrete* and *Hydraulic Performance Assessment of Pervious Concrete Pavements for Stormwater Management* Credit may be too large for download, although they are available from the website. Copies of the studies are also available as hardcopies and on CD.

**Pervious Concrete Research Compilation** – The updated version of the compilation, including abstracts and links to studies, is now available for download from the Foundation's website.

**Ready Mixed Concrete Industry LEED Reference Guide** – The *LEED Guide* is available for download from the Foundation's website. Professionally printed copies are available for purchase for a nominal fee at [www.nrmca.org](http://www.nrmca.org) and free copies on CD are available from the Foundation.

**Crushed Returned Concrete as Aggregates for New Concrete: Final Report** – This report is available for download from the Foundation's website.

**Long-Term Field Performance of Pervious Concrete Study** – The study *Portland Cement Pervious Concrete Pavement: Field Performance Investigation on Parking Lot and Roadway Pavements* is available for download from the Foundation's website.

**Research Supporting Sustainable Development CD** – All of the above studies are also available on the Foundation's CD combining all of the reports supporting sustainable development. Free copies of the CD are available from the Foundation.

**Model Performance Spec Phase I: Preparation of Performance-based Specification for Cast-in-Place Concrete** – This study is available for download from the Foundation's website.

**Model Performance Spec Phase II: Guide to Specifying Concrete Performance** – This study is available for download from the Foundation's website.

**Experimental Case Study Demonstrating the Advantages of Performance Specifications** – This study is available for download from the Foundation's website.

**Quality Management System for Ready Mixed Concrete Companies** – This reference is available for download from the Foundation's website.

**Research to Support the P2P Initiative** – The above four P2P reports are also available on the Foundation's CD combining all of the reports supporting the P2P Initiative. Free copies of the CD are available from the Foundation.

**AP-42 Study Executive Summary** – An Executive Summary of the AP-42 study funded by the Foundation, as well as the revised section from the Environmental Protection Agency, are both available from the Foundation's website.

**Hexavalent Chromium Study Executive Summary** – An Executive Summary of the full hexavalent chromium study is available from the website.

**Self-Consolidating Concrete Formwork Pressure Study Task I Report** – The Task I Report, which is a literature review of existing knowledge on formwork exerted by SCC, is available for download from the Foundation's website.

**Coast in the Eye of the Storm – Hurricane Katrina: August 29, 2005** – This study is too large to be made available for download from the Foundation's website. Hardcopies and copies on CD are available by contacting Foundation staff.

The following items can be purchased through NRMCA at [www.nrmca.org](http://www.nrmca.org) or by contacting Jacques Jenkins at 1-888-846-7622, ext. 1165. Related certifications are administered through NRMCA.

**Pervious Concrete Contractor Certification Text**

**Plant Operator Certification Text and Instructors Materials**

**Truck Mixer Driver's Manual in Spanish—(NRMCA Manual del Conductor de Mixer)**

**Certified Concrete Delivery Professional Program Study Guide in Spanish**

**Plant Inspector's Guide – Available as part of NRMCA's Plant Certification Program/**

**Plant Inspector Qualification Process**

### Thank You to Companies That Have Signed Up as Sponsors of the 4th Annual RMC Research & Education Foundation Golf Tournament

#### Beverage Cart

Propex Concrete Systems  
Stephens Mfg.

#### Platinum Sponsors

EMS Environmental Manufacturing Solutions, LLC  
Grace Construction Products  
Oldcastle Materials  
Sika Corp.  
US Concrete Inc.

#### Gold Sponsors

Banc of America Leasing & Capital Group  
BASF Construction Chemicals  
Cemex, Inc.  
Chandler Concrete Co.  
Concrete Supply Co.  
Erie Strayer Company  
Essroc Cement Corp., Itacementi Group  
Euclid Chemical Co.  
Headwaters Resources, Inc.  
Holcim (US) Inc.  
Irving Materials, Inc.  
Lafarge  
Mack of Charlotte/Mack of Nashville  
Merrill Lynch/Prentice-Thatcher Group  
Metro Ready Mix  
Ozinga Bros.  
Peterbilt Motors Co.  
Ready Mix USA  
S&W Ready Mix Concrete Co., LLC  
Solomon Colors  
Terex  
UBS Financial Services  
Vulcan Materials Co.  
Wachovia Financial Services

#### Silver Sponsors

Mack Trucks, Inc.  
Trimble Mobile Resources Management

#### Bronze Sponsors

B & B Concrete Co., Inc  
Tennessee Concrete Association

*Special thanks to the National Ready Mixed Concrete Association for providing a free Webinar as a benefit to sponsors at the Gold level and above.*

### Golf Tournament Offers Opportunities

The 4th Annual RMC Research & Education Foundation Fundraising Golf Tournament offers opportunities all around—for sponsoring companies, participating golfers and the Foundation itself. The many benefits of sponsorship, outlined on our sponsorship form which is available from the Foundation's dedicated Golf Tournament web page accessible from our homepage at [www.rmc-foundation.org](http://www.rmc-foundation.org), capture just some of the many advantages of participating in the Tournament through sponsorship. The exposure of sponsors, such as in the box at left, allows potential customers to note your support of the industry. Your company's participation also ensures you will receive information on the resources available from the Foundation and, perhaps even more importantly, how your own customers might be able to utilize those resources and benefit from our programs.

Golfing participants in the Tournament also



learn a great deal about the Foundation and its work as well. Several golfers have chosen to make personal contributions to the Foundation after hearing about how we are improving the industry through our programs. Participation allows golfers to meet new people and make new contacts. Perhaps your company may even want to organize and sponsor a foursome to treat some customers to a round of golf at this exciting event.

For more information, or to sign up as a sponsor or player, please visit [www.rmc-foundation.org](http://www.rmc-foundation.org) or contact Jennifer LeFevre at 240-485-1151 or at [jlefevre@rmc-foundation.org](mailto:jlefevre@rmc-foundation.org).

### Foundation to Showcase Work at Upcoming Industry Events

This will be a busy fall as the RMC Research & Education Foundation gears up for booth displays, presentations and its fall Board meeting.

First up will be participation in NRMCA's Board of Directors meeting where the Foundation will have a booth display and where NRMCA's Board will receive an update on the Foundation's activities. Our own fall Board of Trustees meeting will also take place on September 24th in conjunction with this meeting.

On tap for September 9th is a Foundation presentation at the Pennsylvania Concrete Promotion Council meeting taking place in Grantville, PA.

In October, the Foundation will participate in NRMCA's ConcreteWorks and will showcase its deliverables at a booth display, through updates provided at various committee meetings and as part of the annual Golf Tournament.

These events follow the highly successful Transportation Engineering and Road Research Alliance (TERRA) Innovation Series program in late July at the MnROAD Facility, where the Foundation shared booth space with the Aggregate and Ready Mix Association of Minnesota. The program included an MnROAD open house, project site tours, demonstrations and topic forums including a Foundation presentation on pervious concrete research.

If your organization has an upcoming event where you would like to include an update on Foundation activities, please contact Julie Garbini at 240-485-1150.