NHERI Natural Hazards Engineering Research Infrastructure

QUARTERLY NEWSLETTER
NEWS FROM THE NHERI COMMUNITY
SUMMER 2019

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COMING EVENTS

July 22 – 26
SimCenter Programming Bootcamp UC Berkeley Richmond Field Station

July 23 - July 26
NHERI RAPID Facility 2019 Intensive Workshop
Seattle, Washington

July 29 - July 31
9th International Conference on Simulation and Modeling Methodologies, Technologies and Applications (SIMULTECH 2019)
Prague, Czech Republic

July 31 - August 1
OSU & RAPID Joint Facilities Workshop
Corvallis, Oregon

Sept 23 - 24
Lehigh, UC San Diego, Berkeley SimCenter Joint Facilities Workshop
Bethlehem, PA

Oct. 14 -15
Tornado Hazard Wind Assessment and ReducTion Symposium, THWARTS
Champaign, Illinois

Dec. 16 - 17
Lehigh, UC San Diego, Berkeley SimCenter Joint Facilities Workshop
San Diego, CA

FOLLOW US AND JOIN THE NATURAL HAZARDS ENGINEERING COMMUNITY!

DESIGN SAFE RADIO

DesignSafe: The Platform for Natural Hazards Engineering Data

NSF-funded cyberinfrastructure has become the premier source for NHE data

Natural hazards researchers may recall a time when experimental, simulation and field research data sets were like footnotes to papers published — useful but definitely secondary.

Today, thanks to advances in technology and the crusade to reuse results, data sets can be as valuable as the papers themselves — requiring their own permanent landing page on the web and a Digital Object Identifier, or DOI. In fact, more and more journals require authors to reference the datasets they generate through a citation, including a DOI.

THE DOI FOR CAREER-BUILDING

In her career as a data curator, Maria Esteva has witnessed the growing importance of publishing data. In her work with the NSF-funded NHERI award and its DesignSafe cyberinfrastructure, she notes that funding agencies are setting greater value on published research products that applicants show in their resumes, making those data DOIs increasingly valuable for career advancement.

“Simply put, a published data set is evidence of your work,” Esteva says. “When researchers reference a data DOI in their papers, they can get more citations. Plus, they can market and distribute their data easily, by using the DOI in social media or when communicating with colleagues.” In her capacity working with natural hazards researchers, she also emphasizes the educational value of data publishing.

Maria Esteva, Research Associate/Data Archivist, University of Texas, Austin Texas Advanced Computing Center / Natural Hazards Engineering Research Infrastructure

“Through DesignSafe we make natural hazards engineering data available for the world to see,” she says. “DesignSafe’s DataDepot is where your peers can come to find, preview, and reuse data — so that they can enhance their knowledge about what’s being done in NHERI’s experimental facilities.”

IMPORTANCE OF PUBLISHING DATA

For instance, Erica Fischer, assistant professor of civil and construction engineering at Oregon State University, does damage reconnaissance after natural disasters. She co-chairs the Earthquake Engineering Research Institute (EERI) Virtual Earthquake Reconnaissance Team (VERT), which shares all its data products on DesignSafe.

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Fischer says sharing that data via DesignSafe allows reconnaissance teams to improve the quality of their work based on empirical evidence of knowledge gaps and then benchmark that research on real-life situations.

"After a disaster, VERT publishes a report on DesignSafe within 48 hours. We provide a high-level overview detailing the performance of community infrastructure — including hospitals, transportation networks, applicable codes, geotechnical failures and many other topics," Fischer says. "By sharing this data with the DesignSafe community, we know we are providing the information that researchers and institutions can use for making informed decisions on how to respond."

CURATING NATURAL HAZARDS DATA

Using DesignSafe's interfaces, researchers can manage the entire lifecycle of their data, Esteva explains. They can simultaneously work on computational research, curate, or explore, and reuse their data or data from other publications.

For researchers, curating data entails tasks such as selecting, categorizing, describing and relating data using one of five data models suitable to their research method. Once a data set is curated, the DesignSafe interface guides researchers through the publishing steps— including reviewing the data and its description, assigning authorship, licensing the data and requesting a DOI.

