NHERI Natural Hazards Engineering Research Infrastructure

QUARTERLY RESEARCH NEWSLETTER

NEWS FROM THE NHERI COMMUNITY

JANUARY 2021

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COMING EVENTS

DISASTER PRIMR 2021

Texas A&M University
January 31 – February 4, 2021
Virtual event

COASTAL GEOTOOLS

Association of State Floodplain Managers
February 8 – 11, 2021
Virtual event

EERI ANNUAL MEETING

Earthquake Engineering Research Institute
March 23 – 25, 2021
Seattle, Washington
Virtual event

NHERI SUMMER INSTITUTE FOR EARLY CAREER FACULTY

Natural Hazards Engineering Research Infrastructure
June 16 – 17, 2021
San Antonio, Texas

ICONHIC: 3RD INTERNATIONAL CONFERENCE ON NATURAL HAZARDS & INFRASTRUCTURE

Innovation Center on Natural Hazards and Infrastructure
June 22 – 24, 2021
Athens, Greece

FOLLOW US AND JOIN THE NATURAL HAZARDS ENGINEERING COMMUNITY!

FROM THE DIRECTOR

Julio Ramirez, Director NHERI Network Coordination Office

Dear Colleagues,

Despite significant challenges under COVID-19 conditions, all NHERI components have continued to support the efforts of researchers under the restrictions imposed by their institutions to insure the health and safety of all.

I am pleased to note that network efforts in 2020 have been significant, culminating in December with two virtual meetings under the partnerships with EUCENTRE (Italy) and NIED/E-Defense (Japan) attended by almost 150 participants from around the globe.

In another significant achievement in 2020, research highlights from the past five years were showcased in the NHERI Impact 2020 book, published in October. It contains high-impact projects from all NHERI facilities, research that was conducted by faculty at universities throughout the United States.

Last year also saw the publication of the second version of the NHERI Science Plan providing the researchers with a roadmap for research using the NHERI facilities that improves the resilience of our civil infrastructure against earthquakes, windstorms, tsunamis and storm surge.

Besides research support, in the latter portion of the year, NHERI facilities have been active in user outreach and training. Since September 2020 alone, our EFs have offered over two dozen workshops, tutorials, and webinars. Additionally, the NHERI SimCenter stepped up to provide a winter session of its popular software programming bootcamp.

Also, culminating in 2020, NHERI facilities published 15 articles in the journal, Frontiers in Built Environment. The articles became a research topic called Natural Hazards Engineering Research Infrastructure — which is now an E-book. I applaud the efforts of the more than 100 authors who contributed to this collection.

As you will read in this issue of our newsletter, our Experimental Facilities remain focused on their missions, despite COVID-19.

- The NHERI at UC San Diego team continues its work on the complex task of upgrading the LHPOST shake table to shake with six degrees of freedom.
- The Florida International University EF, which has a well-established outreach program, engaged in virtual offerings to provide as much value as an in-person event.
- An interdisciplinary team, including faculty, staff and students from CONVERGE, DesignSafe and the RAPID facility, rolled out a new data model for natural hazards field research. Social and behavioral scientists, engineers, and members of interdisciplinary teams now have this data model for use independently or in collaborative projects.
- In other recent developments, the Education and Community Outreach (ECO) team is helping turn the successful Summer Institute one-on-one virtual meetings into a year-round offering for connecting researchers to experimental facilities.
- The NHERI NCO also sponsored an exhibitor's booth at the 2020 AGU Fall Meeting, which enabled us to share our capabilities with researchers focused on environmental and geotechnical problems.

Perhaps because our work focuses on mitigating damage from natural hazards, our network members are especially forward-thinking and resilient. The year 2021 promises to be another year of world-changing research and innovative outreach.

UC San Diego Shake Table to Transform Earthquake Engineering

Six-degree-of-freedom LHPOST6 will be the nation's largest, most sophisticated shake table

2020 was a busy year for the team at the NHERI UC San Diego experimental facility.

Despite delays caused by the COVID-19 pandemic, the upgrade to the Large High-Performance Outdoor Shake Table, LHPOST, now called LHPOST6, is proceeding. Thanks to a $16.3 million NSF grant in 2018, the world's largest outdoor shake table will be capable of testing structures with six-degrees-of-freedom (6-DOF). The work is scheduled for completion in the fall of 2021.

The project team at the UC San Diego Jacobs School of Engineering — and earthquake engineers around the world — look forward to testing a range of new projects at this unique facility. "We will reproduce earthquake motions with the most accuracy of any shake table in the world," said Professor Joel Conte, principal investigator for the NSF upgrade grant and the NHERI experimental facility.

Since its commissioning in 2004 until its decommission for the upgrade in 2019, 34 landmark projects have been conducted on the LHPOST. The shake table is an NSF shared-use facility, originally part of the Network for Earthquake Engineering Simulation (NEES) and now part of the Natural Hazards Engineering Research Infrastructure (NHERI) network.

Joel Conte, principal investigator of the NHERI at UC San Diego Experimental Facility shows an overhead view of the Large High-Performance Outdoor Shake Table hydraulic system.

SIX DEGREES OF FREEDOM

Testing infrastructure at large scale, under realistic multi-DOF seismic excitation, is essential to understand fully the seismic response behavior of civil infrastructure systems.

When its renovations are complete, the LHPOST6 shake table at UC San Diego will be able to move in all directions: back and forth, up and down, left to right, yaw, pitch and roll.

Reproducing earthquake motions in 6-DOF is key because during a temblor, the ground may move in any direction.

