Sustainable Building Systems for Low Income Communities

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In 2011-12, I continued research into sustainable building systems for low income communities in collaboration with the built environment professional from the Tanzanian National Housing Building Research Agency and the University of Nairobi. Outcomes of the work include 3 papers in a special issue on "Engineering Sustainable Building Materials: Advancing the Structural Performance of Earth-based Technologies" in the *Journal of Sustainability*. Based on work in Kenya and Tanzania, I participated as an invited exhibitor during the twenty-third session of the UN-HABITAT Governing Council Exhibition in Nairobi. I was also part of the US delegation that participated in Penn a NSF-ASCE workshop held in Abuja, Nigeria.

The work that I have been doing in East Africa is being scaled up through working with researchers in globally-dispersed, teams. I am also the UF PI on an NSF grant, "Collaborative Research: Resilient and Sustainable Engineered Fiber-Reinforced Earthen Masonry for High Wind Regions." This project seeks to transform conventional but brittle earthen masonry into an equally sustainable and locally appropriate but radically more damage-tolerant material system. Engineered Fiber-Reinforced Earthen Masonry (EFREM) consists of compressed and stabilized earth blocks and earth mortar, both reinforced with natural or recycled plastic fibers. This goal is being pursued through collaborative and complementary research at the University of South Carolina, University of Nebraska-Lincoln and University of Florida, aimed at: 1) engineering and prototyping stabilized earth blocks and soil mortar, both of which are enhanced through the addition of natural or recycled and non-biodegradable plastic fiber reinforcement; 2) quantifying the enhancement in damage resilience (strength, toughness) for EFREM materials as a result of cement stabilization and fiber reinforcement, and; 3) verifying the structural response of full-scale walls under in-plane, out-of-plane and projectile loads (simulating the impact energy of representative flying debris, which typically cause most of human deaths and injuries). EFREM is envisioned as a novel, affordable and energy efficient system that is engineered for low-income dwellings in rural and remote areas subjected to extreme wind loads.

Other notable efforts including scaling up research in low cost building technologies through a Northwestern University-led proposal "NSF SRN: Sustainability Research Network on Sustainable and Resilient (SURE) Infrastructure Materials – Science, Engineering, Education and Society," which was invited by the NSF for reverse visit. In both NSF proposals, my scope of work focused on investigating hazard resilience of earth-based materials in Tanzania working in collaboration with the National Housing Building Research Association.

Conference papers based on the work have been accepted for presentation in several conferences including the 4th International Network for Tropical Architecture Conference (Singapore), the CIB World Building Congress 2013: Built Environment Research Focused on Social Outcomes (Brisbane, Australia), and the 7th International Structural Engineering and Construction Conference (Honolulu, Hawaii).

The funded research supports three graduate students: Peter Donkor (doctoral student in Design, Planning and Construction); Felicity Amezugbe (pursuing an MSc degree in Building Construction) and Malar Baskaran (MSc student with an expertise in geotechnical engineering).

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