NSF NHERI WALL OF WIND EXPERIMENTAL FACILITY

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The NHERI Program enables research and educational advances that can contribute knowledge and innovation for the nation's civil infrastructure and communities to prevent natural hazard events from becoming societal disasters.

Facility Overview

The NHERI Wall of Wind (WOW) Experimental Facility (EF) at Florida International University (FIU) is a national facility that enables researchers to better understand wind effects on civil infrastructure systems and to prevent wind hazards from becoming community disasters. This facility is powered by a 12-fan system capable of repeatable testing up to 157 mph wind speeds through its flow management system. The unique advantage of the NHERI WOW EF is multi-scale and high Reynolds number simulation of the effects of wind and wind-driven rain which is accomplished using the twelve fans and a water spray system. In addition, the 16,000 sqft. secure area enables researchers to plan and perform experiments to study failure modes for up to Category 5 Hurricane wind speeds. The NHERI WOW EF uses a wide range of equipment, instrumentation, and experimental simulation protocols, as well as a distinguished group of faculty and a well-trained team comprised of technical and operations personnel that allow for the delivery of world-class research.

The NHERI WOW EF provides the following experimental capabilities:

- High-speed holistic testing at multiple scales in simulated hurricane wind speeds up to and including Category 5 Hurricane on the Saffir-Simpson scale
- Destructive tests to study failure modes
- Wind-driven rain simulations to study water intrusion
- Full-and large-scale aerodynamic/aeroelastic testing in atmospheric boundary layer (ABL) flows at high Reynolds numbers
- Testing under extreme environments to develop innovative mitigation devices
- Conventional boundary layer wind tunnel testing in flows with various exposures and with full turbulence spectrum

FIU | Wall of Wind
NHERI Experimental Facility

Research Capabilities

Research topics that can be investigated at the NHERI WOW EF include (but are not limited to):

- Validating Computational Fluid dynamics (CFD) and other numerical simulation methods
- Performance of building envelope
- Effect of shapes and surroundings on wind loading
- Wind effects on small structures
- Wind-induced vibrations
- Innovations in mitigation techniques
- Engineered building systems using new sustainable materials
- Performance based wind engineering
- Environmental sustainability and green energy
- Infrastructure resiliency and public safety
- Non-straight line and short duration wind storms

User Support

The support/services provided by the NHERI WOW EF to the researchers include:

- Support for NSF proposal development
- Safety and user training
- Design, construction and instrumentation of test specimens
- Test protocol development and software implementation
- Operation of the wind tunnel
- Data acquisition, archiving, and curation
- Processing and post processing of the data
- Telepresence for remote participation
- Outreach and dissemination
- Office space and internet service for users during their visit

Proposal Development and Project Execution Process

The following is a flow chart showing the process from initial contact, to proposal submission, to project execution.

01 Initial Contact

- Researcher (PI) contacts the EF's Director or Site Operations Manager (SOM) to discuss a test idea

02 Idea Development

- EF schedules the first conference call meeting between the PI and the EF team to discuss the testing needs to support the proposed research
- EF schedules the follow-up meeting(s) between the PI and the EF team to discuss the test details

03 Proposal Development

- PI develops a preliminary test plan and shares it with the EF's team for feasibility assessment
- EF's SOM provides the PI with test timeline and budget estimate based on the test plan

04 Proposal Submission

- PI submits the full proposal to NSF

05 Award Notification

- PI informs the EF of the awarded project

06 Paperwork

- PI and EF's SOM fill out NHERI NCO-related forms
- A Service Agreement will be signed between the PI and the NHERI WOW EF
- PI creates project folder on DesignSafe-CI website

07 Project Kickoff

- EF's SOM schedules tests, user safety overview and user training
- PI and EF team develop the detailed Experimental Test Protocols

08 Pre-testing Setup

- PI and the EF team work on model design, construction, instrumentation and installation