For example, during the 1994 Northridge earthquake in the Los Angeles area, bridge columns punched through bridge decks, hinting at a strong vertical ground motion. Similarly, during the 1971 San Fernando earthquake, the buildings twisted and swayed, hinting that the ground was probably rotating.

The shake table platen is being stored temporarily on reinforced concrete columns. The 145-ton platen will be machined underneath to accommodate new wear-plates and new vertical actuators.

TALL BUILDING TESTS

The first structure to undergo tests on the renovated shake table will be a full-scale, 10-story building made from cross-laminated timber. The goal of the NHERI Tallwood project, led by Shiling Pei, associate professor of engineering at the Colorado School of Mines, will be to gather critical fundamental data for designing tall wood-framed buildings — as tall as 20 stories — that do not sustain significant damage during large earthquakes.

"As the seismic engineering community increasingly focuses on resilience metrics, the ability to test full-building systems in tri-axial motion will significantly advance our knowledge on the resilience of structural and non-structural assemblies," Pei said.

"We have learned from the past that some engineering problems can only be discovered by subjecting the test structure to 3D motions, such as the response of non-structural components in base-isolated buildings under vertical ground motion." He added, "Our team is very excited to use the increased capacity of the shake table to test our design of the 10-story wood building. We want to validate thoroughly its resilience under realistic loading conditions."

Researchers will use LHPOST6 to test the heaviest test specimens in the world, from multi-story buildings, to bridge columns, bridge bents, wind turbines, and with a full range of ground motions that can occur during an earthquake.

"The 6-DOF capabilities will enable researchers to develop, calibrate, and validate predictive high-fidelity mathematical-computational models, and to verify effective methods for earthquake disaster mitigation and prevention," said Conte. "Results from these tests will improve design codes and construction standards, they'll help us develop accurate decision-making tools for building and maintaining sustainable and disaster-resilient communities."

UPGRADE MECHANICS

The mechanical additions to the shake table include a whole new power infrastructure, new hydraulic pumps, a cooling tower and very large accumulator banks for the facility's hydraulic-powered system.

Other work includes reconfiguring the existing two horizontal actuators, adding another two horizontal actuators, and powering the six vertical actuators to generate table motion in all three directions (longitudinal, transverse and vertical), and all three rotations (yaw, pitch and roll).

The new accumulator bank consists of 75 bottles, with capacity for 10,000 gallons of hydraulic fluid. These pressurized tanks will control the horizontal and vertical actuators that will reproduce multidimensional earthquake motions.

New pressure pipes have a 12-inch inside diameter, with a 1.25-inch thickness.

One of the steel plates to which the horizontal actuator will be anchored, shown prior to grouting.

As with the original LHPOST, the preliminary design of the LHPOST6 was a collaboration between UC San Diego and MTS Systems Corporation. The target performance of the LHPOST6 was defined as its ability to reproduce six tri-axial strong ground motions: from the 1978 Tabas (Iran), 1994 Northridge (California), 1995 Kobe (Japan), 1999 Chi-Chi (Taiwan), and 2015 Nepal earthquakes, and an AC-156 compatible artificial earthquake record developed for seismic qualification testing (ICC 229 2007).

FUTURE OF ENGINEERING AT LHPOST6

The LHPOST has the largest payload capacity in the world and ranks second in size after Japan's E-Defense shake table. The tallest structures ever tested on a shake table have used the LHPOST, which has no roof overhead, and is therefore free from height or crane capacity restrictions. Tall cranes and heavy lifting equipment can easily be deployed to construct full-scale buildings and other structures.

LHPOST6 will be the largest shake table facility in the U.S. and the second largest in the world. It will enable ground-breaking experimental research related to structural, geo-structural, soil-foundation-structural, and non-structural components and systems including how these systems behave during realistic multi-component earthquake excitations, and how they should be conceived and designed to resist such excitations best. Below are some key areas of focus:

Unreinforced masonry buildings
The LHPOST6 will enable the robust assessment of the seismic safety of URM buildings and the development of effective retrofit and strengthening methods.

Steel buildings
LHPOST6 can facilitate research to assess interactions in building systems undergoing earthquakes. Shake table testing will aid in assessing problems such as competing inelasticity in vertical and horizontal lateral-force resisting systems, overstrength and system effects derived from the participation of gravity, and non-structural framing in lateral response.

Structural concrete systems
Experiments on LHPOST6 can help develop innovative, resilient, seismic-resistant concrete systems under multi-axial excitation, specifically to improve modeling and analysis capabilities for component and system behavior. Engineers are particularly interested in using high strength materials (reinforcing bars and concrete) and advanced materials for seismically resilient civil applications. This entails testing special concrete moment frames and structural walls, including the combination of dual systems; precast concrete frame, and wall structures; and sustainable reinforced concrete structures utilizing recycled materials.

Two new pumps add to the existing two. In total, three pumps will pressurize the accumulator bank.

Horizontal actuator connections on the platen.

Uniaxial test validation
Current design standards rely on 3D computational models of structures to extrapolate results of uniaxial shake table tests to project structural performance under multi-axial loading conditions. The lack of pertinent data to validate the accuracy of computational models for these predictive analyses is an important issue. Multi-axis shake table tests are needed to study more realistically the behavior of civil structures and to improve current seismic design methods and standards.

Non-structural components and systems
The scarceness of full-scale building shake table tests that incorporate NCSs limits our understanding of the seismic response of these non-structural components.

Limited recent tests, supported by field observations, demonstrate the importance of advancing our understanding and predictive capabilities under multi-directional loading of NCSs in building systems. Full-scale multi-axial shake table tests are needed to advance the development of a reliable, unified design strategy for NCSs accounting for multi-directional earthquake excitation.

