Student Posters for 2012 ASEE Illinois-Indiana Conference

March 17, 2012 at Valparaiso University

Civil Engineering

1. **An Investigation of Concrete Properties in Support of International Testing Standards**
   Justine Barnes (Valparaiso University)

Concrete is the most widely used building material in the world and as such standards are required to ensure the quality of the product. This research examined two of the standard processes for concrete testing; ASTM C143 The Slump Test of Hydraulic Concrete and ASTM 496 Split Tension Testing.

2. **Evaluation of Effects of Fibers on Concrete Strength and Plastic Shrinkage Cracking under Different Environmental Conditions**
   Joel Frank, José A. Peña (Purdue University Calumet)

The effect of synthetic fibers on the compressive strength of concrete has been studied by several researchers (Bouamarata, 1988). However, researcher has not compared the effect of synthetic, glass, steel fibers to the environment; also the difference of lengths of the fiber and shape on plastic shrinkage. Plastic Shrinkage in concrete appears on the surface of concrete in the early stages of curing with 1 to 3 inch cracks caused by several factors, i.e., wind velocity exceeding more than 5 mph, low relative humidity , high ambient or/and concrete temperatures which produce high evaporation rates before concrete is able to hydrate properly. Fibers in concrete may be used as a method to, reduce the permeability, reduce plastic settlement in cracks, reduce plastic shrinkage in cracks, increase abrasion and impact resistance, and shatter resistance. This project intent to measure the effect of different fibers in concrete comparison will be based on type of fiber (metallic, glass, synthetic) amount of fiber present and environment to control plastic shrinkage. Also determine variance of using fibers in controlling plastic shrinkage in concrete. It is expected that different type of in fibers in concrete would show advantages and disadvantages which could be measurable quantitative and qualitative. This research will help to determine which fibers can decrease plastic shrinkage, while increasing strength in concrete in different environments.

3. **Diffusivity in Concrete**
   Dean Koldenhoven, José A. Peña (Purdue University Calumet)

The high alkalinity of concrete causes a passive layer to form in the surface of the embedded metal. This protective layer may be disrupted by penetration of carbon dioxide (carbonation), chlorides and other deleterious substances. Once the protective layer has been broken, corrosion reaction progress by electrochemical mechanisms, where an anodic reaction causes iron to be dissolved into ions, and a cathodic reaction in which dissolved oxygen is reduced. The corrosion rate of the reinforcement depends then on the rate of cathodic reaction. Diffusion of oxygen through the concrete cover can at times be rate-limiting; therefore its determination is important to determine concrete structures life expectancy. Penetration of oxygen in concrete decreases as relative humidity and cover thickness increase and water to cement ratio decreases, it is also affected by the composition of the concrete and

aggregates used. Most of these factors relate to how the concrete is cured, its age, and under what conditions it ages. The objective of this research is to measure the effective diffusion coefficient of oxygen in concrete as a function of humidity content. The effective oxygen diffusion coefficient is determined by means of electrochemical testing after reaching steady state from the oxygen flow. The results could be used to develop a durability prediction model that will allow to forecast time to corrosion as a function of the concrete properties mentioned above.

4. **Bonding Strength of Epoxy-Coated Reinforcing Bars in Concrete subjected to High Temperatures**
   Drew Oppenhuis, José A. Peña (Purdue University Calumet)

The bonding strength between fiber reinforced concrete and steel rebars subjected to elevated temperatures has been studied by several researchers. The use of epoxy-coated reinforcing bars has become regular in the construction industry during the last 20 years. The use of epoxy coated rebars helps to increase the durability of reinforced concrete when this is subjected to harsh environments. However, the effect of epoxy coating on the bonding strength between the reinforcement and the concrete when the concrete is subjected to high temperatures has not been studied. This research investigates the bonding strength between 20-mm epoxy-coated steel bars and concrete subjected to temperatures in the range of ranging from 350 to 700øC. Fifty modified pullout specimens were prepared using high strength concrete with basalt aggregate and different volumetric mixtures of three types of fibers (brass-coated steel fibers, hooked steel fibers, and high modulus polypropylene fibers). The concrete was cured for 28 days at room temperature. Specific specimens will then be subjected to elevated temperatures (ranging from 350 to 700øC) using a furnace. Specimens designated for control were left at room temperature. All specimens were subjected to tensile testing up to failure. The conditions, cracking and strength of both the control and heat treated specimens was observed and recorded.