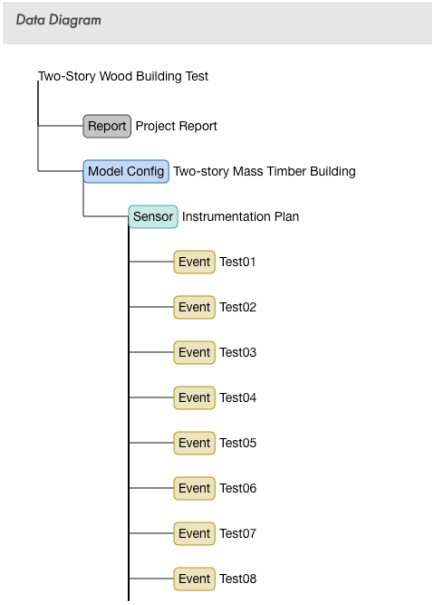
Naturally, natural hazards research can produce enormous and complex data sets. The publication landing page, the DOI, provides different ways to access and navigate such data, including a tree representation showing the different data and documentation components of a research project and how they relate.

CURATING RECONNAISSANCE DATA

OSU's Fischer confirms the importance of providing shared data. "Just as real disaster scenarios cannot be timed or planned, laboratory testing is expensive and time consuming," she says.

An experimental project in the Data Depot. From the landing page (above), users can explore the files within each of the dataset components. The tree view (below) provides the compete structure of the dataset.

Having access to numerical models is necessary for researchers to perform simulations of laboratory tests or community-level performance, Fischer says. Without that data to benchmark numerical modeling techniques, simulations are simply not possible. "Sharing of laboratory testing data is crucial; it allows other researchers to build off of laboratory tests to investigate the influence of other parameters."



A FLEXIBLE DATA PLATFORM

Esteva and the DS team enable researchers to curate data in a way that is not overly complex, but still sophisticated enough to show consistent, clear, and accurate data representations of their work.

"Within DesignSafe, researchers have a lot of freedom to publish their data as they see appropriate," Esteva explains. "Users can arrange the data in different ways and decide what files they want to publish to the world. But there is some structure to it, which helps make the data reusable."

Recreating Tsunamis Triggered by Underwater Volcanoes

To obtain vital data, NSF-funded research simulates volcanic, submarine-generated tsunamis

On December 22, 2018, the Indonesian island-volcano Anak Krakatau erupted, including a violent submarine eruption from its main conduit. More than two-thirds of the volcano collapsed into the sea, resulting in a tsunami that killed more than 400 and injured more than 14,000.

Today, researchers lack critically important data about tsunamis generated by underwater volcanoes. Although relatively rare, submarine volcanic eruptions lead to large and sudden displacement of water or slope failure — which cause tsunamis.

Hermann Fritz, professor at the Georgia Tech School of Civil and Environmental Engineering, aims to provide this missing data. And he is doing it by designing his own tsunami generation machine and creating his own tsunamis in Oregon State University's Hinsdale wave basin laboratory, an NSF-funded NHERI experimental facility.

Fritz's NSF-funded work is particularly appealing in light of several recent volcano-related tsunamis in the Ring of Fire region, including Anak Krakatau. "The processes in that eruption are not exactly the same as the scenarios we created," says Fritz. But there are parallels, he says.

"Ours is a unique application because we did not use the wave basin traditionally," Fritz says. "We basically installed a tsunami wave generator on the basin floor."