Protective systems
Extensive damage in conventional buildings has caused a push in earthquake-affected communities in the past two decades to use low-damage structural earthquake protective systems. Such systems can sustain significant nonlinear response, large lateral displacements, and damping with practically no damage and maintained operability after strong earthquake ground motions.

This is an active research area that includes base isolation, rocking foundations and systems, self-centering systems, inertial force-limiting floor anchorage systems, dampers, buckling-restrained braces, and new materials.

Soil structure interactions
The LHPOST6 is ideally suited for experimental investigations of dynamic SSI.

Three general types of experimental SSI studies can be envisioned:

Verification studies under tri-axial excitation
With verification studies under tri-axial excitation, computer models of the complete soil, foundation, structure system can be used to obtain the total translational and rotational motion of the foundation, which can then be applied at the base of the structure placed on the LHPOST6. The resulting experimental motion of the structure can be compared with the numerical simulation to validate both the theoretical model and computational method.

Hybrid tests
Hybrid tests could be used to study the non-linear seismic response of structures in the presence of soil-structure interaction, as well as studies of the torsional response of structures. And **large soil box tests** under tri-axial excitation could be used to study the nonlinear response of soils, the response of partially saturated soils, and the non-linear interaction of foundations, structures, and the soil.

Geostructures
Soil foundation-structure interaction (SFSI) tests can be used to study the performance of underground structures (such as energy vaults, pipelines, and deep and shallow tunnels), bridge abutments, earth retaining walls, levees, embankments, large cut and fills, and slope stability in hillside construction.

The LHPOST6 can support the testing of underground pipelines subject to liquefaction loads or fault crossing demands by taking advantage of the large displacement capacity of the LHPOST6, enabling researchers to conduct large-scale dynamic testing of underground facilities and pipelines and techniques for evaluating ground movement patterns and stability for a variety of excavation, tunneling, micro-tunneling, and mining conditions.

The NHERI at UC San Diego website provides details on past projects. Test results and research data are available on the NHERI DesignSafe Data Depot repository. For details on LHPOST6, see the recent article in the Frontiers in Built Environment article.

As the upgrade project nears completion, the team at UC San Diego will provide more updates and details about scheduling projects, including non-structural tests in the Tallwood building.

Take a virtual tour of the Large High-Performance Outdoor Shake Table, LHPOST6, hosted by Professor Joel Conte, principal investigator for the NSF upgrade grant and the NHERI Experimental Facility.

Case Study: Sustainable Outreach at the FIU Wall of Wind

Wind engineers participate in university events, partner with a STEM museum, and sponsor an annual engineering challenge

For nearly a decade, the Wall of Wind experimental facility at Florida International University has been the center of multiple successful — and sustainable — outreach programs. The WOW is integral to the International Hurricane Research Center and Extreme Events Institute, both at FIU, whose faculty and staff are enthusiastic advocates of STEM education.

Erik Salna directs outreach at the IHRC and the EEI, and he's created a portfolio of outreach programs that may serve as models for other NHERI EFs. In this case study, we touch on three primary efforts developed by Salna and FIU. The WOW participates big in FIU's annual Engineering Expo; it has a permanent exhibit and long-term partnership with a Fort Lauderdale science museum; and the WOW sponsors an annual engineering challenge event for local high schoolers.

PARTICIPATING IN THE ENGINEERING EXPO

FIU's College of Engineering and Computing holds an annual Engineering Expo, as many colleges do. At FIU, the expo is the engineering school's primary outreach event, a flashy affair with more than 1,600 students from Miami Dade and Broward County schools attending. Elementary, middle and high school students flock to campus where they interact with engineering students, researchers and staff — and get a first-hand view of the FIU engineering campus and labs, including the Wall of Wind.

During the tour, WOW volunteers safely escort students to see the 12 large fans on the one end of the facility, and then to see the turntable where structures are tested by hurricane force winds on the other end. Students learn how the Wall of Wind works, see examples of research projects, and hear about wind engineering STEM careers. Getting a group picture in front of the fans is always a highlight.

The Wall of Wind team participates in the Engineering Expo by conducting tours of the NHERI Wall of Wind, which is located a mile from the main campus.

Effort: Relatively low from WOW Team. Requires advance organization, limited team member participation.

Value: Moderately high. At each expo event, 400-600 local children have a chance to see the massive WOW facility. Provides engagement experience to current engineering students.

ESTABLISHING MUSEUM CONNECTIONS

The Wall of Wind enjoys a special relationship with the Museum of Discovery and Science (MODS), located in Fort Lauderdale, about 40 miles northeast of campus. Local science museums often seek connections with local science experts and partnerships with local universities for developing informal education projects. Salna helped develop an interactive Wall of Wind exhibit for the museum that illustrates the effects of wind on different roof shapes, teaches the science of wind engineering, and shows the importance of mitigating wind damage to your home. A video loop shows examples of wind testing by the real Wall of Wind. Display panels highlight successful research at the WOW.

In May, just before hurricane season begins, the museum holds an annual "Eye of the Storm Hurricane Education Day," a hands-on free event, and the Wall of Wind exhibit is a central feature. Salna arranges for WOW researchers and FIU wind engineering students to greet and educate families and kids while operating the exhibit. They engage younger kids with a building challenge, which is to create a tower using paper and tape and test it for stability using a portable fan. It's a popular activity with pre-k and elementary children, who get enjoyable exposure to the fundamental principles of wind-structure interaction.

Developing a museum partnership is a long-term effort, Salna says, and it is not inexpensive. A small, interactive museum exhibit may cost $30,000. The exhibit will need to be maintained, and, as with the hands-on WOW exhibit, staffed by university in some capacity.

