NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE NHERI

APRIL 2017

QUARTERLY NEWSLETTER
NEWS FROM THE NHERI COMMUNITY

CONFERENCES

MAY 1-3, 2017

NSF Large Facilities Workshop
LIGO, Livingston, Louisiana, USA
Sponsored by: NSF Large Facilities Office

MAY 21-24, 2017

13th Americas Conference on Wind Engineering
Gainesville, Florida, USA
Sponsored by: Herbert Wertheim College of Engineering at UFL

JUNE 4-7, 2017

2017 Engineering Mechanics Institute Conference
San Diego, California, USA
Sponsored by: ASCE Engineering Mechanics Institute

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INSIDE THIS ISSUE

NHERI@UTexas Microtremor Stations: Revolutionary Work in Garner Valley

Brady Cox and his University of Texas, Austin, team are working to quantify uncertainty in shear wave velocity assessments.

In September of 2016, the group conducted field tests for Project CMMI-1261775, titled PECASE: Revolutionizing Surface Wave Methods for Engineering Analyses - from Deterministic and Incoherent to Probabilistic and Standardized (DIPS).

Between September 25th and 30th, both active-source and passive-wavefield surface wave measurements were conducted at the Garner Valley Downhole Array (GVDA) site in Southern California. Ten broadband (120 s – 100 Hz), three-component Trillium Compact microtremor stations available at NHERI@UTexas were deployed for the passive surface wave measurements.

COLLECTING DATA

The goal of the study is to characterize the shearing stiffness of both near-surface (top several meters) and deep (down to several hundred meters) materials in the vicinity of existing surface and borehole accelerometers.

These accelerometers have recorded numerous ground motions and can be used to compute how ground motions recorded within bedrock are amplified or attenuated by the overlying soils as they travel to the surface.

With a robust characterization of the shearing stiffness profile down to bedrock, the frequency-dependent amplification or attenuation can also be predicted using seismic site response analyses and the results compared to the measured ground response.

Continued on page 7

University of Texas graduate students Andrew Stolte (left) and David Teague making surface wave measurements at the Garner Valley Downhole Array site.

NHERI COMMUNITY

High-Achieving Wind Researcher Elawady joins FIU

Amal Elawady, PhD, is the newest member of the leadership team at the NHERI Wall of Wind Experimental Facility (WOW-EF).

She joins the Department of Civil and Environmental Engineering at Florida International University at the rank of an Assistant Professor. She received her B.Sc. and M.Sc. degrees with distinction from Ain Shams University in Cairo, Egypt, in which she continued as a Demonstrator, a title granted only to distinguished graduates.

Her excellent qualifications were immediately recognized by the leading international consultant firm Dar Group, where she worked as a structural engineer. Her passion for academic research drove her to pursue advanced graduate studies; Western University in Ontario, Canada, was a perfect match to her research interests.

Elawady received her PhD degree from Western University in 2016, with a focus on wind and structural engineering. Her PhD project focused on finding solutions to mitigate the replicated failures of transmission line structures during downburst events.

Amal Elawady, PhD, is the newest member of the leadership team at the NHERI Wall of Wind Experimental Facility (WOW-EF).

A major outcome of her work was the development of velocity profiles and load cases simulating the critical effects of the downburst wind fields on transmission line structures.

