CENTER FOR INFRASTRUCTURE ENGINEERING STUDIES

Doctoral Training in Civil Infrastructure Engineering

By

Abdeldjelil Belarbi

John J. Myers

Ronaldo Luna

Richard Stephenson

Cesar Mendoza

UTC ETT48

University Transportation Center Program at

The University of Missouri-Rolla

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16. Abstract

This proposal requests funding does for 6 graduate students to pursue doctoral studies in civil infrastructure the Secretary of the Department of Education identify engineering, which encompasses several disciplines as a national need. Training new professors with technical proficiency in civil infrastructure engineering will develop educational human resources to train better engineers that will build the needed infrastructures for our nation's future. Transportation and communication are critical to U.S. economic strength and maintaining technical superiority in these fields is necessary to retain our leadership position.

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Student: Jared Brewe

Advisor: Dr. J.J. Myers, Ph.D, P.E.

Research Description:

Mr. Brewe's research involves the development of optimized mix proportions for high strength concrete (HSC). Determination of the optimum mixture of materials for concrete production has been the subject of numerous studies over the past century. One major aspect that has been debated was the amount, type or gradation of the aggregates used in the mix. Design and construction specifications have changed in recent years to include more performance specifications for concrete including durability, permeability, shrinkage, and the like; therefore, mix designs have become more advanced to meet these specifications. Mr. Brewe's research has focused on optimizing particle packing since improved mechanical properties can be produced with relatively the same materials as before. His work has focused on improving concrete mixtures with the aid of computers, particle classification methods, newer materials and concrete production methods all with the goal of producing the best concrete for the lowest cost. High Strength Concrete (HSC) with improved properties has been developed by obtaining the maximum density of the matrix. Mathematical models developed by J.E. Funk and D.R. Dinger, are used to determine the particle size distribution to achieve the densest packing of particles in the matrix. Once the particle size distribution of each material is established, these models can be applied to determine the optimal mix. By using these models, mixes with high packing densities can be obtained. These mixes will generally contain a lower amount of cement, but will have enhanced mechanical properties like higher compressive strength, improved durability, etc. In addition, using supplementary cementitious materials, i.e. fly ash or ground-granulated blast-furnace slag, to replace portions of the cement will further reduce the amount of cement. The work developed to date has developed a self-consolidating HPC mix with 15 weight % cement and compressive strengths above 12 ksi. Mixes with higher cement concretes were also developed with compressive strengths above 22 ksi.

Teaching Experience

Mr. Brewe engaged in a number of academic activities that provided him with hands on experience in teaching. He has lectured in one undergraduate course, CE 217 Structural Analysis, and one graduate level course, CE 328 Prestressed Concrete Design, under the direction of Dr. Myers. During the Summer of 2004 and 2005, Mr. Brewe led efforts in a summer program geared at attracting high school students interested in Architectural Engineering. He was responsible for coordination of the weekly afternoon activities and interacted with his advisor on the development of the teaching activities. This program entitled "Introduction to Engineering – Architectural Engineering" was a three week program.

In addition Mr. Brewe has attended a Teaching Assistant Workshop conducted annually at UMR. This is a certification course at UMR required to provide instruction on teaching and required prior to instruction in the classroom.

Student: Donald Deardorff., P.E.

Advisor: Dr. R. Luna, Ph.D, P.E.

Research Description:

Mr. Deardorff's research involves the development of bridge repair cost and functionality models due to earthquake damage that take into consideration regional factors such as bridge type, accessibility (location), available repair resources, differences in bridge construction practices, post earthquake repair experience and public reaction/policy. Earthquake loss estimation studies for highway systems typically involve sophisticated analysis of seismic hazard and infrastructure fragility; however, the resulting direct losses are based on simplified models that may not be indicative of losses for a particular region. Similarly, indirect losses are derived from simplified models of bridge functionality and warrant improvement. The results of these studies are critical for insurance companies and government agencies dealing with emergency relief. Seismic risk assessment studies due to future earthquakes are useful for planning officials and Federal/State transportation departments for determination of emergency corridor effectiveness due to estimated network damage and prioritization of bridges for seismic retrofit. This research is focused on the development of more sophisticated highway seismic loss estimation models with particular application to the St. Louis study region currently included in a University of Missouri-Rolla (UMR) research project.