Effort: Moderately high to high. Requires professional-level exhibit development and construction. Requires working relationship with a nearby museum.

Value: Very high. An engaging museum exhibit may be experienced by thousands of visitors each year.

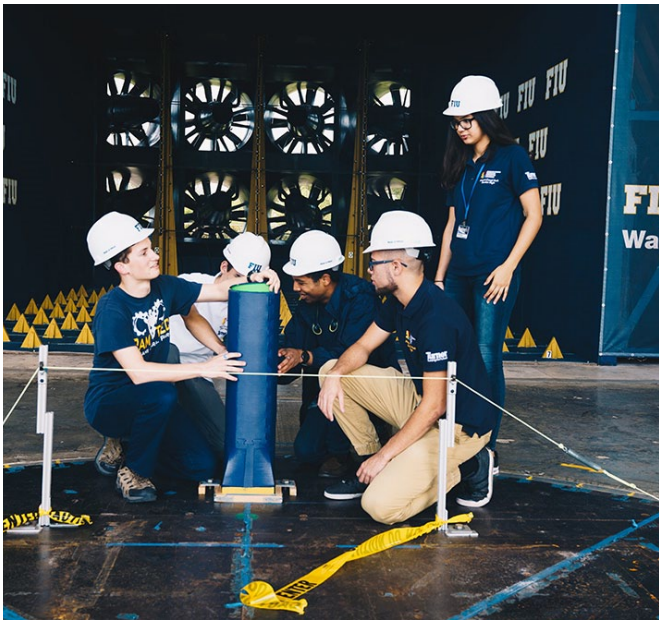
In 2020, the COVID-19 quarantine kept the museum closed, and the Eye of the Storm event was cancelled. Salna and MODS decide to go virtual, with only a few months to plan. With funding from the Florida Division of Emergency Management, Salna called in expertise from many partners, and, with his own experience in television production, he managed the creation of a 12-part video series on hurricane science, mitigation and preparedness, which included a video about the Wall of Wind. The video series is called, appropriately, the Eye of the Storm, and it was strategically released at the beginning of the 2020 hurricane season.

Both accessible and informative, the Wall of Wind video was a great success on many social media platforms, including thousands of views on the MODS YouTube Channel, Salna explains. It was marketed to hurricane communities along the Gulf and East Coast and continues to get views today. NSF featured the film in their September video gallery.

Natural hazards educators must be willing to dive into unfamiliar territory, Salna says, and learn how to do things such as writing a video script. Creating a 12-minute video will take at least three full days to shoot and edit, and for this it is most efficient work with a professional videographer.

Effort: Moderately high. Video production costs can run at least $500 per minute. Salna's experience in television production kept costs low for the project.

Value: Potentially very high. Video is easy to share, and an engaging "evergreen" video can provide high-quality engagement for several years.



Students setting up a test for the WOW Challenge.

Participants in the Wall of Wind Challenge must make an oral presentation.

AN ENGINEERING CHALLENGE FOR HIGH SCHOOLS

One of the most popular outreach efforts for the WOW is the Wall of Wind Mitigation Challenge, which also receives funding from the Florida Division of Emergency Management. Although similar to college-level civil engineering challenges, this one, aimed at South Florida high school students, is arguably more rigorous. As the next generation of engineers to address natural hazards and extreme weather, this STEM education event features a competition between high school teams to develop innovative wind mitigation concepts and real-life human safety and property protection solutions defined by the Wall of Wind research team. Students must build a physical specimen to test, and they also must prepare an oral presentation and a technical paper.

The live testing event is an exciting day at the Wall of Wind facility. Students have their wind-resistant structures tested by the WOW, and their work is judged by the WOW team, local engineering experts, and even TV meteorologists from The Weather Channel and CNN. Local media cover the event, which adds to the day's excitement. No matter how students place in the challenge, Salna says, it's a once in a lifetime opportunity for the high school students – an experience they never forget.

Effort: High. Requires a formal curriculum, faculty involvement, and significant onsite and external organization.

Value: Very high. Local schools get extensive, high-quality exposure to the facility. Media coverage exposes the community to the facility's role in STEM education and natural hazards mitigation.

TAKEAWAYS FOR NHERI EXPERIMENTAL FACILITIES

For all outreach efforts, Salna now emphasizes the importance of gathering data on effectiveness, including pre-event and post-event surveys to measure learnings. Social media and website analytics are also useful measures of a program's success.

Get involved with university and local STEM-related events. Develop a web-accessible STEM curriculum and engage with K-12 teachers. Consider simple, inexpensive ways to replicate your facility's efforts in a classroom. Initiate mutually beneficial relationships with your university and college, local school districts, area museums, and nearby governmental and non-governmental agencies.

For ideas, FIU's Salna recommends checking hazard outreach sites such as NOAA's Education page, STEM-Works, or TeachEngineering. And the NHERI Education and Outreach group is happy to help other Experimental Facilities in outreach efforts.

The Wall of Wind Exhibit is popular with families at the Museum of Discovery and Science.

Watching a Challenge test underway.

Wall of Wind Challenge winners, 2019.

The Wall of Wind Exhibit at the Museum of Discovery and Science.

A Novel Tool for Publishing Social Science, Engineering, and Interdisciplinary Natural Hazards Data

A collaborative vision becomes reality in the DesignSafe-Cyberinfrastructure

During field research in the natural hazards space, scientists and engineers from different disciplines use sophisticated equipment and diverse methods to collect differing types of data — from 35mm photos and lidar imagery, to survey responses from community members, to biometrics. Although qualitatively distinct, these data need to be managed together to facilitate accurate analysis and curation workflows which culminate in publicly shared data and findings. Throughout the research process, a significant challenge is to bridge complementary perspectives for interdisciplinary teams that work collaboratively, and for users to discover field research data.