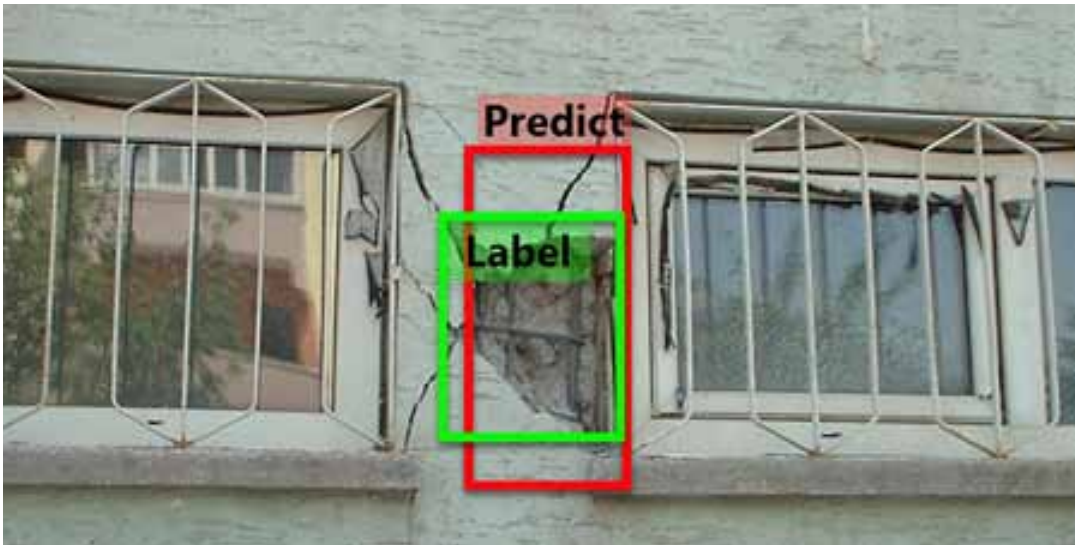
During her PhD, Dr. Elawady worked closely with the ASCE-74 Committee, which develops guidelines for transmission line structures.

A major outcome of her work was the development of velocity profiles and load cases simulating the critical effects of the downburst wind fields on transmission line structures. The proposed approach was recently approved by the committee, which included, in addition to scientists, about 40 practitioners from various utility companies in North America.

As a result of her innovative work, along with the industrial impact of her research, Elawady has received numerous prestigious awards. Among her honors are the distinguished Alan Davenport Award for Excellence in Wind Engineering in 2015 and the Robert Addie Graduate Scholarship in Wind Engineering in 2016.

Internationally, she received the O.H. Ammann Fellowship from the American Society for Civil Engineers (ASCE) for creating new knowledge in the field of High Intensity Wind and infrastructures design and for influencing the codes of practice with new design guidelines.

RESEARCH WORKBENCH



The automated system identifies structural damage on images collected from the 2003 Bingöl earthquake in Turkey. The green box with the tag "Label" denotes a true spalling damage area. The red box with the tag of "Predict" is the estimate provided by the new system. This automated damage assessment system could dramatically reduce the time it takes for engineers to assess damage to buildings after disasters. (Image source: DataHub.)

Purdue Research Aims to Accelerate Disaster Reconnaissance Data Use

To streamline the grueling task of post-disaster data collection and organization, Purdue researchers seek to use computers to automate the process.

Shirley Dyke, Purdue Professor of Civil and Mechanical Engineering, and Chul Min Yeum, post-doctoral researcher, are developing deep learning algorithms to classify images and identify regions of concern.

"Rather than having teams spend several hours trying to organize their data and figure out how to collect essential data during the next day, we'd rather enable doing this automatically and rapidly with our algorithms," Dyke says.

"We want to automatically determine if an instance of structural damage is there, and understand what additional data should be collected in the affected community. This work will allow teams to collect more data and images, knowing that it can be made available for use."

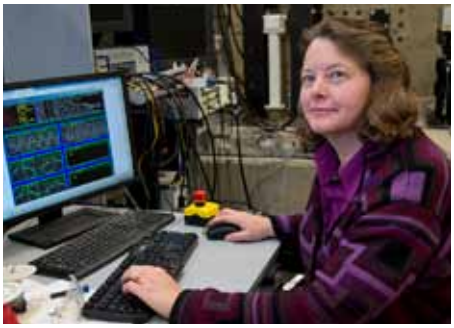
Dyke's project builds on work by Yeum both in computer-vision technologies and deep learning methods. Deep learning draws on neural network techniques and large data sets to create algorithms and design classifiers for assessing the data.

"Deep learning has been applied to many everyday image classification situations, but as far as we know, we're the first to employ it for damage assessment using a large volume of images," Yeum says.

Training the system requires a painstaking process of manually labeling tens of thousands of images from diverse data sets according to a chosen schema. The computer system learns about the contents and features of each class, and then it trains the algorithms to find the best ways to identify the areas of interest.