5. **Site Improvement by Design and Use of Pervious Concrete Pavement**
   Aleksandar Elek, José A. Peña (Purdue University Calumet)

The use of impervious concrete as a pavement has negatively affected the natural flow of rain water causing flooding and resulting in the underutilization of land in the form of retention ponds. Impervious pavements have many negative effects on the environment, including water supply toxicity, increase in severity and likelihood of flooding, and creating heat island effect. Flooding is one of the most common hazards in the United States. Flooding risks has worsened from the use of traditional imperious concrete pavements. Heat island effect is described as built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8-5.4 øF warmer than its surroundings. To date, the limitations of pervious concrete have been its durability and life expectancy when having to withstand slow or stopped traffic loading. By optimizing mix designs and innovative site layout this research attempts to design a pervious concrete mix that can withstand greater compression loads while maintaining high porosity. Two mixes were designed to meet or exceed compression loads, splitting tensile, and pull out of embedded rebar strength for typical parking lots. A total of 46 test specimens per mix design were tested at various curing intervals for compressive, splitting tensile, and pull out strength of embedded rebar, as well as porosity. All testing procedure will follow the ASTM guidelines and specification. The optimal mix design that based on mean time to drain 12? of water, total mean compressive strength, mean splitting tensile, and mean pull out strength were selected. The second phase of the research was to design the Anderson Building parking lot at Purdue university to maximize the ability of the pervious concrete to handle storm water. Finally the research includes a cost

analysis of the selected pervious concrete used in the purposed re-design of the Anderson Building parking lot.

Electrical/ Electronic Engineering

6. Proximity Sensor Assist for the Visually Impaired
Riley Albers, Rachel Coulter, Derek Egley, David Jung, Adam Whitmer (Valparaiso University)

The Proximity Sensor Assist is a device that uses an ultrasonic sensor to detect objects in front of the user. It is intended to supplement the detection capabilities of a typical cane used by the visually impaired. The device then provides haptic feedback to the user via a small vibrating motor.

7. Jewelry Box Assembly System for an Individual with Disabilities
Andrew Schiller, Matthew Gaide, Tyler Heagney (Valparaiso University)

The goal of this service learning project was to design, manufacture, and implement a semi-automated system to assist a person with disabilities in the assembly of jewelry boxes. The system was implemented at the non-for-profit organization, Opportunity Enterprises, which collaborates with companies to create jobs for individuals with disabilities. Prior to the implementation of the new system, a full-time volunteer was required to assist in the assembly process. Unfortunately, the organization only has a finite number of volunteers; therefore, a volunteer was not always available. The assembly system consists of parallel hoppers to store boxes and their corresponding lids, a linear motor and track for the delivery mechanism, a push button for the user interface, a programmable logic controller (PLC) with connecting relays to control the system, and a door mechanism to remove the assembled boxes. After the hoppers are filled with the jewelry box components, the individual with disabilities can work independently to assemble the boxes. Additionally, because the system is semi-automated, the individual with disabilities still has the opportunity to practice his motor skills.

8. Simulation and Fabrication of a Wideband Planar Antenna
Michael Ausserer, Matthew Hein, Ian Stevenson (Rose-Hulman Institute of Technology)

Combining a high-impedance FSS with a complementary low-profile broadband antenna and selecting frequencies compatible with the radiation profile of an Archimedean spiral impacts wide-bandwidth performance. S11 values from CST simulations were compared to those measured from a PCB-milled antenna.

9. Wideband Planar Antenna using a Variable Frequency Selective Surface
Michael J Ausserer, Matthew S Hein, Ian C Stevenson (Rose-Hulman Institute of Technology)

Adding a high-impedance surface under a planar antenna improves performance compared to that of the antenna over a metal ground plane. Much of the previous work in high-impedance surfaces concerns artificial structures functioning over a relatively narrow band of frequencies. By varying the unit cell geometry of a frequency selective high-impedance surface, the surface can be designed to operate over a broad band of frequencies. This paper describes an approach of combining this variation in geometry with a complementary low-profile broadband antenna, selecting frequencies compatible with the radiation profile of an Archimedean spiral and improving the wide-bandwidth performance. After modeling the structure of the antenna and high-impedance surface, a PCB milling machine is employed to fabricate the antenna on high-frequency Rogers Laminate from Gerber files generated by

CST Microwave Studio. This paper compares S11values from simulations carried out using CST Microwave Studio to those measured for the fabricated antenna using a vector network analyzer.

10. Behavior of pacemaker leads in the presence of low intensity magnetic fields.
Varun V. Hariwan, Kyle D. Stewart (Trine University)

Implanted pacemakers may be interrupted while undergoing an MRI. Few studies have been done on the effect of MRI on pacemaker leads. In vitro tests using an induced magnetic field shows that an external field of 10-100 kHz produced a non-linear pacing signal significantly influencing a pacemaker.

11. United Electrical Engineering and Design Engineering Technology Packaging Project
Nick Cocanower, Daniel Grabill (Trine University)

Combining two different engineering fields, students were forced to experience a real life career situation. The class was assigned and successful in communicating, resulting in quality packaging for Electrical Engineering printed circuit boards in a Design for Manufacturing and Assembly course.