The R&D team was a partnership among research scientists with DesignSafe at the University of Texas Austin, CONVERGE at the University of Colorado Boulder, and the RAPID facility based at the University of Washington. All are components of the NSF-funded Natural Hazards Engineering Research Infrastructure, NHERI.

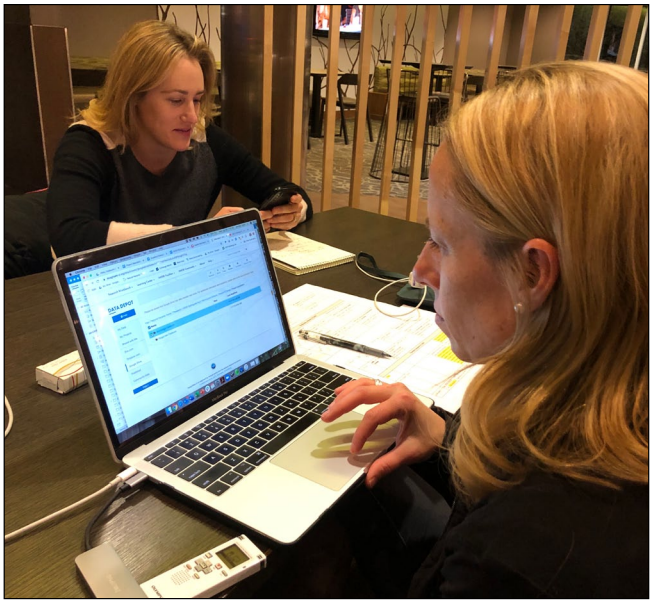
NHERI CONVERGE seeks to advance social science, engineering, and interdisciplinary work in natural hazards and is working to further a vision for managing and publishing field research data to enable such collaboration. This vision seeks to cohere interdisciplinary work as it is conducted across geographic space and time: from fieldwork in disaster-affected places, to data analysis, to publication. The vision has taken shape in the form of a novel field research data model for social science, engineering, and interdisciplinary natural hazards research.

For instance, a post-disaster reconnaissance team may consist of social scientists who are assessing resident access to clean water and engineers who are assessing residential homes and the electrical grid. “With a single data model, the team’s research can be examined in a much more holistic way,” said Lori Peek, principal investigator of the NHERI CONVERGE facility.

ROBUST DATA MODEL

Users can think about the data model as the template that standardizes data organization and description and clarifies how different data and documentation components relate to one another.

DesignSafe’s model is robust enough for researchers to publish qualitative and quantitative data as well as data collection protocols, research instruments, and Institutional Review Board (IRB) protocols. In this way, the final publication reveals the structure of data in relation to how the research project was conducted. All data, protocols, and instruments published via DesignSafe Cyberinfrastructure are assigned a permanent Digital Object Identifier (DOI), allowing researchers to share and others to cite their work.



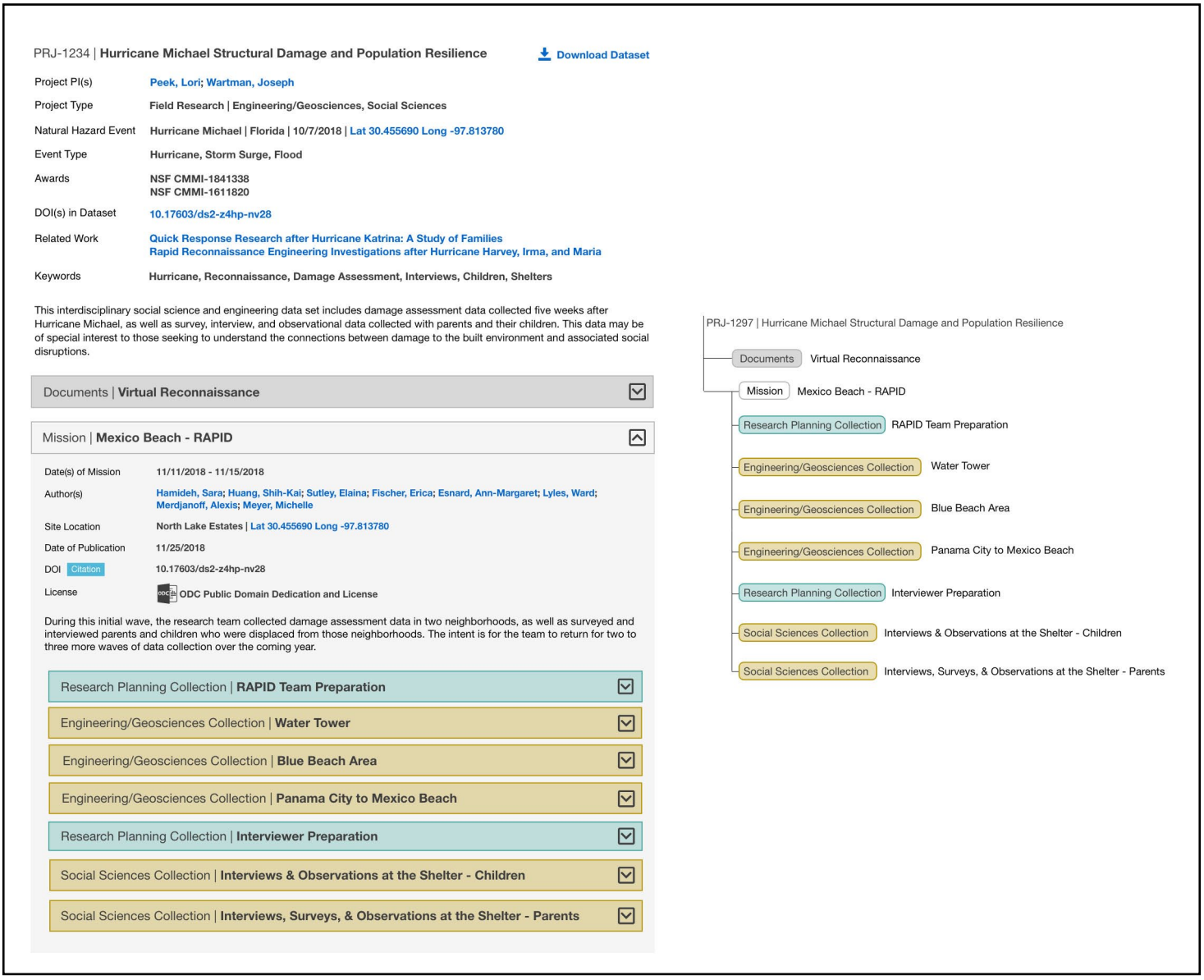
Natural Hazards Center researchers Rachel Adams (left) and Jennifer Tobin (right) upload qualitative interview audio files to the secure DesignSafe Data Depot after a day of conducting fieldwork in Anchorage, Alaska. Source: Lori Peek, 2020.