So far, Dyke and Yeum have gathered about 100,000 digital images for training the system, contributed from researchers and practitioners around the world. Most of these are from past earthquakes, but other hazard images from tornadoes and hurricanes also are collected.

"We will seek opportunities to test our system in the field, perhaps by working with researchers who are examining the tens of thousands of buildings exposed to significant ground motions in Italy in the past months," Dyke says.



Shirley Dyke, professor of Civil and Mechanical Engineering at Purdue, is working on deep learning algorithms to classify images and identify regions of concern. (Photo: Purdue University)

"The classifiers trained using our database of past images would be applied to new images collected on site to directly support teams in the field."

"As we develop the methodologies to automatically organize the data, we are engaging researchers who deal with reconnaissance missions and building codes," Dyke says, "so that these classifiers can be used by people around the world."

Project: CMMI 1608762 CDS&E: Enabling Time-critical Decision-support for Disaster Response and Structural Engineering through Automated Visual Data Analytics

Source: Purdue University

FACILITIES

Discussing a scale model in UF's Terraformer wind tunnel. From left, Ryan Catarelli, PhD student, Forrest Masters, Professor of Civil and Coastal Engineering, and Pedro Fernández Cabán, PhD student.

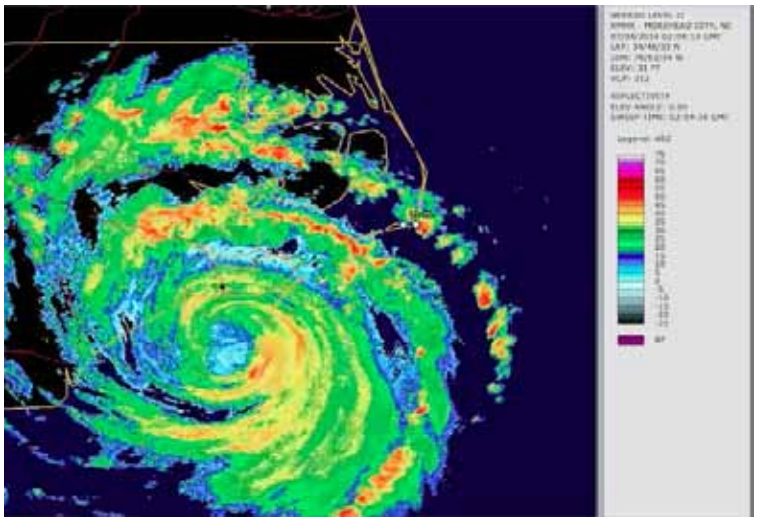
UFlorida's Terraformer on Science Nation

Wind engineer and 13th generation Floridian Forrest Masters knows how to ride out a hurricane. Masters and a team at the University of Florida are developing a world-class facility to help engineers and scientists better understand the high wind storms that batter communities along U.S. coastlines.

Recently, the UF team was profiled in Science Nation, the NSF science news show. The four-minute segment is available at www.nsf.gov/news/special_reports/science_nation/index.jsp

The episode explains research underway at UF and features excellent footage of the Terraformer wind tunnel, which can dial up any type of terrain in 90 seconds, and a second high-speed simulator that can generate winds over 230 miles per hour.

The research in this episode of Science Nation is supported by NSF award #1520843, Experimental Facility with Boundary Layer Wind Tunnel, Wind Load and Dynamic Flow Simulators, and Pressure Loading Actuators.



EDUCATION CORNER

REU Program in Full Swing

By Karina Vielma-Cumpian

The NHERI REU summer program has gained momentum in its inaugural year. The Education and Community Outreach Committee (ECOC), a leadership group of representatives from the ten NHERI equipment sites, worked diligently to plan and organize this year's recruitment, application, and selection process. The ECOC was formed for this purpose and has been instrumental in the success of this year's program.

Karina Vielma-Cumpian Research fellow and education specialist at the University of Texas, San Antonio.

