

CHANCELLOR POSITION REQUEST:

June 18, 2009

Overview

The Civil and Environmental Engineering Department would expand its research activities through a search for a full-time, tenure track faculty position in the area of **Sustainable Structural Infrastructure**. The focus of this position would be to integrate existing and proposed research foci across campus. Specifically, the position would bring expertise integrating new material developments into the structural infrastructure and developing monitoring programs to evaluate the life-cycle performance of these structures. The infrastructure crisis that the country is currently facing requires innovations in materials, structural systems, sensor technology and monitoring techniques of the nation's infrastructure. This position would directly complement the following existing research programs and proposed Chancellor Position Requests:

Existing Programs:

- Structural Engineering and Mechanics (monitoring and material implementation)
- Building Materials and Wood Technology (material development)
- Polymer Science (material development)
- Computer Science – Sensor Networks Group (monitoring and instrumentation development)
- Electrical Engineering (instrumentation development)
- Architecture and Design (material implementation)

Proposed Chancellor Positions with complementary vision:

Concurrent requests are being initiated through the Department of Natural Resources Conservation (Building Materials and Wood Technology group), Architecture and Design (Art, Architecture and Art History) and Landscape Architecture and Regional Planning. These are distinct in that they are related to sustainable building design: site sustainability, energy efficiency, indoor air quality and sustainable building materials. In discussions with these Departments noted the “highly complementary” nature of this position with a high likelihood of collaboration.

Proven Excellence of Amherst Campus in Research Area

The CEE Department has exhibited excellence in research related to structural infrastructure sustainability. Currently there are three active researchers in this area (Arwade, Brena, Civjan), who have actively collaborated in cross-disciplinary projects. The additional position would extend the capabilities of this research group and facilitate interactions with a wider range of research groups both within the UMass Amherst campus and beyond. A sampling of current and past CEE projects by these faculty members related to this research area are listed at the end of this document.

Interdisciplinary/Transdisciplinary Nature

By nature, infrastructure projects are complex and lend themselves to interdisciplinary research. Through effective collaborations these projects can become transdisciplinary. The CEE research group has existing collaborations with Architecture and Design, Building Materials and Wood technology, government agencies and private industry. Their interactions with Computer Science, Polymer Science, Electrical Engineering and Mechanical and Industrial Engineering are expected to lead to increased collaborations. Deepak Ganeson, lead of the Sensor Networks Group in Computer Science, has noted the likely collaborations between this position and his group.

For the proposed research area advancing the state of the art in the following are critical: sensor technologies, monitoring techniques, material development, structural applications of new materials and advanced computational methods. These advances cannot be explored independently from one another, but must address the entire context of the national infrastructure problems. Research must be transdisciplinary, with breakthroughs in each realm immediately integrated into the others. Materials must be developed with specific structural applications in mind, while the context of structural systems must be redefined for the capabilities of new materials. Sensing technologies must address specific requirements of these materials and systems while innovations in sensing will drive the evaluation methods of new structural systems.

Department/College Support

The Department and College fully support a position in the area of Sustainable Structural Infrastructure and will provide startup and facilities required for the success of this position. The CEE department also fully supports the interdisciplinary initiatives indicated by this proposal and has discussed the position with related departments.

Established Leadership on Campus

The CEE Department is the home group for research in the area of Structural Infrastructure at UMass. They have led initiatives to develop funding in collaborations with Architecture and Design, Building Materials and Wood Technology and Electrical and Computer Engineering. Civjan is a member of the UMass Environmental Performance Advisory Committee (EPAC) and is working through this committee to further collaborations related to sustainability. Arwade is leading a multidisciplinary research team to pursue an NSF "Emerging Frontiers in Research and Innovation" proposal which is focused on a program requested topic of "Engineering Sustainable Buildings".