DesignSafe’s novel data model was developed with the expertise of Maria Esteva, data curator for the DesignSafe data repository, and Craig Jansen, who specializes in user interface design. Multiple researchers within the NHERI community contributed their knowledge, field experience, and feedback to the design.

“This new data model will help advance collaboration across disciplines, geographic sites, and hazards within the disaster social science and engineering fields,” said Peek.

DESIGNING FOR COLLABORATION

The CONVERGE vision was executed in the DesignSafe Cyberinfrastructure. DesignSafe, the National Science Foundation-supported online platform dedicated to natural hazards research, allows hazards and disaster researchers to securely store, analyze, publish, preserve, and share their data along with associated data collection instruments and research protocols.



With the new data model, researchers can curate and publish preliminary field reports, field data, research protocols, and research instruments. This example data model clarifies how engineers and social scientists can work together to structure an interdisciplinary, multi-component project. Source: Craig Jansen, 2020.

Designing and implementing a model to curate and share field research data required interdisciplinary collaboration. Social scientists, engineers, data curators, user-experience designers, and developers brainstormed, drew, discussed, implemented, and tested the field research data publication pipeline in DesignSafe.

Then, in 2019 at the annual Natural Hazards Workshop, over 70 researchers provided feedback on a mock-up of the social science and interdisciplinary data model. That feedback was then implemented before its 2020 release in DesignSafe.

At the 2020 Natural Hazards Researchers Meeting, Maria Esteva and Craig Jansen, along with team members Nathanael Rosenheim and Elaina Sutley, presented a discussion on the complexities involved in the development of the data model.

RAPID expertise. The NHERI RAPID facility at the University of Washington also played an integral role in partnering with DesignSafe and CONVERGE to develop the novel data model. Not only did they provide engineering feedback on the field research portion of the data model, they also ensured that the RAPID Application (RApp) for mobile data collection would seamlessly integrate with DesignSafe.

FOSTERING AN INTERDISCIPLINARY CULTURE

In order to introduce the new data publication capabilities to the natural hazards research community, in the summer of 2020, CONVERGE and DesignSafe hosted a series of Publish Your Data! events for social scientists and interdisciplinary researchers. Over 40 researchers from academia and the federal government, and graduate students, took part. Several have already begun publishing their research data and protocols from recent as well as legacy studies using the new data model. Upon completion of the training and data publication process, researchers are designated as CONVERGE Data Ambassadors.

"Data Ambassadors are now sharing their new knowledge with others and helping to shift the culture in the field," Peek said. Ellen Rathje, who is the principal investigator for NHERI DesignSafe, agreed and is impressed by the eager participation. "This is really exciting to see the interest from the social science community, and it has helped us to expand our capabilities even further at DesignSafe," she said.

Nathanael Rosenheim, one of the first research team members to publish a data collection instrument using the new data model, described the new data model as "intuitive and easy to use." He added, "I can really see the value of data sharing and publication. I hope that other researchers will use the household survey instrument we developed for the Longitudinal Community Resilience Focused Technical Investigation of the Lumberton, North Carolina Flood of 2016." Other motivating examples of recent data publications under the new data model can be found at the CONVERGE website.

LONGTERM VISION FOR NATURAL HAZARDS RESEARCH

The team encourages all researchers to contribute and publish field research data, instruments, and research protocols on DesignSafe. Those materials that are already published via the Data Depot on DesignSafe have received a permanent DOI and are available for download and reuse by members of the community.

Researchers Jennifer Tobin, Elaina Sutley, Mason Mathews, and David Hondula draw images of data collection to publication processes to help inform the development of the field research data model. Source: Lori Peek, 2018.

"As the number of published datasets and other materials grows, so too will the opportunities for collaboration and replication across field sites," Peek said. This possibility for expanding interdisciplinary collaboration and encouraging data reuse is central to the vision motivating this effort.

Moving forward, the leaders of DesignSafe, CONVERGE, and RAPID will continue to train and support researchers who wish to securely store and share their data. This work will influence the natural hazards field in two ways: It will help ensure that the results of publicly funded research are made available to the public, and it will enable others to ask new questions with existing data. Ultimately, this ongoing effort is about advancing the state of research and innovation, one dataset at a time.