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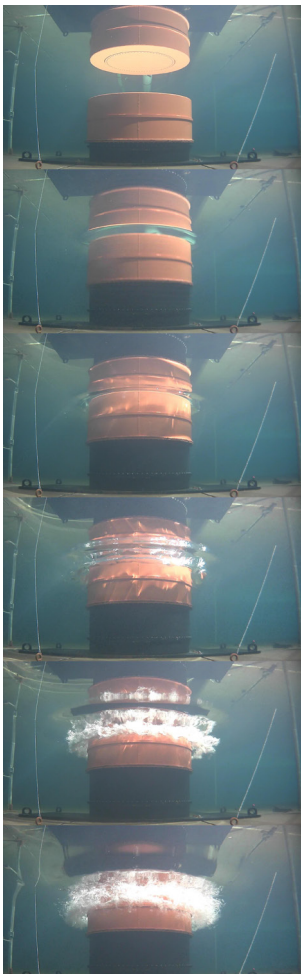
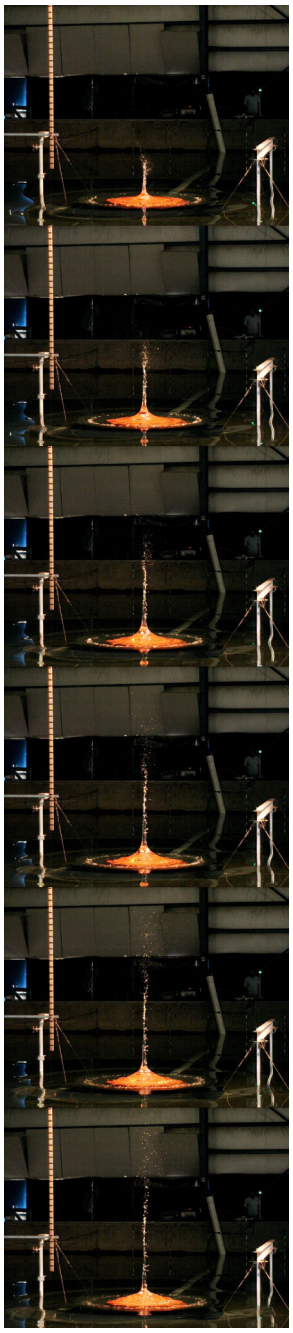
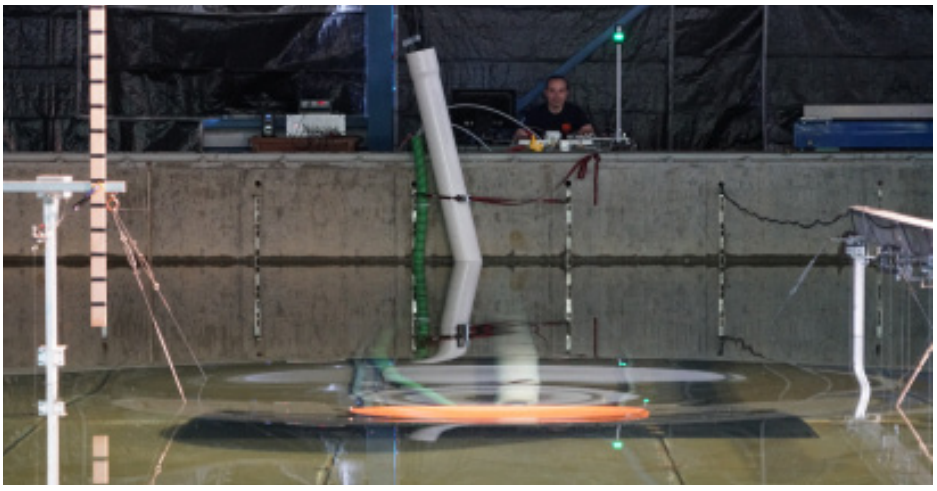


Underwater video time-series (top to bottom) of volcanic tsunami generator punching/ erupting through the water surface with depth of 0.97 m and launch pressure of 145 psi (10 bar). Note the total reflection of the VTG on the water surface (Photo: Yibin Liu, Georgia Tech).



Video time-series (top to bottom) of surface spike above the submerged VTG with water depth of 1.17 m and a launch pressure of 130 psi (Photo: Yibin Liu, Georgia Tech).



The volcanic tsunami generator on the basin floor launched by Fritz at the pneumatic control stand. (Photo: Angela Del Rosario, REU).

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Working with an engineering firm to fabricate the device, Fritz and his team designed an underwater volcano that could send a vertical column of water up through the water's surface to cause a big displacement — so he and his team could record and study the processes of submarine-generated tsunamis.

In over 300 experiments with his custom-built volcanic tsunami generator, Fritz and his graduate student Yibin Liu simulated different types of volcanoes, and they measured 3D velocities and surface elevation around the volcano – as well as runup on the shoreline.

The team captured underwater and overhead video. In addition, Fritz's collaborators at University of Oregon and Texas A&M Galveston performed hybrid modeling of 3D submarine volcanic eruption tsunami-generation scenarios.

Although earthquakes cause most tsunamis, recent events in the Ring of Fire show that it is vital to understand the kinds of underwater eruptions and landslides that cause tsunamis.

Data from this work will help researchers understand how tsunami waves propagate from such an eruption and, perhaps more importantly, validate and improve prediction models.