Funding Sources

Established funding of CEE led projects has been obtained for related projects listed at the end of this document. Sources for this funding has been Federal (National Science Foundation, Army Corp of Engineers(pending)), National (Portland Cement Association, American Concrete Institute),

Regional (New England Transportation Consortium, Massachusetts Highway Department, Massachusetts Executive Office of Transportation, Vermont Agency of Transportation). Private collaborations have been included in research projects with concrete admixture companies, design firms and producers of materials. The additional position is expected to significantly expand the sources of funding and collaborations required for funding from these agencies.

Research opportunities in this area are the focus of several newly announced National funding directives. Examples include an NSF RFP on “Emerging Frontiers in Research and Innovation” which specifies “Engineering Sustainable Buildings” as a research thrust. Other related NSF programs are the Civil Infrastructure Systems (CIS, within the Resilient and Sustainable Infrastructures cluster), Small Business Innovation Research Program as well as unsolicited proposals submitted directly to related program areas. The Federal Highway Administration (FHWA) has multiple levels of funding including direct funding and discretionary research funding provided to State Departments of Transportation, examples include the Innovative Bridge Research and Construction Program, Highways for Life program, National Cooperative Highway Research Program (NCHRP). The NCHRP includes a “Highway Innovations Deserving of Exploratory Analysis (IDEA)” program seeking proposals with potential to advance the construction, safety, maintenance, and management of highway systems with an innovative materials and construction focus.

It is expected that 2010 and following years will see a marked increase in funding in the expertise of this position from all funding sources due to: Federal Stimulus funding, general public policy shifts in the direction of sustainable infrastructure, critical national need to address inadequate infrastructure, and innovations in the field.

Prospects for Establishing UMass as a Leader in the Field

The prospects for establishing UMass as a leader in the field are very high. The CEE group already has significant expertise and experience in the field of implementation of new materials and modeling. Other groups on campus are leaders in sensor technology, sensor networks and materials development, as noted previously. Within CEE, the Integral Abutment Bridge (IAB) monitoring research is one of a handful of Universities with long term monitoring of 4 IAB structures (1 completed for MA, 3 under construction for VT), one of only 3 Universities to have studied the effectiveness of Hycrete (concrete admixture to extend the life of concrete structures – currently earmarked for funding through the Department of Defense with a 2nd earmark being sought) and the only University to have installed monitoring equipment in 2 structures containing Hycrete. The addition of a faculty member in this area will serve to bridge the existing gap between these existing programs and develop the critical mass within CEE to advance this area of research.

Current and past CEE projects related to the proposed research area:

Bridge Monitoring of Integral Abutment Bridges (IAB): IAB's are a newer method of construction which eliminate expansion joints with the intent of avoiding many long term durability issues in bridges. Civjan and Brena have instrumented IAB's for MassHighway (4 years of data) and VTrans (5 year project, currently 3 structures under construction) to monitor long term performance of these types of structures.

Bridge Monitoring Load Testing: Brena and Civjan have evaluated deteriorating concrete and damaged steel bridges in Vermont to determine the capacity of these structures – showing that bridge performance was much better than assumed by VTrans.

Hycrete Admixture: Hycrete is a concrete admixture certified as a Cradle to Cradle sustainable material, and the company is a member of the U.S. Green Building Council. The product use is for preventing corrosion and waterproofing concretes, leading to further design life. Civjan has been the PI on 2 of the 4 University studies on the material. Funding was through the New England Transportation Consortium. Two structures have been instrumented by Civjan to evaluate long term corrosion performance. Hycrete, Inc. has recently received federal earmark funding through the Army Corp of Engineers which will include UMass research, and a further collaboration on a federal earmark through the Department of Defense is being requested.

Oriented Strand Lumber: Arwade, collaborating with BMAWT, has obtained funding from NSF to model the properties of structural composite lumber. The material is a highly renewable and sustainable resource which currently has limited structural use pending research on the material variability and limit states.

Structural Uses for Steel Foams: Arwade is studying the potential use of steel foam materials as a structural material to absorb impact load.

Fiber Reinforced Polymers (FRP): Brena has worked with the New England Transportation Consortium and American Concrete Institute to study the use of FRP materials for strengthening and repairing deteriorating concrete structures. In addition, his research has investigated new implementations of these materials for infrastructure projects.