Teaching Experience

Mr. Deardorff engaged in a number of academic activities that provided him with hands on experience in teaching. He taught two undergraduate Laboratory sessions as a GTA under the direction of Dr. Luna. He then developed the first draft of the Laboratory Manual for that same course, CE 215. Finally, he participated in teaching the lecture hours of CE 215 "Fundamental of Geotechnical Engineering" lecture during the Fall 2003 semester with additional responsibility for the same course during the Winter 2004 semester. To provide him with different teaching forums he also developed a distance-learning teaching materials for the Civil Engineering Department on the topic of CE 314 - Geosynthetics in Engineering in collaboration with Dr. Luna.

These initial experiences provided him with the confidence to teach a continued education course: "Basic Hazards in the U.S. (HAZUS) Multi-Hazards Training" (course code E313) under FEMA oversight. This took place on April 2004 and about 20 attendees were present from different sectors in industry.

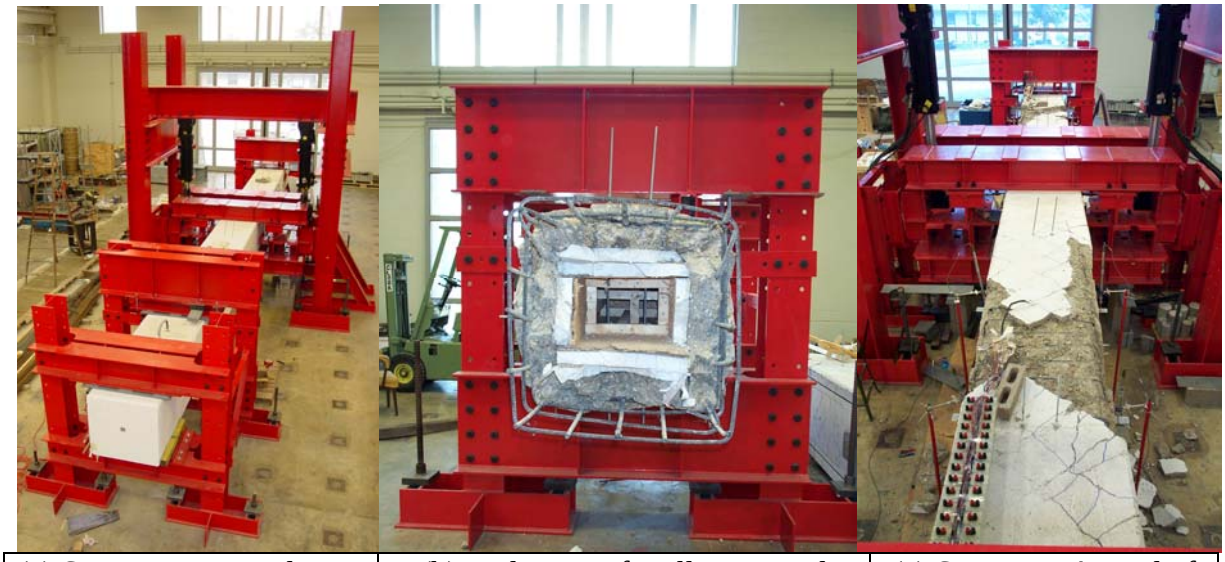
He also enrolled in EC 401 "Teaching Engineering" course and attended the 10-day GTA workshop at UMR (completed January 2002). Participated in the HELPERS Program with the Rolla Public School District (k-12).

Student: Gary Greene, Jr., P.E.

Advisor: Dr. A. Belarbi, Ph.D, P.E.

Research Description

Mr. Greene tested two full-scale hollow girders specimens that were 15m long. The first girder was loaded under full-reversal cyclic torsion, and the second under full-reversal cyclic torsion combined with shear. These girder tests are needed to determine the effect of cyclic loading on the characteristics of the shear flow zone, the extent of softening of concrete in compression, the damage to the concrete struts due to orthogonal cracking, and the occurrence and severity of spalling. The experimental outcome of the proposed research is the development of a truss model that can predict the behavior of a reinforced concrete (RC) member under seismic actions that induce torsional stresses. Such a model could then be used to predict the seismic response of a structural system.