09 Running Time

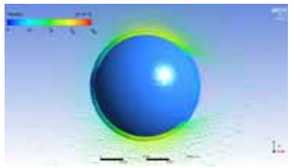
- EF team operates the WOW facility and acquires data
- EF team uploads raw data to the project folder on DesignSafe-CI website
- EF team dismantles the test setup

10 Post-testing

- EF team uploads test documents to the project folder on DesignSafe-CI website

2017 NSF Supported Projects (Selected)

Title: Damage and Instability Detection of Civil Large-scale Space Structures Under Operational and Multi-hazard Environments based on Change in Macro-geometrical Patterns/Shapes
PI: Guirong (Grace) Yan, Missouri University of Science and Technology
NSF Program: Structural and Architectural Engineering and Materials (SAEM)



Summary: The ultimate goal of this study is to detect instability or damage of civil large-scale space structures under multi-hazard environments to prevent structures from collapsing. In order to validate a two-way wind-structure interaction CFD model used in this study and to reveal the dynamic responses of a dome structure under extreme winds, a 1:50 scaled model of a dome structure will be tested at the NHERI WOW EF. The model structure will be equipped with more than 300 pressure taps to measure surface static pressures and the wind load experienced by the structure. This experiment provides, for the first time, an opportunity to test a very large scale dome structure under hurricane level winds.

Title: Experimentally Validated Stochastic Numerical Framework to Generate Multi-Dimensional Fragilities for Hurricane Resilience Enhancement of Transmission Systems
PI: Abdollah Shafieezadeh, Ohio State University
NSF Program: Engineering for Natural Hazard (ENH)

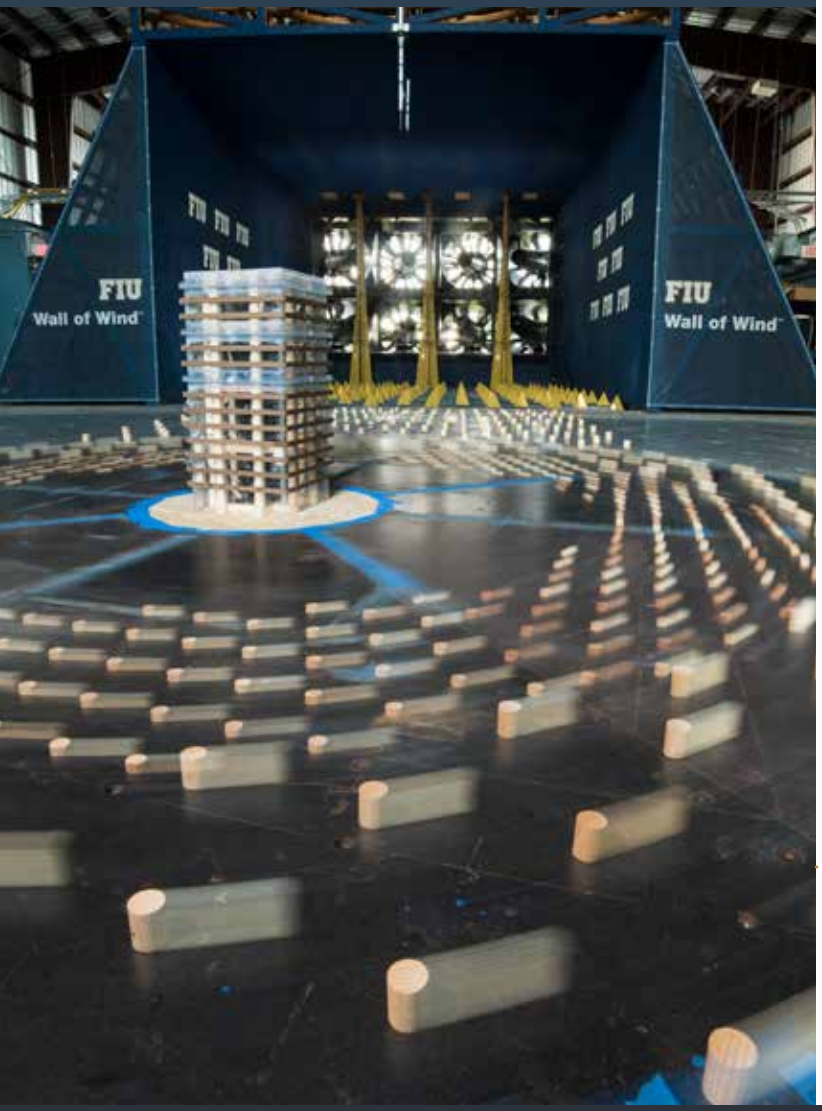
Summary: This research will produce a state-of-the-art experimentally validated stochastic numerical framework to generate multi-dimensional fragility models for hurricane resilience enhancement of transmission systems. The research will involve a series of aeroelastic wind tunnel studies on the wind response of multi-span transmission systems at the NHERI Wall of Wind EF at FIU. These novel sets of experimental data, together with high-fidelity three-dimensional nonlinear finite element models of tower-conductor-insulator-foundation systems, will provide new and critical insights into various complex wind-induced behaviors of these systems. The WOW tests will also enable characterization of dynamic boundary effects from neighboring spans. The multi-dimensional fragility surfaces, based on validated numerical models, will provide component- and system-level structural and functional failure probabilities for units of transmission tower-lines.

