DESIGNSAFE-CI
A NATURAL HAZARDS ENGINEERING COMMUNITY
Winter 2016

NHERI NEWS

UPCOMING NHERI EVENTS

Call for Participants for a National Science Foundation Workshop Series
Application materials due by Monday, Dec. 19.
To register click here.

University of California at San Diego Experimental Facilty Workshop. Dec. 14 & 15
Englekirk Structural Engineering Center.

We would love to hear your story suggestions. Email jordan.moss@utsa.edu to share.

Inside this issue...

UC San Diego shakes things up with research

On a recent afternoon, two Jacobs School engineers equipped with 3D glasses stood in front of a towering 12' digital reproduction of a six-story building, projected onto a curved wall of screens. They had tested the building a few weeks before, putting its light-weight steel frame through a series of increasingly powerful earthquake and fire tests on the world's largest outdoor shake table at UC San Diego. Now researchers were zooming in and out of the building's digital twin to assess damage.

This virtual inspection was made possible by data gathered by small drones, which flew around the building, first before the tests to help create a digital, 3D map of the structure, and then during the tests to capture the impact of the earthquake. Finally, after the tests, they took to the sky to look for damage. Researchers used powerful visualization algorithms to turn the data the drones col- lected into an immersive 3D environment. The combination of these unique technologies — a one-of-a-kind shake table and powerful data visualization methods — allows structural engineers at the Jacobs School to get an incredibly detailed digital model of the structures they test. This in turn allows them to make recommendations to improve design methods and building codes around the nation and the world.

"This series of tests is particularly important because, for the first time, we simulated on a shake table an aftershock and main shock occurring after a live fire," said principal investigator and UC San Diego structural engineering professor Tara Hutchinson.

In the past 12 years, many projects have been put to the test on the shake table at the NSF-funded Englekirk Structural

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Researchers at the University of California San Diego prepare for a series of shake table tests deisnged to test the structural integrity of buildings during earthquakes and fires.

Texas demonstrates 3D levee imaging

UT is working to bring levee research into the future

Conference attendees gather around during a demonstration.

The University of Texas is helping to break new ground in natural disaster research. On Nov. 11 in St. Louis, Missouri a workshop was held featuring presentations on equipment and non-intrusive levee imaging.

The workshop featured a demonstration of a proof-of-concept 3D imaging study on the Mel-Price Wood River levee. Equipment was used during the demonstration to collect a dataset of three component, three-dimensional waveforms that can be processed for 3D levee imaging purposes via full-waveform inversion.

To help highlight equipment the urban, mobile, hydraulic shaker Thumper was utilized to generate small-strain dynamic vertical and horizontal loading on the ground surface at many locations on the crest and toes of the levee.

The response of the levee was then recorded using a combination of hundreds of vertical and three-component geophones deployed in a dense grid over the crest, slopes and toes of the levee.

Researchers with ideas that could piggyback on the levee imaging workshop in order to generate preliminary proposal data are encouraged to contact the University of Texas. Please contact Farnyuh Menq (fymenq@utexas.edu), the University of Texas NHERI Site Operations Manager, with any questions regarding the workshop, piggyback proof-of-concept tests, or the equipment facility.

Jupyter Notebooks underscore intitial webinars

DesignSafe hosted three webinars this Fall providing users with hands-on training for how to upload, manage, and analyze their research data using the scientific applications available in DesignSafe's Data Depot and Discovery Workspace within the Research Workbench .

The initial webinars provide foundational training on general use of DesignSafe, the use of MATLAB, and the use of Jupyter Notebooks for both Python and R. The Jupyter Notebook is a web application that allows you to create and share documents that contain live code, equations, visualizations and explanatory text. Many people use Jupyter in a similar fashion as they use MATLAB to analyze and plot their data, with the additional benefit of capturing descriptive text, references, and other important information that might otherwise be written in a lab notebook or a separate text file. We will soon be sharing example Jupyter Notebooks in the Data Depot that users can copy and customize for their research.

The webinar recordings are available online in our Training Archive . In the Spring we will continue the webinar series, starting with an introductory session for researchers that are new to DesignSafe along with some sessions on advanced topics to explore more in-depth use cases of DesignSafe for natural hazards engineering research.