(a) Specimen in Loading Frame	(b) End View of Hollow Tested Specimen	(c) Specimen At End of Test
Photographs of the first test specimen		

Teaching Experiences

During spring semester of 2005, Mr. Greene was the instructor for Basic Engineering 50, Engineering Mechanics – Statics, Section E. He was completely responsible for developing the lecture notes and giving the lectures. Mr. Greene continued his teaching experience during the fall semester of 2005, and was the instructor for Civil Engineering 223, Reinforced Concrete Design, Section B. Again he was completely responsible for developing and giving the lectures, and creating, proctoring, and grading four one-hour examinations. Mr. Greene received formal instruction on teaching methods by completing Civil Engineering 382, Teaching Engineering, during the summer semester of 2004, and a 1.5 day ExCEED Teaching Workshop during fall semester 2004. In addition to activities on campus, Mr. Greene is a member of the American Concrete Institute (ACI), and a member of Committee E802, Teaching Methods and Educational Materials.

Student: William Otero-Benítez, P.E.

Advisor: C. Mendoza, Ph.D.

Research Description

William Otero studies the energy distribution in sediment-laden open channel flows. The first part of his investigation consists on a mathematical analysis of the thermodynamic consistency of the traditional methods applied in civil engineering for the estimation of suspended sediment transport. This will shed light on the physical range of applicability of these methods

The second part of the investigation proposed consists on the development of a thermodynamically consistent computational approach to study sediment transport in shear flow laden with dilute/dense concentration of suspended solid particles in an open channel will be developed.

It is anticipated that the results of this investigation will have a significant impact on the current understanding of the foundations of the suspended-sediment transport phenomenon in open channels and on the methods used to compute it.

Teaching Experiences

During his three years of graduate studies, William Otero has being the Graduate Assistant in the LEAD (Learning Center) Program provided for students registered in the course CE 230 Elementary Fluid Mechanics. In this program a more personal approach to teaching is offered allowing for the formation of small discussion groups in which help some of the class concepts can be revisited and clarified.

In addition to that, Mr. Otero taught the Lab. Section for the course CE 234 Water Resources Engineering in the Spring and Fall Semesters of 2003. For this, he developed a Laboratory Manual which included conceptual information to support the class lectures and organized step-by-step laboratory activities. This laboratory section also included a weekly one-hour lecture component for which Mr. Otero was completely responsible.

In addition, William Otero received formal instruction on specialized teaching methods for engineering in the course CE 382 Teaching Engineering (Summer Semester of 2003). Also, Mr. Otero took part on a 2-day ExCEED Teaching Workshop in the Fall Semester 2004.

Student: Mariel Quevedo-Torres

Advisor: Dr. R.W. Stephenson, Ph.D, P.E.

Research Description

Mrs. Quevedo-Torres is conducting studies on the liquefaction behavior of silt soils under initial static shear stresses. She is developing liquefaction test protocol using the newly commissioned cyclic simple shear testing equipment. Low plasticity silt samples, consolidated from slurry in UMR's unique large diameter radial consolidometer will be subjected to various levels of static shear stress then loaded cyclically until liquefaction occurs. The relationship between static shear stress, silt plasticity and number of stress cycles to liquefaction will be analyzed.

Fig. 1: Large Diameter Consolidometer

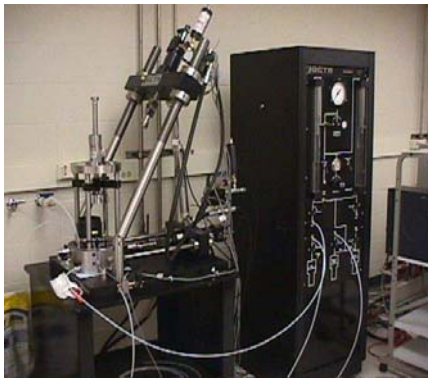


Figure 2: Cyclic Simple Shear Equipment

Teaching Experience

The following is a brief description of Mrs. Quevedo-Torres' supervised teaching experience.

- Introduction to Geotechnical Engineering Laboratory, CE-215
  She taught one section during the Fall Semester of 2003 and have been teaching two sections since the Fall Semester of 2004. Her responsibilities include preparing a small introductory lecture explaining the importance, applications and procedure of each laboratory activity, preparing the syllabus and report presentation instructions. Also she was responsible for grading reports, in-lab exercises and any additional homework required for the laboratory.

- Foundation Engineering II, CE-329
  She assisted Dr. R.W. Stephenson teaching the course. She taught five lectures, 75 minutes each. My responsibilities included preparing the class material, visual aides such as Power Point presentations, board notes, in class examples and exercises, and homework problems. She was also responsible for grading the homework developed.