Title: Uncovering Potential Risks of Wind-induced Cascading Damages to Construction Projects and Neighboring Communities
PI: Youngjib Ham, Florida International University
NSF Program: Civil Infrastructure Systems (CIS)

Summary: Using knowledge on potential at-risk construction resources obtained through experimental testing of extreme wind events, this project will partially or fully automatically model the current state of construction sites through machine vision techniques using multimodal visual data obtained from construction workers and camera-equipped unmanned aerial vehicles. To perform multi-physics simulation of multiple discrete objects in unstructured construction sites, an impulse-based discrete element method will be conceptualized. Component-based vulnerability and impact analysis with 3D Building or Civil Information Models (BIM/CIMs) will then be conducted to generate fundamental and highly specific knowledge on wind-induced damage mechanisms. Finally, the entire system will be validated in real-world construction projects and within a 12-fan NHERI Wall of Wind facility that can generate up to hurricane category 5 wind speeds.

Live Streaming of Experiments at the NHERI WOW EF

The NHERI WOW EF is committed to community outreach activities that promote science, technology, engineering and mathematics (STEM). As part of this commitment, the NHERI WOW EF is using a system of high definition and surveillance cameras to live stream experiments that are performed at the facility throughout the year. Announcements for live streaming of tests will be sent out through the **designsafe-ci.org.** If you are interested in watching experiments that are performed at the NHERI WOW EF, please visit **fiu.designsafe-ci.org** for the schedule of upcoming tests.



Research Planning Workshops

NHERI Wall of Wind (WOW) Experimental Facility (EF) is currently accepting requests from faculty (potential EF users) to attend **Research Planning Workshops, throughout the year, at the WOW EF in Miami, FL. Financial support is available on a limited basis and will be distributed with preference to early registration.**

The Research Planning Workshops are designed for individuals and smaller groups (2-3) to help them determine the best way to engage with the WOW facility while developing NSF proposals. This one-day workshop can be scheduled any time of the year by sending an e-mail request to Arindam Chowdhury (chowdhur@fiu.edu) or Maryam Refan (mrefan@fiu.edu) and mentioning the preferred date(s) to attend the workshop. The main focus of these workshops is to:

1. Help potential EF users in developing the experimental section of their individual or collaborative NSF proposals in a one-on-one setup
2. Provide researchers with information on the capabilities of the NHERI WOW EF to advance natural hazard engineering research
3. Provide a tour of the NHERI WOW EF and describe the three main types of multi-scale tests (aerodynamic/ aeroelastic, destructive and wind-driven rain) conducted at the EF
4. Discuss the NHERI Science Plan and recent advancements in experimental and numerical research in natural hazard mitigation
5. Help the users to explore opportunities to utilize the NHERI WOW EF for NSF projects, including but not limited to, projects focusing on validating computational fluid dynamics and other numerical simulation methods

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