In the fall semester, the committee met monthly to discuss the summer schedules along with drafting and editing recruitment materials. After careful review, the student application went live on the DesignSafe NHERI site in late November and the deadline for submission was extended to March 1st. Applications were distributed to the sites, and currently, a committee from each site is reviewing over 40 applications to select participants for the nine operational experimental sites including:

- Advanced Technology for Large Structural Systems (ATLSS) Engineering Research Center, Lehigh University.
- The Center for Geotechnical Modeling (CGM), University of California-Davis.
- Powell Laboratory (terraformer wind tunnel and full-scale destructive testing for extreme wind events), University of Florida.
- Wall of Wind International Hurricane Research Center, Florida International University.
- Large High Performance Outdoor Shake Table (LHPOST), University of California-San Diego.
- O. H. Hinsdale Wave Research Laboratory, Oregon State University.
- Rapid Response Research Experimental Facility, University of Washington.
- Experimental equipment site for dynamic in-situ testing using large-scale mobile shakers, University of Texas-Austin.
- Computational Modeling and Simulation Center, University of California-Berkeley.
- Cyberinfrastructure and Data Management, University of Texas-Austin.

Students will be notified in late March about their application status and those accepted will begin important processes in preparation for the summer program such as faculty mentor and graduate student mentor matching. The ten-week REU summer program will take place in two blocks; May 29 – August 4 and June 19 – August 25.

NHERI COMMUNITY

Meet the NHERI User Forum

Charged with providing community leadership, facility coordination, and leading education and community outreach activities for NHERI, the Purdue University-led Network Coordination Office (NCO) coordinates and organizes the network's three governance groups: the NHERI Council, the Network Independent Advisory Committee, and the User Forum. As the NHERI community continues with its research and education efforts, these groups serve as guiding forces.

Julio Ramirez, Purdue professor of Civil Engineering and Director of the NHERI NCO

The User Forum, whose membership is now established, is composed of elected members from different specialties within the user community.

The group provides input to the Council on community satisfaction and raises awareness of community priorities and needs. The User Forum works with the NCO to ensure transparent access to the eight NHERI Experimental Facilities, and to develop effective education and community outreach strategies. The group is also directly engaged in developing and updating the NHERI-wide Science Plan.

USER FORUM MEMBERSHIP, YEAR 1:

Earthquake
Erik A. Johnson, University of Southern California

Wind Engineering
Mohamed Elsharawy, Svend Ole Hansen Wind Engineering
Ramtin Kargarmoakhar, T.Y. Lin International

Coastal Engineering
Nina Stark (Vice-Chair), Virginia Tech

Wood Construction
Elaina J. Sutley (Secretary), University of Kansas

Geotechnical
Adda Athanasopoulos-Zekkos, University of Michigan
Russell Green (Chair), Virginia Tech

Steel Construction
James O. Malley, Degenkolb Engineers, San Francisco

Social Sciences & Policy
Liesel A. Ritchie, University of Colorado, Boulder

Details about the User Forum are available on the DesignSafe-CI site.

NHERI COMMUNITY

NHERI Project Awardees : March 2017

FLORIDA INTERNATIONAL UNIVERSITY

Wall of Wind Facility
Experimentally Validated Stochastic Numerical Framework to Generate Multi-Dimensional Fragilities for Hurricane Resilience Enhancement of Transmission Systems, Award 1635569, Abdollah Shafieezadeh, Ohio State University

Uncovering Potential Risks of Wind-induced Cascading Damages to Construction Projects and Neighboring Communities, Award 1635378, Youngjib Ham, Florida International University

Collaborative Research: Progressive Failure Studies of Residential Houses Towards Performance Based Hurricane Engineering, Award 1234004, Steve Cai, Louisiana State University; Arindam Chowdhury, FIU

CAREER: Full-Scale Simulation of Peak Responses to Reduce Hurricane Damage to Low Buildings and Use of Related Research to Develop Hurricane-Engineering Expertise, Award 1151003, Arindam Chowdhury, FIU

Innovative Hurricane Damage Mitigation Systems, Award 1541142, Arindam Chowdhury, FIU

Pervasive Spectrum Sharing for Public Safety Communications, Award 1443999, Kemal Akkaya, Florida International University