Allocations policy for high performance computing

DesignSafe Allocations Policy for Access to High Performance Computing Resources

DesignSafe's Discovery Workspace provides access to many scientific applications supporting natural hazards engineering research that use the high performance computing resources at the Texas Advanced Computing Center (TACC). A modest amount of computing time is allocated to each DesignSafe user for scientific codes such as ADCIRC, OpenSEES, OpenFOAM, and others. Users requiring additional computing time with access to a larger number of processing cores or more data storage may submit allocation requests per our Allocations Policy . The DesignSafe project team will work with researchers to determine the optimal approach to meeting your computing and storage needs while maintaining the data sharing, discoverability, and reuse advantages of the Data Depot.

UW RAPID kicks into high gear

When natural disasters happen, there is a small window to collect valuable data that could save future lives, and The University of Washington NHERI RAPID team is working to make sure this data gets collected.

Joe Wartman, H.R. Berg Associate Professor of Geotechnical Engineering at the University of Washington, is helping the RAPID team get off the ground.

"We just got started in September (2016)," Wartman said. "Unlike the other experimental facility we are getting built from the ground up. Our timeline for year one is set around developing our science plan."

The goal of the science plan is to help Wartman and the RAPID team gain a better idea of what kind of data they need to be collecting in the field. According to Wartman the science plan will help answer to key questions for the RAPID team moving forward. The first is what are the key data gathering needs and opportunities in wind and seismic disasters. The second is what kind of hardware and software instrumentation tools will RAPID need. A community input workshop to develop science plan is currently in the planning stages.

"A science plan can be used in different ways by different groups," Wartman said. "Researchers can look at it and develop research plans to address the issues that we encounter. In five years, the science plan will help us see what we have accomplished."

Joe Wartman is working the next two years getting the UW RAPID team ready. The team will be ready in Sept. 2018.

While still in year one, Wartman says the team is focusing on using the science plan to determine what kind of equipment they will need moving forward. Year two will be spent gathering and calibrating all the equipment, and year three will see the RAPID team fully operational.

Wartman and the RAPID team face a unique set of challenges compared to other NHERI facilities. Being a response-based team, the unit will have to be prepared to go whenever a disaster strikes in order to avoid the loss of valuable data. While the science plan will help the RAPID team quickly plan, Wartman says there are a lot of other factors to consider before they deploy that will be unique to each disaster.

"You have to stop and ask, 'Hold on what's happened?' " Wartman said. " 'What's been affected? What reports are we seeing? Is it safe to go at this point in time? Are there live power lines down? Is it overseas?' We never want to get in the way of rescue and recovery units either. The data is perishable, though, so we will have to move quickly."

For Wartman, the fully operational stage of the RAPID team in 2018 can't come fast enough.

"I've done work with the Network for Earthquake Engineering Simulation (NEES) and we learned a lot but nothing is ever as rich and complex as the real world, Wartman said. "When a disaster strikes you have full-scale living lab. It's extraordinary to go in and learn how systems function. The recon findings are of great value in a limited amount of time and often on a smaller budget. You learn fundamental things that might inspire follow up work in the labs. We are the only facility in world that does this."

For more information on the University of Washington RAPID team please visit https://rapid.designsafe-ci.org.

Wall of Wind blows researchers away

Florida International University recently had a chance to blow perspective researchers away. FIU hosted its 2016 National Science Foundation NHERI Wall of Wind Experimental Facility User Workshop on Nov. 18. The goal of the workshop was to spread the word to people in the engineering community about the facilities capabilities and the work being done there.

Arindam Chowdhury, director of the laboratory for wind engineering at the FIU International Hurricane Research Center and associate professor in the civil and environmental departments at FIU, was thrilled to show off the wall of wind.

"It was a great opportunity to show what our facilities are capable of," Chowdhury said. I think they really got to learn a lot from the wall of wind doing hands on experiments. Seeing it in person is a totally different thing than seeing videos or pictures."

The workshop kicked off with a tour of the Wall of Wind facility. Attendees were shown the facilities and introduced to some of the research that has been ongoing at the Wall of Wind. Chowdury feels that many left with a good idea of the types of research they could do at the facility.

"We got a good indication of who is interested in what proposals in the near future," Chowdhury said. "It was very productive."

