University of Missouri-Rolla

UTC NEWS

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Inside...

Upcoming Events

10th North American Masonry Conference
June 3–6, 2007
St. Louis, MO
www.masonrysociety.org/namc

Sixth International Conference on Case Histories in Geotechnical Engineering*
August 4–9, 2008
Washington D.C.
www.6icchge2008.org

See call for papers on page 3

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The Flood Frog:
an Autonomous Wireless Device for Flood Detection and Monitoring

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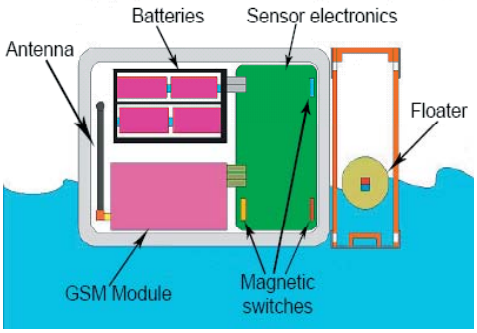
Accurate real-time monitoring is gaining critical importance in a broad range of domains. Of particular interest to this research is the development of monitoring and detection systems for both environmental and structural phenomena. Transportation infrastructures, particularly bridges, provide examples for both categories. Flooding of low water bridges is one example of rapidly evolving environmental phenomena, while stress and vibration are examples of structural phenomena in need of monitoring.

Early warning and advanced preparation for emergency are two of the most effective lines of defense against disasters such as floods, earthquakes, wildfire, and hurricanes. The impact of disastrous events, including the recent hurricanes Katrina and Rita, underscores the limits of established early warning systems, especially with regard to rapidly evolving situations.

Environmental monitoring, which refers to measuring and recording parameters such as temperature, humidity, acoustic emission, and pollution in a selected site, enables early detection of catastrophic events. Ongoing provision of information facilitates recovery efforts and aids in containment of aftereffects. Structural monitoring is another important issue, as periodic collection of information about the health of a structure can prevent sudden breakdown, save money, and most importantly, protect human lives. In this context, changes in stress and vibration can serve as warnings for impending structural damage. Regardless of the phenomenon being monitored, the



information should be collected with resolution and frequency sufficient to enable accurate and timely evaluation of impending danger.

In most monitoring solutions, major challenges include infeasibility, installation and maintenance costs, power needs, and inconsistency.

A novel monitoring system that is less costly, more dependable, and more flexible is quite necessary. Our proposed solution to this challenge is an autonomous embedded system, termed the Flood Frog. The system is based upon a wireless network composed of inexpensive sensor nodes. Sensor networks have been successfully used in a broad range of applications, including habitat monitoring and shooter localization. The size, unobtrusiveness, and expendability of wireless sensor nodes make them ideal candidates for detection and monitoring systems.

The specific contribution of this research is the development of an autonomous, low-power, wireless device designed to achieve dramatic reductions in both equipment and installation costs. It incorporates a variety of embedded sensors, is battery-powered, and communicates using the GSM/GPRS mobile phone network, eliminating the need for cables of any type. The standard battery pack included in the waterproof case allows for a typical unattended field life of 3–4 years, although a much longer life can be achieved by fine tuning the frequency of operations. Embedded in the device are temperature, water level, tilt, and acceleration sensors. A digital camera, as well as supplemental analog and digital sensors, can be optionally added without requiring additional conditioning electronics or power sources.

The data collected by each sensor, any alarms triggered, and software anomalies detected during operation are written to the internal memory and automatically delivered to a number of recipients through SMS messages, e-mail, and FTP file upload. Parameter adjustment and software upgrades can be carried out remotely, reducing the cost of maintenance.

The Flood Frog is ready to be networked through the addition of lightweight sensor nodes that expand the monitoring capabilities of the system. A local wireless sensor network would allow more accurate measurement of quantities, as the sampling points are distributed along the structure, which can be arbitrarily large, especially for bridges and buildings.

The cost reduction achieved by the Flood Frog has the potential to expand the practice of structural health monitoring to a significantly higher number of existing and new infrastructures. This improvement will increase safety and reduce the cost of operations by facilitating real-time monitoring and yielding a more efficient maintenance schedule that extends the useful life of a wide range of infrastructures. Additionally, its general design allows easy adaptation to a wide range of alternative monitoring applications.

IGC 2006

December 2006
Madras, India

IGC 2006 was a conference held by the Indian Geotechnical Society (IGS). In December of 2006, the conference was held in Madras, India, and was hosted by the IGS Chennai chapter. This year's main theme was "Geotechnical Engineering—Indian Experience." However, 15 sub-themes covered many other important fields in geotechnical engineering. The contributions for this conference were based on the latest achievements in geotechnical engineering.

UMR's own Shamsher Prakash, Professor Emeritus, delivered a keynote lecture on "Recent advances in Geotechnical Earthquake Engineering." In addition to this lecture, Dr. Prakash was awarded the bi-annual IGS-Kueckelmann prize for significant contribution to geotechnical engineering in India. He received the award from Major General S.N. Mukherjee, President of IGS (see photo).

Awards & Honors

The American Concrete Institute (ACI) recently elected **Dr. John J. Myers** as an ACI Fellow.