"The wave characteristics could be potentially quite different for submarine volcanic eruptions. Some of the models that have been in operation have been very well established for tsunami warning purposes for earthquakes, but their associated tsunamis may not be directly applicable."

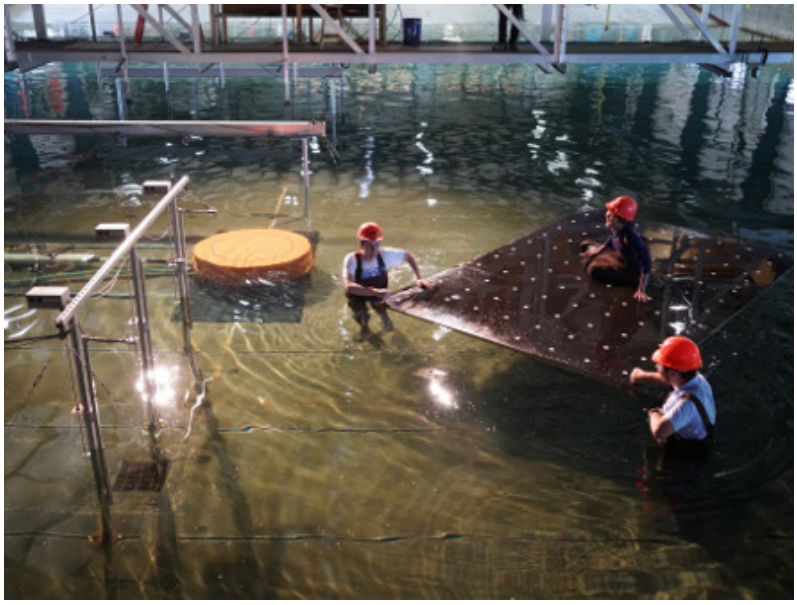
"It's very hard to determine the size of a potential tsunami generated by a submarine volcanic eruptions," Fritz says. "So that is our challenge, to characterize these tsunami waves."

Data from Fritz's experiments may help coastal communities modify their warning systems to account for these unusual, but deadly, natural hazards.

Fritz's long-term goal is to transform the field's assessment and mitigation of submarine volcanic tsunamis.

Award Abstract #1563217
Collaborative Research: Physical Modeling of Submarine Volcanic Eruption Generated Tsunamis

Hermann Fritz explains tsunami generation to Oregon State University's STEM Academy Middle School ECamp. (Photo: Angela Del Rosario, REU)



NSF REU students have fun rafting/floating the dotted calibration board on top of the submerged orange volcanic tsunami generator. The calibration board is used for the stereo, video-based, 3D surface reconstruction. (Photo: Hermann Fritz, Georgia Tech)

Data from this work will help researchers understand how tsunami waves propagate from such an eruption and, perhaps more importantly, validate and improve prediction models.

In Earthquake-Prone Regions, What Makes for a Resilient Home?

American and Japanese earthquake engineers perform full-scale shake tests on multi-story, wood-frame buildings

Earthquakes are a defining force of nature in places like Japan and the West Coast of the United States. Earthquake engineers not only want to prevent billions of dollars in property-damage; they want to ensure residents in earthquake-stricken regions can return to their homes as quickly as possible.

With residential resilience in mind, a team of NSF-funded researchers participated in shake table experiments on two full-scale wood-framed buildings at the world's largest shake table, E-Defense, in Miki, Japan. Team leader for the U.S., Maria Koliou, assistant professor in the Zachry Department of Civil and Environmental Engineering at Texas A&M University, says that the resulting data provides new insights about building and repairing such structures – with the goal of swift residential reoccupation.

"This research provides a unique set of data on the performance of wood-frame structures and non-structural elements within them under strong earthquakes. We used the advanced monitoring equipment from the NHERI RAPID facility at the University of Washington within a well-controlled laboratory environment," Koliou says. "This allowed us to identify damage patterns, perform measurements, and see how damage occurs and propagates in these structures."

SHAKE TESTS AT E-DEFENSE

The researchers performed shake tests on two wood-frame buildings under varying conditions to the respective foundations: one on a base isolation system and the other on a fixed foundation. The latter was equipped with a soil box, which simulated soil-structure-interaction effects of earthquakes.