While the Wall of Wind largely focuses on wind research Chowdhury believes that the work being done at the wall could be applied to other areas of research as well.

"It is definitely possible to apply some of the stuff we learn to earthquake scenarios," Chowdhury said. "I saw many people from the other (research) communities that are interested in doing some wind research as well."

The conference also covered a variety of other NHERI areas. Among the items covered was a detailed explanation of the process for accessing National Science Foundation (NSF) funding for the use of the NHERI Wall of Wind facility.

"We distributed the pamphlets and talked about the rates so they would know what we are capable of," Chowdhury said. "We also got to talk about the unique capabilities of the Wall of Wind and has the opportunity to show some examples of projects being conducted here."

> "If anyone wants to diversify and do multi-hazard testing this is the place to come to."
>
> - Arindam Chowdhury

The Cyber Infrastructure (CI) team from the University of Texas made an appearance at the conference via an online presentation. The CI team went over the process for data storage and curation as well as cyber security aspects of the NHERI grant.

"We had an internal presentation form our cyber presence," Chowdhury said. "It helped show how people from far away can watch the tests being run here and view the data that we are working to collect."

With much of NHERI focused on earthquake research the Wall of Wind hopes to expand and grow the wind hazard research community. Like other NHERI facilities the ability to collaborate is a huge asset for the Wall of Wind. By having multiple institutions being able to work together the research possibilities grow.

Later in the afternoon the conference attendees were split up into three different groups to discuss the future of NHERI.

"We had three groups and moderators that spoke to the groups about how we can improve NHERI as well as future project ideas," Chowdhury said. "This discussion included ideas for the non-wind facilities."

Overall Chowdhury feels the conference went very well and will help to further the awareness of the Wall of Wind and the future of wind based research.

"We had a forum and it indicated that there are people interested in submitting a proposal or setting up a conference," Chowdhury said. "We got interest from several potential users. If anyone wants to diversify and do multi-hazard testing this is the place to come to."

Confrence attendees look on during a tour of Florida International University's Wall of Wind experimental facility.

Education Corner

University of Washington looks at seismic events in the Pacific Northwest

The state that comes to mind the most often when people think of earthquakes in the United States is California. In comparison to The Golden State, the Pacific Northwest region remains largely unprepared for "the big one" and at the University of Washington, engineers are working to develop solutions to potential problems caused by seismic events. By working to improve the resilience of buildings, bridges and other structures, researchers hope to find ways to minimize the damage in the event of an earthquake.

In this lecture by Jeffery Berman, associate professor of civil and environmental engineering at the University of Washington, you can learn about earthquake hazards in the Pacific Northwest and examine the structural engineering technologies that enable quicker and more efficient post-event repairs.

Check out Doctor Berman's full lecture on seismic events in the Pacific Northwest on YouTube by clicking here.

"The seismic hazard of Seattle is unique," Berman said. "Earthquakes occur less frequently and the faults of the region are not as well understood as the faults in California."

Know your ECO

Connecting members of the education and science communities is the primary mission of the ECO.

With all the exciting work being done at NHERI sites across the country, somebody has to help spread the word. That's where the NHERI Education and Community Outreach (ECO) committee comes into play.

The ECO has a representative at each NHERI site. ECO team members all combine their efforts into the planning and strategic actions that NHERI as a whole takes. They also help report the educational activities that are happening at their sites.

One such ECO committee member is Karina Vielma-Cumpian, a research fellow and outreach specialist at The University of Texas at San Antonio. Vielma-Cumpian says the scope of the ECO covers all levels of education.

"It (ECO) encompasses all educational activities that connect the research to the practice," Vielma-Cumpian said."We have K-12 outreach and that's important to keeping kids motivated to go into STEM fields," Vielma-Cumpian said. "At the undergrad level, we have wcompetitions and the research experience for undergraduate students (REU). Then we have the graduate students who act as mentors to the undergraduate students. We also have graduate students that will be participating in the summer institute."

Vielma-Cumpain thinks that the connections being made will postitvely impact the field and future STEM students.

"I think the engineering world has room for everyone to do something," Vielma-Cumpian said. "It's just a matter of making those connections to students."

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Continued from front

Engineering Center — everything from wind turbines, to parking garages, to one-story masonry structures and six-story concrete buildings.