EDUCATION CORNER

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

Robin Nelson, PhD
Educational Specialist, NHERI ECO

On behalf of the NHERI ECO Committee, we would like to thank everyone who shared information about the NHERI Research Experiences for Undergraduates (REU) and Summer Institute.

Through virtual recruitment events, we reached over 110 undergraduates and 20 early career faculty.

This year, we took a slightly different approach to recruit undergraduates and early-career faculty for the NHERI ECO events. As in previous years, we sent flyers, albeit virtually, and emails. But this year, we also held virtual informational events to help undergraduates and early career faculty become familiar with the NHERI REU or Summer Institute programs and assist with the application process. Through virtual recruitment events, we reached over 110 undergraduates and 20 early career faculty.

We invite faculty and undergraduate students interested in learning about the NHERI REU program to attend our last REU virtual information session on Thursday, January 21, 2021 from 4:00-5:00 pm Central Time. The NHERI network, sites, and program will be introduced, and REU alumni will share their experiences. You can register for the event on Eventbrite at https://bit.ly/REU_NHERI.

This year, we are very excited to announce the addition of CONVERGE to the NHERI REU program — the eleventh site to the NHERI family. CONVERGE, along with the ten other NHERI sites, will host REU students this summer. While NHERI ECO hopes to host an in-person REU program, we are prepared to offer hybrid or remote options as we continue to deal with uncertainties due to university policies in response to COVID-19. Regardless of the modality, the NHERI REU Program will take place this summer, and REU students will present their research at the annual research symposium, which will be held August 9-10, 2021.

The NHERI Summer Institute for Early Career Faculty will take place on June 16-17, 2021. The Summer Institute is a free two-day workshop for early career faculty interested in learning about the NHERI network and conducting collaborative natural hazards engineering research.

We hope to offer a face-to-face and hybrid option as in previous years, but the NHERI ECO is prepared to offer a fully remote option if necessary. If you are interested in attending, please visit the DesignSafe Learning Center to register.

A limited number of travel awards are available for early career faculty and applications are due February 10, 2021. Early career faculty — including pre-tenured faculty, senior level graduate students, and post-doctoral researchers — are invited to apply for the travel awards. We encourage researchers interested in collaborative interdisciplinary research projects as well as women and minority scholars to apply.

Thank you again for sharing information about NHERI, the REU program, and the Summer Institute for Early Career Faculty. We look forward to welcoming new undergraduates and early-career faculty into our NHERI community this summer!

The NHERI Summer Institute for Early Career Faculty takes place on June 16-17, 2021.

GRANTS AWARDED

using NHERI facilities and resources

Q2 2020 – Q3 2020

April 1, 2020 through Sept 30, 2020

COOPERATIVE AGREEMENTS

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Large Wave Flume and Directional Wave Basin 2021-2025
Award Number: 2037914; Principal Investigator: Daniel Cox; Co-Principal Investigators: Christopher Higgins, Pedro Lomonaco; Organization: Oregon State University; NSF Organization: CMMI; Start Date: 01/01/2021; Award Amount: $946,800.

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Large-Scale, Multi-directional, Hybrid Simulation Testing Capabilities 2021-2025
Award Number: 2037771; Principal Investigator: James Ricles; Co-Principal Investigator: Richard Sause; Organization: Lehigh University; NSF Organization: CMMI; Start Date:01/01/2021; Award Amount:$1,028,905.

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Large, Mobile Dynamic Shakers for Field Testing 2021-2025
Award Number: 2037900; Principal Investigator: Kenneth Stokoe; Co-Principal Investigators: Robert Gilbert, Brady Cox, Patricia Clayton; Organization: University of Texas at Austin; NSF Organization: CMMI; Start Date: 01/01/2021; Award Amount:$1,089,907.

Natural Hazards Engineering Research Infrastructure: Cyberinfrastructure (DesignSafe) 2020-2025
Award Number: 2022469; Principal Investigator: Ellen Rathje; Co-Principal Investigators: Clinton Dawson, Jean-Paul Pinelli, Jamie Padgett, Scott Brandenberg; Organization: University of Texas at Austin; NSF Organization: CMMI; Start Date: 10/01/2020; Award Amount: $12,355,424.

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Geotechnical Centrifuges 2021-2025
Award Number: 2037883; Principal Investigator: Ross Boulanger; Co-Principal Investigators: Daniel Wilson, Bruce Kutter, Jason DeJong; Organization: University of California-Davis; NSF Organization: CMMI; Start Date: 01/01/2021; Award Amount: $1,304,566.

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Twelve-Fan Wall of Wind 2021-2025
Award Number: 2037899; Principal Investigator: Arindam Chowdhury; Co-Principal Investigators: Ioannis Zisis, Peter Irwin, Seung Jae Lee, Amal Elawady; Organization: Florida International University; NSF Organization: CMMI; Start Date: 01/01/2021; Award Amount:$1,101,789.

Natural Hazards Engineering Research Infrastructure: Experimental Facility with Boundary Layer Wind Tunnel 2021-2025
Award Number: 2037725; Principal Investigator: Jennifer Bridge; Co-Principal Investigators: Kurtis Gurley, Forrest Masters, Brian Phillips; Organization: University of Florida; NSF Organization: CMMI; Start Date:01/01/2021; Award Amount:$1,057,425.

STANDARD GRANTS

MsRI-EW: Conference to Identify Research Infrastructure Concepts for a National Full-Scale 200 mph Wind and Wind-Water Testing Facility; Virtual; August 2020;
Award Number: 2034656; Principal Investigator: Arindam Chowdhury; Co-Principal Investigators: Ioannis Zisis, Amal Elawady; Organization: Florida International University; NSF Organization: CMMI; Start Date: 07/01/2020; Award Amount:$49,624.