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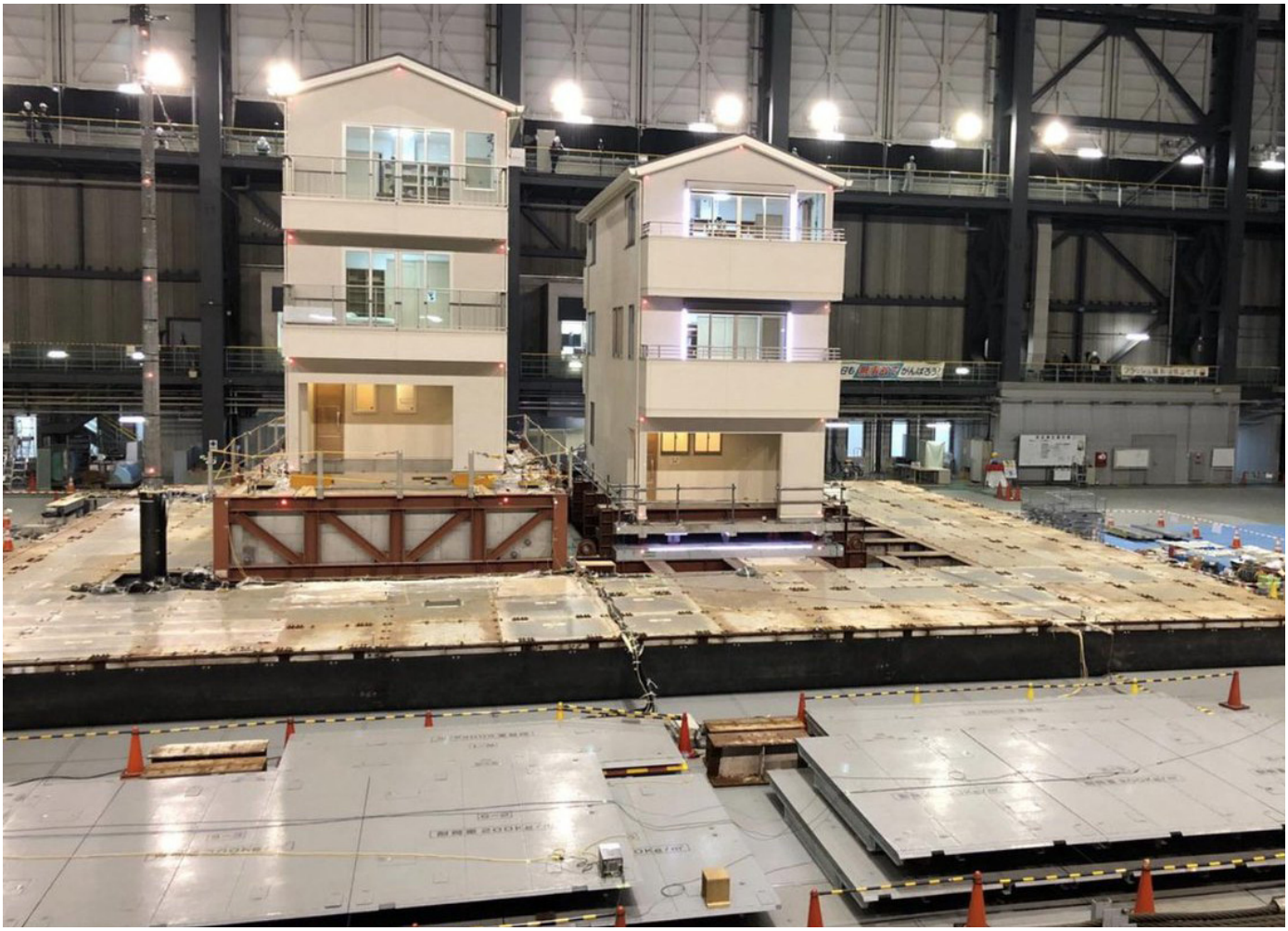

At Japan's E-Defense facility, the experimental wood-frame structure on the left rests on a standard foundation, in a soil-box; the structure on the right rests on a base-isolation system. This video of a simulated earthquake reveals a significant difference in seismic performance: https://vimeo.com/330801828 Note the damage to non-structural elements. (Video: Texas A&M)

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The soil box also allowed researchers to see the interaction of non-structural components, such as pipes, during earthquakes. In homes without resilient lifeline utilities, residents are unable to move back into their homes — even if the structure has minimal structural damage.

