

## **Enthusiasm in the Engineering Curriculum**

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### **Abstract**

What makes a teacher effective in the classroom? One measure taken in a sophomore level class at the University of Arkansas is to create enthusiasm about class topics. Civil engineering students at the University of Arkansas are required to enroll in CVEG 2113, Structural Materials. This class introduces young engineers to materials used in today's construction industry. Nearly two-thirds of the class material focuses on concrete materials. Group and individual projects are performed by students not only to familiarize but increase interest in concrete materials. Some projects are required while others are encouraged. Projects include a high-strength concrete contest, concrete Frisbee contest and certification in concrete testing. The high-strength concrete contest introduces students to High Performance Concrete (HPC) by requiring groups of students to work together in designing, batching, and testing their own concrete mixtures. This contest creates a sense of competitiveness between groups when testing the concrete mixtures. The concrete Frisbee competition is an optional project offered to the students. The competition is intended to be a fun way for the students to demonstrate their knowledge regarding concrete materials. Frisbees are judged for originality in appearance, weight, and flying distance. In the spring 2005 semester, 18 out of the 27 students enrolled participated in this competition. Lastly, students are encouraged to become certified by the American Concrete Institute (ACI) in the testing of fresh concrete. This certification process allows the students to become familiar with testing procedures used for concrete materials in the construction industry. In addition, it provides summer internship opportunities. An overwhelming majority, 24 of the 27 students, participated in this certification process. These projects have encouraged some students to fabricate concrete countertops outside of class for a local homeless shelter. Students on several occasions have stated that upon leaving the class, they not only learned the class material, but had fun doing it.

### **Introduction**

Structural Materials, CVEG 2113, is a required civil engineering class at the University of Arkansas. The class is typically taken by second semester sophomores or first semester juniors. The course introduces students to construction materials used in everyday civil engineering applications. Approximately two-thirds of the class discussions involve concrete materials with the remaining lectures concerning steel, wood, and fiber reinforced polymers. The class schedule consists of two fifty-minute lectures and one three hour laboratory each week of the semester. The laboratory is designed to emphasize material presented during class lectures.

In and out of class projects are performed by students to create interest in the subject area, in particularly, concrete materials. Some projects are required while others are encouraged. Projects include the high-strength concrete contest, concrete Frisbee competition, and concrete testing certification. These projects have encouraged some students to apply their knowledge and experiences from the classroom once leaving the course. On several occasions, students have noted that Structural Materials is a course in which they learned and had fun doing it.

### **High-Strength Concrete Contest**

The high-strength concrete contest was introduced in the Fall 2003 semester in an effort to create interest in concrete materials. In addition, the high-strength concrete contest introduces students to High Performance Concrete (HPC) by requiring groups of students to work together in designing, batching, and testing their own concrete mixtures.

This contest consists of four sections: cost, performance, written report, and presentation. Students are given a concrete mixture proportion which serves as the standard mixture. This control mixture is part of a past research program and the fresh and hardened properties have been well documented. Mixture cost and performance on the standard mix is also provided to the students. The individual costs and properties of the available materials that can be used in the mixture are also provided. Many students find themselves performing research at the library or on the internet to obtain additional knowledge on developing high-strength concrete mixtures. After much research and calculating material quantities, the mixtures are batched and fresh concrete properties are obtained, Figure 1. Compressive strength is determined at 1, 7, and 28 days of age.



**Figure 1: Students Performing Fresh Property Tests on Their Concrete Mixture**

The contest has produced impressive results over the past few semesters. Groups have developed concrete mixtures with water-to-cementitious material ratios ranging from 0.18 to 0.35. Compressive strength values have reached almost 12,000psi for 1-day and over 17,000psi for 28-day. In comparison, most sidewalks and driveways are cast with 3,000psi concrete.

The high-strength concrete contest has seen great success in promoting concrete materials to students. Further, it introduces students to high-strength concrete in a “not so textbook method” by creating enthusiasm about a concrete mixture they had a hand in creating.

### **Concrete Frisbee Competition**

The concrete Frisbee competition is an optional project offered to the students. The competition is intended to be a fun way for the students to demonstrate their knowledge regarding concrete materials. In addition, the competition challenges the students to think of ways to making their Frisbees lighter and more creative. Design criteria including Frisbee dimensions are provided to the students. Frisbees are judged on the following criteria:

- Appearance – Originality in design
- Weight – Lightest Frisbee
- Flying distance – Average distance after three throws

In the Spring 2005 semester, 18 out of the 27 students enrolled participated in this competition. Participants are shown in Figure 2.