EAGER: Joint Hazard Mitigation in the Era of COVID-19: Implications for Engineered Structures and Services
Award Number:2041666; Principal Investigator: David Mendonca; Co-Principal Investigators: Julio Ramirez, Tracy Kijewski-Correa, Ann-Margaret Esnard; Organization: Rensselaer Polytechnic Institute; NSF Organization: CMMI; Start Date: 09/01/2020; Award Amount: $299,824.

MRI: Acquisition of a High Performance Data Acquisition System to Enable Experimental and Computational Research on the System Level Response of the Built Environment
Award Number: 2020745; Principal Investigator: Lelli VanDenEinde; Co-Principal Investigators: Joel Conte, Jose Restrepo, Veronica Eliasson, Machel Morrison; Organization: University of California-San Diego; NSF Organization: CMMI; Start Date:07/15/2020; Award Amount:$607,704.

CAREER: Innovative Technology for Mass Timber and Hybrid Modular Buildings
Award Number: 2046001; Principal Investigator: Erica Fischer; Organization: Oregon State University; NSF Organization: CMMI; Start Date: 09/15/2021; Award Amount:$559,396.

Collaborative Research: Self-Centering Pendulum Shear Walls in Buildings via Nonlinear Elastic Kinematics
Award Number: 2035690; Principal Investigator: Rigoberto Burgueno; Organization: SUNY at Stony Brook; NSF Organization: CMMI; Start Date: 06/01/2020; Award Amount:$339,690.

An Uplift Friction Damper for Seismically Resilient Mass-Timber Buildings
Award Number: 2025449; Principal Investigator: Daniel Dowden; Organization: Michigan Technological University; NSF Organization: CMMI Start Date:09/01/2020; Award Amount:$204,514.

Collaborative Research: Aerodynamic Shape Optimization of Tall Buildings using Automated Cyber-Physical Testing
Award Number: 2028762; Principal Investigator: Brian Phillips; Organization: University of Florida; NSF Organization: CMMI Start Date: 01/01/2021; Award Amount:$530,917.

Collaborative Research: Aerodynamic Shape Optimization of Tall Buildings using Automated Cyber-Physical Testing
Award Number: 2028647; Principal Investigator: Zhaoshuo Jiang; Organization: San Francisco State University; NSF Organization: CMMI Start Date:01/01/2021; Award Amount:$285,491.

Field Testing of Concrete Buildings for Damage and Collapse Assessment
Award Number: 2036193; Principal Investigator: Halil Sezen; Co-Principal Investigators: Alper Yilmaz, Rongjun Qin; Organization: Ohio State University; NSF Organization: CMMI; Start Date: 08/15/2020; Award Amount:$299,998.

RAPID: The COVID-19 Pandemic Seattle, Washington Street View Campaign
Award Number: 2031119; Principal Investigator: Joseph Wartman; Co-Principal Investigators: Scott Miles, Youngjun Choe, Nicole Errett; Organization:University of Washington; NSF Organization: CMMI; Start Date: 05/01/2020; Award Amount:$196,943.

Data-Based System Reliability Design for Wind
Award Number: 2013697; Principal Investigator: Mircea Grigoriu; Organization: Cornell University; NSF Organization: CMMI; Start Date:08/01/2020; Award Amount:$464,750.

Collaborative Research: Real-Time Hybrid Simulation Enabled Damping System Assessment using Scaled Aeroelastic Models of Tall Buildings
Award Number: 2011423; Principal Investigator: Wei Song; Organization: University of Alabama Tuscaloosa; NSF Organization: CMMI; Start Date: 09/01/2020; Award Amount:$315,742.

Collaborative Research: Real-Time Hybrid Simulation Enabled Damping System Assessment using Scaled Aeroelastic Models of Tall Buildings
Award Number: 2011396; Principal Investigator: Teng Wu; Organization: SUNY at Buffalo; NSF Organization: CMMI; Start Date:09/01/2020; Award Amount:$275,778.

RAPID: A Multi-Wave Study of Risk Perception, Information Seeking, and Protective Action in COVID-19
Award Number: 2028412; Principal Investigator: Samantha Penta; Co-Principal Investigators: Lauren Clay, Amber Silver; Organization: SUNY at Albany; NSF Organization: CMMI; Start Date: 06/01/2020; Award Amount: $47,972.

Full-Waveform Inversion of Seismic Input Motions in a Truncated Domain
Award Number: 2044887; Principal Investigator: Chanseok Jeong; Organization: Central Michigan University; NSF Organization: CMMI Start; Date: 09/01/2020; Award Amount:$64,847.

Investigation of a Novel Pressurized Sand Damper for Sustainable Seismic and Wind Protection of Buildings
Award Number: 2036131; Principal Investigator: Nicos Makris; Co-Principal Investigator: Usama El Shamy; Organization: Southern Methodist University; NSF Organization: CMMI; Start Date:10/01/2020; Award Amount:$600,827.

RAPID: Performance of Agricultural Storage Silos and Farm Bins in Nebraska and Iowa During the August 2020 Derecho
Award Number: 2050152; Principal Investigator: Christine Wittich; Organization: University of Nebraska-Lincoln; NSF Organization: CMMI; Start Date: 09/01/2020; Award Amount: $41,934.

Three-Dimensional Dynamic Nonlocal Beam Formulation for Simulation of Damage and Failure in Reinforced Concrete Structural Elements
Award Number: 2032352; Principal Investigator: Petros Sideris; Organization: Texas A&M Engineering Experiment Station; NSF Organization: CMMI; Start Date:10/01/2020; Award Amount:$259,414.

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