LEHIGH UNIVERSITY
Collaborative Research: Semi-Active Controlled Cladding Panels for Multi-Hazard Resilient Buildings
- Award 1463497 – PI James Ricles, Lehigh University; co-PI Spencer Quiel, Lehigh University
- Award 1463252 – Simon Laflamme, Iowa State University

Collaborative Research: A Resilience-based Seismic Design Methodology for Tall Wood Buildings
- Award 1636164 – Shiling Pei, Colorado School of Mines
- Award 1635227 – PI James Ricles, Lehigh University; co-PI Richard Sause, Lehigh University
- Award 1635156 – James Dolan, Washington State University
- Award 1634628 – John van de Lindt, Colorado State University
- Award 1634204 – Jeffrey Berman, University of Washington
- Award 1635363 – Keri Ryan, University of Nevada

OREGON STATE UNIVERSITY
Non-linear Long Wave Amplification in the Shadow Zone of Offshore Islands, Award 1538624, Costas Synolakis, Pat Lynett, University of Southern California, Directional Wave Basin

Nonlinear Long Wave Amplification in the Shadow Zone of Offshore Islands, Award 1538190, James Kaihatu, Texas A&M University, Directional Wave Basin

Fundamental Mechanics and Conditional Probabilities for Prediction of Hurricane Surge and Wave Loads on Elevated Coastal Structures, Award 1301016, Dan Cox, Oregon State University, Large Wave Flume

Probabilistic Assessment of Tsunami Forces on Coastal Structures, Award 1536198, Mike Motley, Randall LeVeque, Frank Gonzalez, University of Washington, Large Wave Flume

Two-Phase Flow Modeling of Wind Influences on Wave Breaking, Award 1436642, Qingping Zou, University of Maine, Large Wave Flume

Numerical and Probabilistic Modeling of Aboveground Storage Tanks Subjected to Multi-Hazard Storm Events, Award 1635784, Jamie Padgett, Rice University, Directional Wave Basin

Physical Modeling of Submarine Volcanic Eruption Generated Tsunamis, Award 1563217, Hermann Fritz, Josef Dufek, Georgia Tech, Directional Wave Basin

Telescopic Structural Flood Walls, Award 1621727, Jorge Cueto, Smart Walls Construction LLC, Large Wave Flume

UNIVERSITY OF CALIFORNIA, DAVIS
Centrifuge
- CPT-Based Characterization of Intermediate Soils, Award 1300518, Ross Boulanger, UC Davis
- Engineering Research Center for Bio-mediated and Bio-inspired Geotechnics (CBBG), Award 1449501, Jason DeJong, UC Davis as sub to Arizona State
- Centrifuge Modeling of Coastal Soil-Structure Instability, Award 1538211, H. Benjamin Mason, Oregon State
- Liquefaction Evaluations of Finely Interlayered Sands, Silts and Clays, Award 1635398, Ross Boulanger, UC Davis
- Collaborative Research: Validation of Constitutive and Numerical Modeling Techniques for Soil Liquefaction Analysis, Award 1635307, Bruce Kutter, UC Davis
- Soil-Foundation-Structure Interaction Effects on Cyclic Failure Potential of Silts and Clays, Award 1563638, Scott Brandenberg, UCLA

UC SAN DIEGO
Collaborative Research: A Resilience-based Seismic Design Methodology for Tall Wood Buildings, Award 1636164, Shiling Pei, Colorado School of Mines

Continued on next page

EXPERIMENTAL FACILITIES

NHERI Project Awardees
Continued

UNIVERSITY OF FLORIDA
BWLT Boundary Layer Wind Tunnel

- MRI: Development of a Versatile, Self-Configuring Turbulent Flow Condition System for a Shared-Use Hybrid Low-Speed Wind Tunnel, Award 1428954, Forrest Masters, University of Florida
- Cyber-physical Systems Approach to the Optimal Design of Structures for Wind Hazards, Award 1636039, Brian Phillips, University of Maryland, NHERI
- CAREER: Behavior of Hurricane Wind and Wind-Driven Rain in the Coastal Suburban Roughness Sublayer, Award 1055744, Forrest Masters, University of Florida
- Collaborative Research: Performance-Based Framework for Wind-Excited Multi-Story Buildings, CMMI 1462076, Ahsan Kareem, Notre Dame, NSF Enhancement Project, supported by NHERI
- Collaborative Research: Performance-Based Framework for Wind-Excited Multi-Story Buildings, University of Michigan, Seymour Spence, Award 1462084, NSF Enhancement Project, supported by NHERI