Congratulations to **Jared Brewe**, UTC's 2006 Student of the Year (Read about his research on p. 4)

Dr. Shamsher Prakash was admitted as an Honorary Fellow of Indian Geotechnical Society and was admitted to the order of the Golden Shillelagh of MSM-UMR Alumni Association

Call for Papers

Are you an engineer, geologist, scientist, teacher, or other professional? You are invited to submit original and unpublished papers for the Sixth International Conference on Case Histories in Geotechnical Engineering. Abstracts are currently being accepted, and the deadline for submissions is March 15, 2007. Abstract instructions can be found at http://www.6icchge2008.org. Even if you aren't planning on submitting an abstract, check out the Web site for information on attending this exciting, internationally attended conference.

This conference will take place August 12–16, 2008, in Arlington, Virginia, and includes special lectures, state of the art and practice presentations, exhibitions, a short course, a special symposium, and professional development credit availability. Please bring your families and discover the rich history and interesting sites of Arlington, Washington D.C., and surrounding areas.

You may also contact the conference chairman, Shamsher Prakash, at prakash@umr.edu.

Optimization of High Strength Concrete

By Jared Brewe

The majority of my research has looked into optimization and properties of high strength concrete. My research began with trying a different approach into concrete mixture optimization. I started by working with the ceramic engineering department and studying the particle packing theories they use in design of refractory materials. The idea behind particle packing is to determine the optimum amount and distribution of particle sizes that will minimize the void space between particles or will maximize the density of the particle mixture. Using these theories, I produced a 2-inch cube, made from Type III cement, silica fume, and quartz sand, with a compressive strength of over 22,000 psi at 28 days. This approach can also help reduce the amount of cement required for a mix without losing concrete compressive strength. This reduction can happen because the optimized aggregate distribution has a greater density, thus requiring less cement to fill the voids.

A paper was published in the 2006 National Bridge Conference titled, "Particle Size Optimization for Reduced Cement Content High Strength Concrete," which further describes the optimization approach. This approach is an idealized case that would need changes before being used in the real world, but the theory also provides another approach to concrete mixture optimization. Further research into the application of these theories in actual concrete mix design is ongoing.

Currently, I am also working on the early-age, stress-strain relationships of concrete.

Many differences occur between normal strength concrete and high strength concrete, one of them being the stress-strain relationship. Higher strength concrete will typically have a higher modulus of elasticity but will have a lower ultimate strain at failure. The prestressed concrete industry is greatly affected by these properties, because higher strengths can lead to longer and fewer girders per bridge, as well as other improved properties. The industry also prefers higher strength concrete because the prestressing strand can be released at an earlier date since the required concrete strengths have been developed. In the prestressed concrete industry, the allowable compressive stress that can be applied to concrete at the release of prestressing strands is currently 0.6f'c, that restriction being developed for normal strength concrete. This value is used to prevent excessive micro-cracking, which would be detrimental to the concrete. Since the properties of higher strength concrete differ, we are going to find out if this value could be increased to allow for more optimized sections and earlier release times.

I have performed some additional research related to this previous work looking into the effects of accelerated or steam curing and match curing on the early-age properties of concrete, as well as effects on the shrinkage of concrete. We are trying to develop correction factors to be used when determining the shrinkage of accelerated cured concrete.

Transportation Research Board 86th Annual Meeting

In January 2007, several participants from UMR traveled to the TRB 86th Annual Meeting in Washington, D.C. Below is a list of authors from UMR (unless otherwise noted) and their respective papers/presentations. In addition, Dr. Louis Ge attended the meetings, and Dr. Ashraf Ayoub and Dr. John J. Myers presided over the "Developments in Cracking and Durability of Concrete" and "Bridge Rehabilitation and Durability of Fiber-Reinforced Plastics" sessions, respectively. You can read more about these papers by searching the TRB Annual Meeting Interactive Program found at http://www.trb.org/am/ip. Congratulations to all participants!

Genda Chen
Coaxial Cable Sensors for Distributed Crack Detection in Reinforced Concrete Bridge Columns and Decks

Vivek Goswami and Ghulam Bham
Gap Acceptance Behavior in Mandatory Lane Changes Under Congested and Uncongested Traffic on a Multilane Freeway

Feifei Lu and Ashraf Ayoub
Analytical Evaluation of Effect of Bond Properties on Behavior of FRP-Strengthened Reinforced Concrete Girders

John J. Myers on behalf of Brahim Benmokrane (University of Sherbrooke, Canada)
FRP-Reinforced Concrete Bridges with Extended Service Life

John J. Myers, Xianlin Shen, and Norbert Maerz
Effect of Varied Surface Roughness, Putty Thickness, and Concrete Strength on Interfacial Bond Strength of FRP to Concrete

Thomas M. Petry and Cheng-Ping Jiang (Black and Veach)
Soil Suction and Behavior of Chemically Treated Clays

Nominations Needed

Nominations are invited for the 2007 Shamsher Prakash Research Award for Geotechnical Engineering Research. Nominees must be an engineer or scientist and 40 years old or younger. Further details can be found at the following Web site: http://www.yoga10.org.

2006 Award winners
Mitsu Okamura, Japan
Jonathan P. Stewart, California, USA

Previous winners have hailed from Greece, India, Thailand, Japan, Italy, and USA. Further information can also be gained by e-mailing Dr. Shamsher Prakash at prakash@umr.edu.