Back in 2011, Hutchinson assembled a team of engineers to test the safety of a five-story building's nonstructural components — elevators, stairs and facades. Those tests resulted in new building design requirements and new construction methods — and will likely yield more insights in coming years.

More recently, researchers tested different ways to retrofit wood-frame soft-story structures, which feature large open spaces on the first floor. The series of tests was critical to an initiative to seismically retrofit about 6,000 of these buildings in California alone.

"Earthquake engineering is very important for society because engineers help lessen the number of deaths in earthquakes and decrease disruptions on society," said Joel Conte, a professor of structural engineering and the principal investigator on the Jacobs School's shake table. The facility has made a significant impact on building design and codes, he said.

Hutchinson's latest $1.5 million project is a good example of the facility's mission. It is supported by a coalition of government agencies, foundations and industry partners including the U.S. Department of Housing and Urban Development, the California Seismic Safety Commission and partners from the steel industry and insurance companies. The researchers received approximately $1 million in in-kind donations from industry partners to build and outfit the structure.

The building's architectural layout was designed to replicate a multi-family residential condominium or apartment building at full scale. But in this case, engineers were pushing the limit of structural height, erecting the building 64 feet above the shake table. The largest building of this construction type tested before was a two-story residential structure. Testing a building at full scale is important because certain failure mecha- nisms can't be reproduced when structures are scaled down, said Conte. In this recent experiment, engineers were trying to find out how a mid-rise building made of cold-formed steel framing would perform during an earthquake and a post-earthquake fire. The answer is that it did well after going through the seismic tests. "The building could have been easily repaired," Hutchinson said. "The occupants would have gotten out safely."

Hutchinson believes that it's likely because the structure is lighter than a concrete building of the same height and as a result has less mass to generate damaging forces.

The fire tests however were less kind to the structure, which was equipped with few fireproof materials and fire-stop systems. Researchers led by Brian Meacham, a professor at the Worcester Polytechnic Institute, ignited pans of heptane, a liquid fuel, in eight rooms on the building's second and sixth floors to achieve temperatures as high as 1000 degrees Celsius (almost 1800 degrees Fahrenheit) within the seismically damaged rooms. Doors fell off their plastic hinges, which melted. Several of the researchers' video cameras, installed to record the fire's progression, suffered a similar fate. Finishing materials detached from ceilings and walls. The simulated earthquakes occurring after the fire tests further weakened some of the structure's floors, bringing them close to collapse.

The building's performance was captured by an extensive array of more than 250 analog sensors, as well as digital cameras — and of course, by drones. The drones, operated by the research group of professor Falko Kuester, took 4K video footage of the building during each of the tests as well as hundreds of high-resolution images, before and after.

"We used the drones to get the right sensor to the right location at the right time," Kuester said. He and his team then compiled the data into high-resolution 3D models consisting of billions of data points, called point clouds.

Hutchinson, Conte and colleagues navigated through the point clouds together using the tall, curved display environment called the WAVE (for Wide-Angle Virtual Environment). The WAVE is a Holodeck-like environment that allows the viewer to step into a virtual recreation of the research. An array of 35 monitors that ends in a crest above viewers' heads and a trough at their feet, the WAVE fills a person's field of view for 180 degrees at the vertical and 160 degrees at the horizontal. If you are wearing special 3D glasses, the display can also tell where you are looking and adjust the images it shows accordingly. Users can step back to study the entire structure and then zoom in to see the tiniest details, such as cracks and changes in shape and color.

"This is big VR for big data and big science," Kuester said.

The WAVE and its software allow researchers to travel through space and time to explore how structures have changed and how they have been damaged by natural disasters such as earthquakes.

At the same time, the shake table allows researchers to gather baseline data before and right after an extreme event, an opportunity that they wouldn't have in real life.

"We'll then have high definition data from before, during and after the test, which was never available before," Kuester said.

The next step for engineers is to look closely at this data and produce a series of technical reports and scientific papers — a process that could take a year or so.

UC San Diego's shake table is funded by a $5.2 million grant from the National Science Foundation. The facility is part of the NSF's Natural Hazards Engineering Research Infrastructure — a network of state-of-the- art research facilities and tools designed to better understand and prevent earthquakes as well as wind and water hazards.