KEY DATA GLEANED

The preliminary data from these tests has provided insight into how wood-frame structures perform during an earthquake and can be used as a foundation for key actions.

One is the verification and validation of existing analytical models related to the seismic response and retrofit of wood-frame buildings.

The data also will inform a post-earthquake functionality-and-recovery framework based on damage assessment and homeowner decision-making choices, such as seismic retrofits, including variables such repair times and repair costs.

With the tests now complete, the team plans to host an expert panel that includes collaborators from Japan and leading experts from the U.S. from a variety of technical areas.

“This panel will help us identify similarities of damage patterns and structural performance between the U.S. and Japanese structures for wood residential construction,” Koliou says.

“We are interested in identifying how similar the construction and damage would be in the U.S. urban environment. We also want to identify restoration times and associated costs for resilience-assessment studies.”

PROJECT IMPACT

By studying the seismic performance and system interdependencies for wood-frame buildings, and restoration/retrofit interdependencies and efficiency, this study will help policymakers in the United States, Japan and other countries to establish methods and processes to integrate resilience into their infrastructure planning and strategic investment efforts for urban residential areas.

Structural and non-structural damage to a wood-frame structure. (Photo: Maria Koliou)

The work is a collaborative effort between Japan’s National Research Institute for Earth Science and Disaster Resilience (NIED) and National Science Foundation (NSF). Koliou’s Rapid Response research project is part of the NSF-funded Natural Hazards Engineering Research Infrastructure (NHERI).

Award Abstract #1829433 and #1829412
RAPID/Collaborative Research: Japan-U.S. Collaboration on the Seismic Resilience of Wood-frame Building Systems

Maria Koliou
Assistant Professor
Zachry Department of Civil and Environmental Engineering
Texas A&M University

REU SUMMER PROGRAM UNDERWAY

On behalf of the Education and Community Outreach Committee, we are excited to announce the 2019 REU Summer Program.

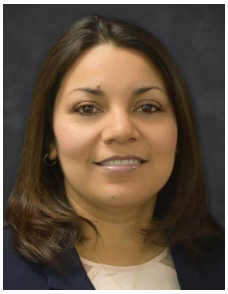
The first block of the NHERI REU program with 19 researchers started on May 28; the second block began June 17, welcoming 12 students to the ten-week summer research program.

During weekly research meetings, the undergraduate students meet remotely to share research experiences.

They will participate in the Natural Hazards Workshop at the University of Colorado-Boulder and present their work.

On August 1-2, all 31 NHERI REU students from the ten affiliated sites will come together at the Research Symposium in Austin, Texas, to present their research, network with one another, and tour the NHERI@UTexas mobile shaker trucks and the DesignSafe computing center.

SUMMER INSTITUTE SUCCESS



Karina Vielma, EdD
NHERI Education and Community Outreach (ECO) Research Fellow and Educational Specialist
University of Texas, San Antonio

On June 5-7, we held another successful NHERI Summer Institute at the University of Texas at San Antonio.

The NHERI NCO funded 21 travel awards for early career faculty and senior-level graduate students to attend the workshop.

The program included presentations from all NHERI sites, the National Science Foundation, CAREER award and CONVERGE.

Overall, we received many positive reviews and look forward to continuing and promoting our educational programs — with the goal of advancing the Natural Hazards Engineering community!

The NHERI SimCenter is hosting four REU students at UC Berkeley this summer. Their research topics represent an expanding field of civil engineering into regional risk, vulnerabilities, and consequences. From left, Ellie Month a rising junior in environmental engineering at Cornell University, Fernanda Breña, a rising senior in civil engineering at Tufts University, Paola Vargas, a senior in environmental engineering at the University of Michigan, and Haley Hostetter, a rising senior in civil engineering at Southern Illinois University. Find out more about their research interests and summer projects at the SimCenter website.

Greetings from the NCO! Spring 2019 was a busy one for the NHERI community. We're pleased that this year we've had the highest number of REU applicants ever; 140 undergraduates applied for our 30 available slots.

Julio Ramirez
Director, NHERI Network Coordination Office,
Karl H. Kettelhut Professor of Civil Engineering,
Purdue University

GOVERNANCE

During the period of reporting, January 1 to March 31, 2019, the NHERI Council continued its practice of monthly meetings. It held meetings on January 10, February 7, and March 7. The approved minutes can be found at the NHERI Council page on DesignSafe.