12. Immersive 3-D Virtual Lab Modules for Hydrology & Hydraulics Courses
Site Guo, Chandramouli Viswanathan, John Moreland, Chenn Zhou (Purdue University Calumet)

There is an observed deficiency in student understanding of the 3-D nature of ground water contamination. This understanding is necessary to implement solutions to remedy contaminated areas. Simulation and 3D Virtual Reality have been used to develop interactive modules to improve student learning.

13. Device Authentication using Physical Unclonable Functions
Markia Mann, Jennifer Fletcher (Purdue University Calumet)

Physical Unclonable Functions (PUFs) have been around for quite some time, but using ring oscillators to implement them, is a newer concept. The goal is to implement a ring oscillator that provides a unique device identifier onto an FPGA board. This will provide a new way to store secrets.

Mechanical Engineering

14. AN IMPROVED METHOD FOR QUANTIFYING THE STIFFNESS OF RUNNING SHOES
Kyle Zobeck, Erick Bodett, Marjorie Ballun, Bruce Williams, Craig M. Goehler, Kathleen Sevener (Valparaiso University)

A running shoe is designed to protect a runner's foot from injury by stabilizing motion and cushioning impact. As material technology and product testing develop, shoes can offer more protection through advanced designs. A common test performed to evaluate shoe designs is known as a flexion test. Flexion tests are used to measure a shoe's stiffness. A simple flexion test involves applying a force to the bottom of a fixed shoe so that the shoe bends. Flexion test results are used to determine a stiffness value for the shoe; however, this value only characterizes a limited portion of the shoe. In the present study, a modified flexion test and test apparatus were developed to address limitations of the standard flexion test and develop a better way to quantify shoe stiffness. Unlike a standard flexion test, the modified flexion test permits determination of shoe stiffness values at different locations within the shoe. For the

present study, stiffness was measured at two locations, the shoe forefoot and the shoe mid-foot, in shoes of two different architectures from two shoe manufacturers. The two shoe architectures exhibited a noticeable tactile difference in stiffness and are hereafter referred to as stability and flexible shoes. Flexion tests were performed on each shoe at the designated loading location with loading rates of one, five, and ten inches per minute. All tests were performed using an MTS Q-Test 150 load frame. Flexion test results showed that the stability shoes have higher stiffness values than the flexible shoes in both the forefoot and mid-foot regions and that the loading rates applied had no significant effect on the measured shoe stiffness. Future work will examine the effects of flexion locations, shoe wear, and higher loading rates (more consistent with dynamic loading of a shoe in use) on shoe stiffness.

15. A Study on the Effects of Shoe Architecture on Impact Forces during the Gait Cycle

Bethany Powell, Ryan Post, Bruce Williams, Kathleen Sevener, Craig M. Goehler (Valparaiso University)

This study expands on a previous study that examined the forces on the foot during the gait cycle, comparing two different shoe architectures: flexible and stability. Along with increasing the number of subjects and the number of trials, the protocol included the comparison of a second shoe brand.

16. The Claaaaaaw!: A Neuroprosthetic Teaching Aid

Adam B. Furore, Eric D. McLeish, Hobey Tam (Rose-Hulman Institute of Technology)

A teaching device to be implemented in a neuroprosthetics course was designed and fabricated to condition electrical impulses from the user's innate nervous system to control a claw machine that has freedom of motion in the 3 principle axes of motion and a claw to enable manipulation of objects.

17. Supersonic Nozzle Design

Nathan Shumway, Dr. Fredrick Haan (Rose-Hulman Institute of Technology)

This project's goal was to design and create a converging-diverging nozzle and Schlieren system that could work with a small compressor. After testing the compressor and two different nozzles the system produced clear images of oblique shocks.

18. An Orthopedic Fixation Device Simulating the Gait Cycle

Derek B. Archer, Karah E. Hickman, Lance G. Irwin (Rose-Hulman Institute of Technology)

An orthopedic fixation device is needed to test company-specific knee implants. This device simulates the gait cycle and allows the tibia to be statically tested in different phases with easy input from the user.

19. SAE Supermileage Car

Todd Richardson, Michael Winkler, Brock Reinig (Trine University)

The goal of this competition is to create a single person high mileage vehicle. The vehicle is built to strict standards and has a specified course which it must complete. The competition gives us a chance to improve our design skills as well as group management skills.

20. 3-Wheel Moonbuggy Prototype

Nick Beitler, Wes Verner, Billy Recker, Lucas Garrow, David Butcher, George Markou (Trine University)

One of the senior design projects for the Design Engineering Dept. at Trine University includes competing in the NASA Great Moonbuggy Race. The competition requires completion of a functional moonbuggy prototype.