Recent NHERI grant awardees

All awards are funded by the National Science Foundation.

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Large-Scale, Multi-directional, Hybrid Simulation Testing Capabilities
James Ricles (Principal Investigator)
Richard Sause (Co-Principal Investigator),Lehigh University
Award amount: $3,040,268.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Geotechnical Centrifuges
Ross Boulanger (Principal Investigator)
Bruce Kutter (Co-Principal Investigator)
Daniel Wilson (Co-Principal Investigator), UC Davis
Award amount: $2,914,099.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Large Wave Flume and Directional Wave Basin
Daniel Cox (Principal Investigator)
Christopher Higgins (Co-Principal Investigator)
Pedro Lomonaco (Co-Principal Investigator), Oregon State University
Award amount: $1,451,079.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Large, Mobile Dynamic Shakers for Field Testing
Kenneth Stokoe (Principal Investigator)
Brady Cox (Co-Principal Investigator)
Patricia Clayton (Co-Principal Investigator), University of Texas at Austin
Award amount: $1,475,349.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infra structure: Experimental Facility with Large, High Performance, Outdoor Shake Table
Joel Conte (Principal Investigator)
Tara Hutchinson (Co-Principal Investigator)
P. Benson Shing (Co-Principal Investigator)
Gilberto Mosqueda (Co-Principal Investigator)
Yael Van Den Einde (Co-Principal Investigator), University of California-San Diego
Award amount: $2,114,868.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Boundary Layer Wind Tunnel, Wind Load and Dynamic Flow Simulators, and Pressure Loading Actuators
Forrest Masters (Principal Investigator)
H. Hamilton III (Co-Principal Investigator)
Jennifer Rice (Co-Principal Investigator)
David Prevatt (Co-Principal Investigator)
Kurtis Gurley (Co-Principal Investigator)
University of Florida
Award amount: $1,508,392.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Twelve-Fan Wall of Wind
Arindam Chowdhury (Principal Investigator)
Peter Irwin (Co-Principal Investigator)
Ioannis Zisis (Co-Principal Investigator)
Florida International University
Award amount: $1,639,835.00
Start Date: January 1, 2016 End Date: December 31, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Network Coordination Office
Julio Ramirez (Principal Investigator)
Antonio Bobet (Co-Principal Investigator)
Billy Edge (Co-Principal Investigator)
JoAnn Browning (Co-Principal Investigator)
Delong Zuo (Co-Principal Investigator)
Purdue University
Award amount: $4,100,000.00
Start Date: July 1, 2016 End Date: June 30, 2021 (Estimated)

Natural Hazards Engineering Research Infrastructure: Post-Disaster, Rapid Response Research (RAPID) Facility
Joseph Wartman (Principal Investigator)
Michael Olsen (Co-Principal Investigator)
Jennifer Irish (Co-Principal Investigator)
Scott Miles (Co-Principal Investigator)
Jeffrey Berman (Co-Principal Investigator)
University of Washington
Award amount: $792,088.00
Start Date: September 1, 2016 End Date: August 31, 2021 (Estimated)

Natural Hazards Engineering Research Infrastructure: Cyberinfrastructure
Ellen Rathje (Principal Investigator)
Jean-Paul Pinelli (Co-Principal Investigator)
Daniel Stanzione (Co-Principal Investigator)
Jamie Padgett (Co-Principal Investigator)
Clinton Dawson (Co-Principal Investigator)
University of Texas at Austin
Award amount: $8,000,000.00
Start Date: July 1, 2015 End Date: June 30, 2020 (Estimated)

Natural Hazards Engineering Research Infrastructure: Computational Modeling and Simulation Center
Stephen Mahin (Principal Investigator)
Ahsan Kareem (Co-Principal Investigator)
Gregory Deierlein (Co-Principal Investigator)
Laura Lowes (Co-Principal Investigator)
Camille Crittenden (Co-Principal Investigator)
University of California-Berkeley
Award amount: $4,200,000.00
Start Date: October 1, 2016 End Date: September 30, 2021 (Estimated)

NHERI research in action

Student researchers work on a centriguge at the Center for Geotechnical modeling at The University of California at Davis. Current experiments at UC Davis are focusing on soil structure and soil liquefaction.

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