**Figure 2: Spring 2005 Concrete Frisbee Participants**

Frisbee designs ranged from removing the center portion of the Frisbee to solid disks. Several Frisbees were painted to improve the appearance. Glass micro-bubbles and small styrofoam balls were used to develop lightweight Frisbees. Fiberglass mesh was also used as reinforcement to improve durability of the Frisbees. Durability is an important factor in the competition since the Frisbee must endure three throws.

The day of the competition the Frisbees are weighed and judged on appearance. The flying portion of the competition is held at a large field on the University of Arkansas campus. Average distances of over 150ft, flight and roll, have been observed. Figure 3 shows students participating in the flying portion of the competition.



**Figure 3: Students Participating in the Flying Portion of the Competition**

### **Concrete Certification**

The Department of Civil Engineering together with the Arkansas Ready-Mixed Concrete Association (ARMCA) provides an opportunity for students to become certified by the American Concrete Institute (ACI) in the testing of fresh concrete. The certification is not required for the class; however is strongly encouraged. For many construction projects, fresh concrete property testing is required by a certified individual. For this reason, the concrete certification enables students to obtain summer internships. Furthermore, preparation for the certification has been found to be an effective method for teaching students about fresh properties of concrete and factors affecting these properties.

Two examinations are conducted to verify a person's knowledge and ability to perform the fresh concrete tests. Passing a one-hour 55 multiple choice question written examination is required. In addition the student must pass a performance exam. The performance exam requires an

individual to demonstrate their ability to perform the tests that are included in the certification. A student conducting one of the tests during the performance exam is shown in Figure 4. To successfully pass the performance exam, the student must correctly perform each test as stated in the American Society for Testing and Materials, ASTM, standards.



**Figure 4: Student Performing Concrete Test in Performance Section of Exam**

In the spring 2005 semester 24 of 27 students participated in the certification program. This statistic illustrates interest by the students since the certification is optional and requires payment of \$50.00 to ACI. The certification process has affected students in several ways. For students with interests in other areas of civil engineering, the certification process has educated them on concrete and its' material properties. For students interested in the concrete industry, it provides them with an opportunity for education, research, and future job employment. A former student was asked about his experience with the certification program.

Brad Miller, a recent graduate at the University of Arkansas, passed the ACI Field Certification – Grade I exam in the spring of 2003. He was heavily involved in concrete research at the university. His duties included mixing concrete, testing the fresh properties of concrete, and making cylindrical tests specimens. Brad commented, upon completion of the class, on his certification experience in the following:

*“Proceedings of the 2005 Midwest Section Conference of the American Society for Engineering Education”*

As a result of the dedication of my instructors, numerous reviews, and practice labs, I was extremely confident in my ability to pass the ACI exam. I felt my instructors were effective in conveying proper techniques and procedures. The newly acquired skills I learned through the ACI certification process have increased my overall knowledge of concrete and materials. This is a knowledge that aspiring civil engineers can't afford to be without. The ACI program has given me the necessary skills and training to help further my education and career as a civil engineer.

### **Concrete Countertops**

The enthusiasm and success created from the previously discussed projects led several students in the spring 2005 semester to construct concrete countertops, Figure 5.



**Figure 5: Concrete Countertop**

Two students designed and built several concrete countertops for a local homeless shelter in Fayetteville, AR. The students partnered with several architectural students for the project which included countertops and cabinetry. The students believed that the projects they had performed in the class helped in the construction of the countertops for this voluntary project.

### **Conclusion**

The high-strength concrete contest, concrete Frisbee competition, and concrete certification offered in the Structural Materials course at the University of Arkansas have created enthusiasm about concrete materials. It is believed that these additions to the class have been an effective method for teaching relevant course topics in a fun way. Many students after completing the class have mentioned how these projects have helped them obtain a better understanding of concrete materials. In addition, some students plan to continue study in the area of concrete materials.

## **Biography**

STEPHAN DURHAM will be an assistant professor at the University of Colorado at Denver in the Department of Civil Engineering starting in the Fall 2005. He obtained his MSCE and Ph.D. degrees from the University of Arkansas in the area of repair and strengthening of concrete bridge superstructures. His interests include concrete materials and repair.

W. MICAH HALE is currently an assistant professor at the University of Arkansas in the Department of Civil Engineering. He obtained his MSCE and Ph.D from The University of Oklahoma in the area of high performance concrete and the effects of pozzolan admixtures in concrete. His current research includes the effect of blast furnace slag in concrete mixtures and bond strength of prestressing strands.