MAWLS, Multi Axis Wind Load Simulator
Natural Hazards Engineering Research Infrastructure: Experimental Facility with Boundary Layer Wind Tunnel, Wind Load and Dynamic Flow Simulators, and Pressure Loading Actuators, Award 1520843

- Upgrade to Instrumentation, Forrest Masters, University of Florida
- Masonry Demonstration Project Being Filmed for Outreach, Education and Safety Training, H.R. Hamilton, University of Florida

UNIVERSITY OF TEXAS, AUSTIN
- PECASE: Revolutionizing Surface Wave Methods for Engineering Analyses - from Deterministic and Incoherent to Probabilistic and Standardized (DIPS), Award 1261775, Brady Cox, University of Texas, Austin

Revolutionary Work in Garner Valley

Continued from Page 1

This dataset will be used to establish a "site signature" for the GVDA site, which will allow for realistic quantification of shear wave velocity (Vs) uncertainty in seismic site response analyses. It is hoped that more realistic estimates of Vs uncertainty will contribute to better comparisons between calculated and recorded site response at the GVDA.

"Traditionally, surface wave methods (SWMs) have been used to provide a single, deterministic shear wave velocity (Vs) profile for each site tested, without consideration given to uncertainty," Cox says.

"However, as our profession moves toward probabilistic design and performance-based engineering, the inability to quantify uncertainty in Vs from SWMs has been exposed as a major impediment to future progress."

QUANTIFYING UNCERTAINTY
Cox's DIPS plan is revolutionary in its aim to "smooth out the dips" in SWMs, transforming them from deterministic and incoherent to probabilistic and standardized.

The work aims to revolutionize SWMs in two ways: (1) by quantifying uncertainty in Vs profiles derived from SWM's such that suites of acceptable Vs profiles are provided with confidence-intervals on layer thickness and velocity—advancing from deterministic to probabilistic, and (2) developing standards for SWM's applied to solving engineering problems—advancing from incoherent recommendations to coherent standards.

Cox's team is in the process of analyzing the surface wave datasets collected at GVDA. Then, the suites of Vs profiles they develop will be used to perform site response analyses.

Brady Cox, Associate Professor of Civil Engineering, University of Texas, Austin

"Our site response analyses, which contain realistic estimates of epistemic uncertainty and aleatory variability in Vs, will be compared with the recorded site response, which is currently poorly predicted using standard 1D site-response methods and existing borehole Vs profiles," he says.

Cox's work emphasizes the importance of accurate shear wave velocity profiles in earthquake hazard studies. All methods used to measure Vs (both invasive/borehole methods and non-invasive/surface wave methods) contain uncertainty. It should no longer be acceptable for Vs profiles to be reported without accompanying estimates of uncertainty. Otherwise, subsequent analyses will be performed with assumed estimates of uncertainty, which are often not accurate.

Without meaningful estimates of epistemic uncertainty and aleatory variability, a Vs profile used for seismic site response is often varied by +/- 20-30 percent in an attempt to account for these uncertainties.

While performed with the goal of being conservative, this approach may actually be unconservative, as the problem is one of predicting resonances at the site, which may be diluted by such a wide range of input profiles that do not meaningfully represent site conditions.

The dataset will be available from the DesignSafe repository in the near future.

In February, the team at the UC Davis NHERI Centrifuge Equipment Facility had its National Science Foundation Business Systems Review. It was not all business, as the review team took time out for a tour of the facility.

Rear (from left): John Tsitsikaos (NSF), Erica Stein (NSF), Florence Rabanal (NSF), Joy Pauschke (NSF), Ross Boulanger (UC Davis), and Dan Wilson (UC Davis). Front: Donna O'Malley (NSF).

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