The second governance group, the community-elected User Forum, has met 21 times since its creation, including face-to-face meetings at the NHERI Summer Institute on July 24 and 25, 2017, and June 4, 5 and 6 of 2018. During this past quarter, the committee met three times: on January 28, February 28 and on March 11, 2019. The approved minutes can be found on the User Forum page.

The third governance group, the Network Independent Advisory Committee (NIAC) did not meet this quarter, but the group did have an in-person meeting during the NHERI Summer Institute, June 5-7, 2019, in San Antonio, TX.

SCIENCE PLAN

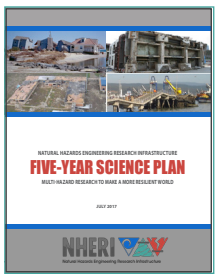
The International Workshop to Develop Research Campaigns, Interdisciplinary Teams and Disruptive Technologies for the NHERI Five-Year Science Plan for Natural Hazards was held March 18-19, 2019, at the Westin-Alexandria, VA. The workshop had two main objectives:

1. Identify the contributions from disruptive/transformational technologies to the NHERI Science Plan to achieve the vision of NHERI, such as:
   - Advanced computational methods and high-performance and real-time computing
   - Data-driven science
   - Robotics
   - Bio-inspired engineering design
   - Additive manufacturing
   - Advanced materials

2. Elucidate potential research campaigns encompassing one or all of the hazards under the scope of NHERI.

During the second day of the workshop more than 70 participants focused on the following themes:

- Earthquake and Related Landslides
- Windstorm Hazards
- Storm Surge and Tsunami Hazards



Attendees convened in breakout sessions and developed examples of research campaigns for inclusion in the NHERI Science Plan — and to potentially pursue proposals to execute them.

The workshop report and presentations from plenary and breakout sessions can be found in DesignSafe-CI Science Plan page on the NHERI Science Plan page.

INTERNATIONAL PARTNERSHIPS

On February 7-8, 2019, the second meeting for NHERI and NIED/E-Defense Collaborative Research on Earthquake Engineering took place in Miki, Japan. The meeting was in conjunction with a full-scale shake table test of wood frame residential construction on the E-Defense shake table.

In this issue of the *NHERI Quarterly*, you can read about the American aspect of the experiment led by Maria Koliou of Texas A&M University (see page 5).

Using equipment from the U of Washington RAPID facility, the team collected data on structural and non-structural seismic performance — with a goal of integrating resilience into urban residential areas.

Northridge earthquake damage (Photo: FEMA)

Tsunami damage (Photo: FEMA)

2019 Q1 Awards

RAPID/Collaborative Research: Data Collection on Wildfire Urban Interface (WUI) for Schools and Hospitals Following the 2018 California Camp Fire
Award Number:1917298; Principal Investigator: Erica Fischer; Co-Principal Investigator: Sara Hamideh; Organization: Oregon State University; NSF Organization: CMMI Start Date: 03/01/2019; Award Amount:$38,110.

RAPID/Collaborative Research: Data Collection on Wildfire Urban Interface (WUI) for Schools and Hospitals Following the 2018 California Camp Fire
Award Number:1917316; Principal Investigator:Hussam Mahmoud; Organization: Colorado State University; NSF Organization: CMMI Start Date: 03/01/2019; Award Amount:$6,120.

Performance-Based Wind Engineering: Stochastic Approximation Algorithms for Wind-Induced Dynamics of Next-Generation Tall Buildings and Tower Structures
Award Number:1852678; Principal Investigator:Luca Caracoglia; Organization:Northeastern University; NSF Organization: CMMI Start Date:05/01/2019; Award Amount:$257,777.

Effect of Heterogeneous Terrain on Wind Loads on Buildings
Award Number:1856205; Principal Investigator: Sungmoon Jung; Co-Principal Investigator: Xiuwen Liu; Organization: Florida State University; NSF Organization: CMMI Start Date:08/15/2019; Award Amount:$451,993.

RAPID: Performance of Reinforced Concrete Structures with Externally Bonded Fiber Reinforced Polymer Composite Retrofits in the 2018 Anchorage, Alaska Earthquake
Award Number:1916972; Principal Investigator: Jovan Tatar; Organization: University of Delaware; NSF Organization: CMMI Start Date:02/15/2019; Award Amount:$39,850.

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