Testing Coastal Natural Hazards at the O.H. Hinsdale Wave Research Laboratory

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National Science Foundation

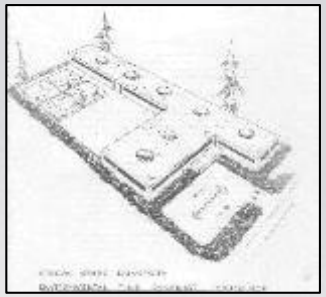
Oregon State University

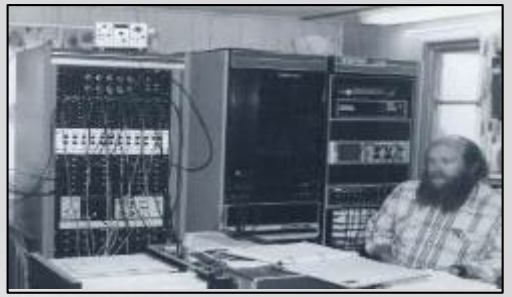
Coastal Natural Hazards

- Tsunamis
- Storm waves
- Storm surge
- Volcanic Eruptions
- Landslides

O.H. Hinsdale Wave Research Laboratory at Oregon State University, in Corvallis

- Established in **1972** with the construction of the Large Wave Flume.
- 50+ years of uninterrupted research and **physical model testing** at the largest nearshore experimental facility in the US.
- The building houses the **Large Wave Flume** (LWF), **Directional Wave Basin** (DWB), and office space for staff, graduate students, visiting researchers, and clients.
- Through our work, we perform research to improve the resilience and sustainability of coastal areas, and to develop innovative solutions to the design of coastal infrastructures.





O.H. Hinsdale Wave Research Laboratory (HWRL) at Oregon State University, in Corvallis

- From 2004 to 2014, the HWRL was an Experimental Facility of the NSF Research **Project NEES** (Network for Earthquake and Engineering Simulation).
- Since 2016, the HWRL is an Experimental Facility of the NSF **Project NHERI** (Natural Hazards Engineering Research Infrastructure)
- In 2022, the HWRL was recipient of the International **Hamaguchi Award** conferred by PARI for our significant scientific contributions to the enhancement of community resilience against tsunami, storm surge and other coastal disasters.

- HWRL is also an associated test facility of PMEC (Pacific Marine Energy Center)
- Since 2019, the HWRL is an Experimental Facility of the US Department of Energy supported TEAMER (Testing & Expertise for Marine Energy)

TEAMER
Testing & Expertise for Marine Energy

Resources at O.H. Hinsdale Wave Research Laboratory

- Large Wave Flume
  - Piston-type wavemaker
  - Portable elevated-hinge wavemaker
  - Upcoming (2023): wind generator
- Directional Wave Basin
- Submersible Force Balance Plate
- Qualisys Motion Tracking System
- General instrumentation (wave gauges, velocimeters, pressure gauges, position transducers, axial and multi-axial load cells, IMUs, OBS, …

Large Wave Flume

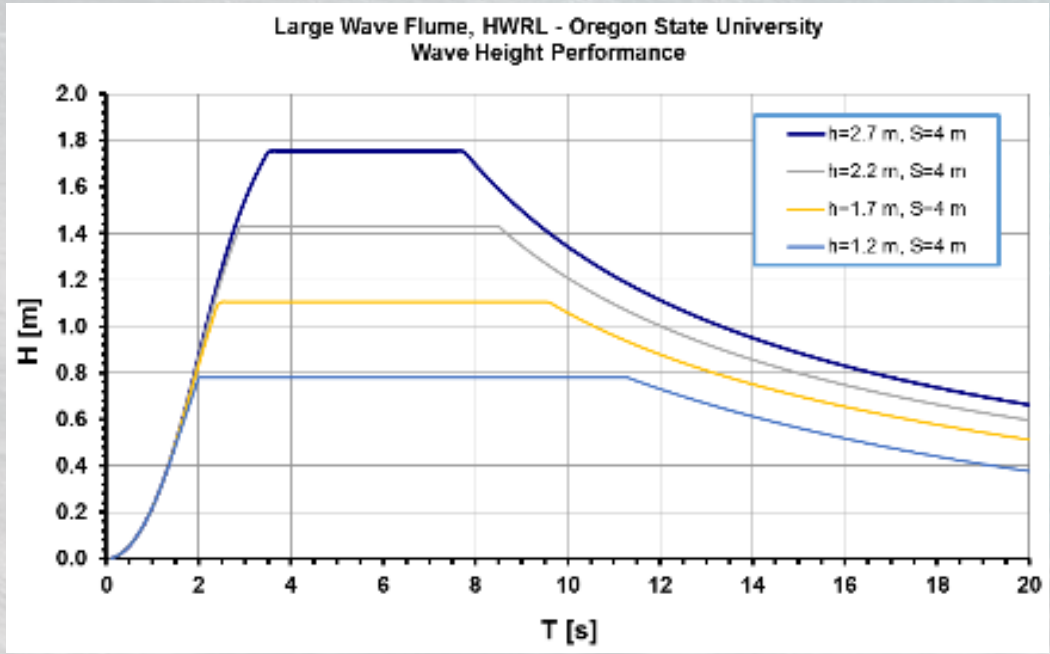
Specifications:

- Length: 104 m (342ft)
- Width: 3.7 m (12ft)
- Height: 4.6 m (15ft)
- Max water depth: 2 m (6.5 ft) for tsunami, 4 m (13.1 ft) for wind/storm waves
- Movable adjustable bathymetry/beach

Large Wave Flume – Piston-type wavemaker

Specifications:

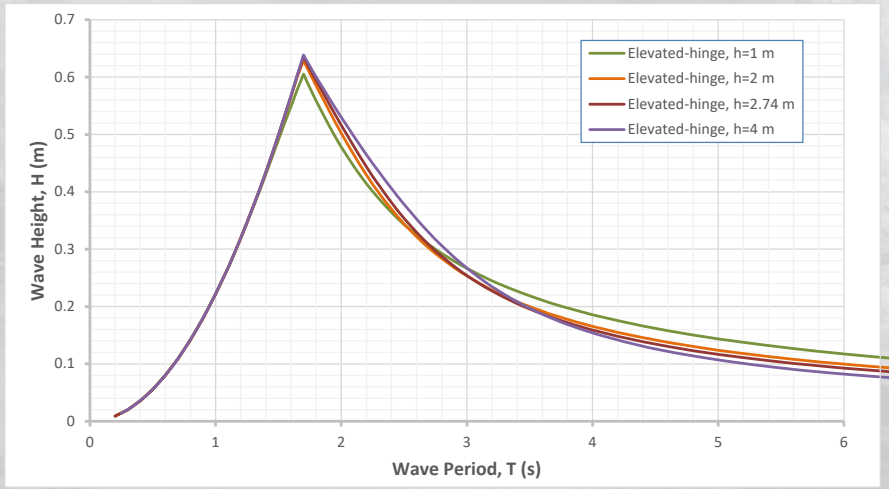
- Width: 3.7 m (12 ft)
- Height: 4.5 m (14.8 ft)
- Stroke: 4.2 m (13.7 ft)
- Max water depth: 2 m (6.5 ft) for tsunami, 2.7 m (9 ft) for wind/storm waves
- Dry-back
- Position feedback Active wave absorption (Awasys and MTS)
- 450 kW Hydraulic actuator system

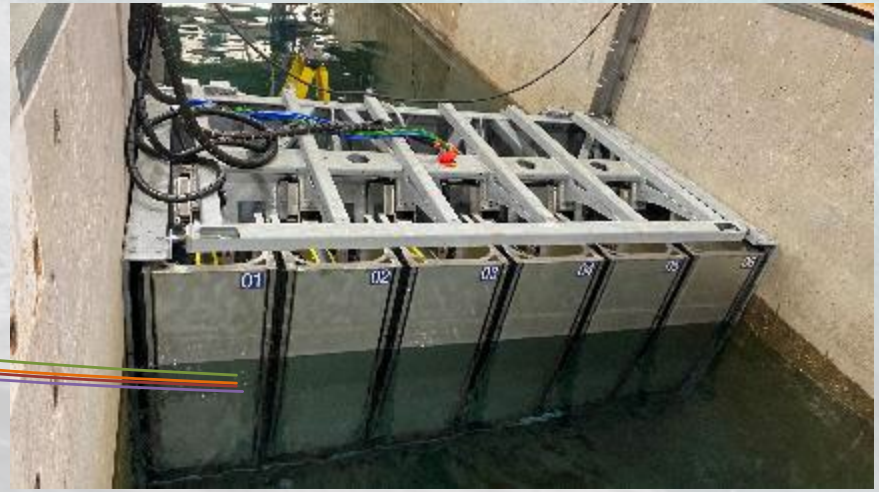


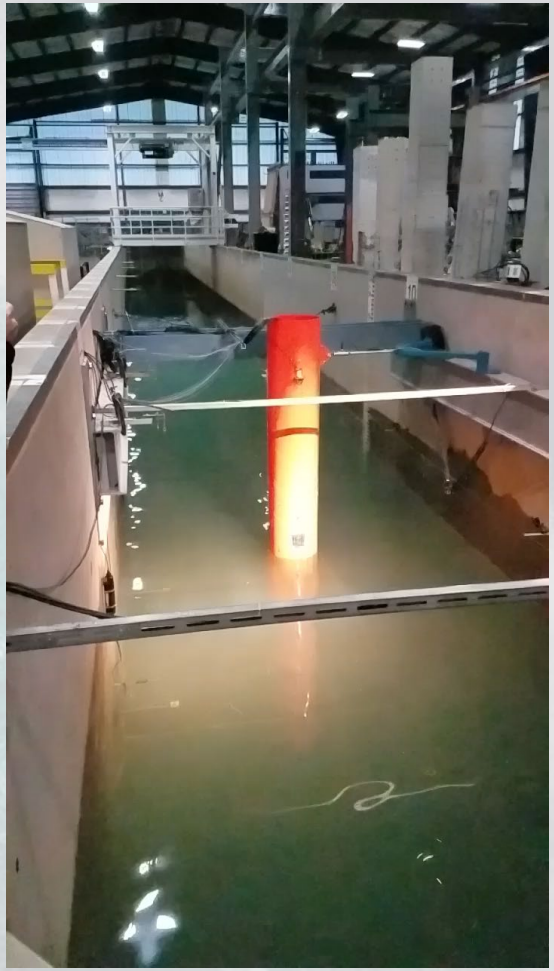
Large Wave Flume – Removable Elevated-hinge wavemaker

Specifications:

- Width: 3.7 m (12 ft)
- Height: 1.8 m (5.9 ft)
- Stroke: +/-20^{o}
- Max water depth: 4 m (13.1 ft) for deep-water waves
- Dry-back
- Force feedback Active wave absorption (Edinburgh Designs Ltd)
- 6 paddles, electric-drive
- System of deployable panels for water depths from 1.5 m to 4 m
- Compatible with double-sided generation (85 m testing section)
- Compatible with reversible current generation



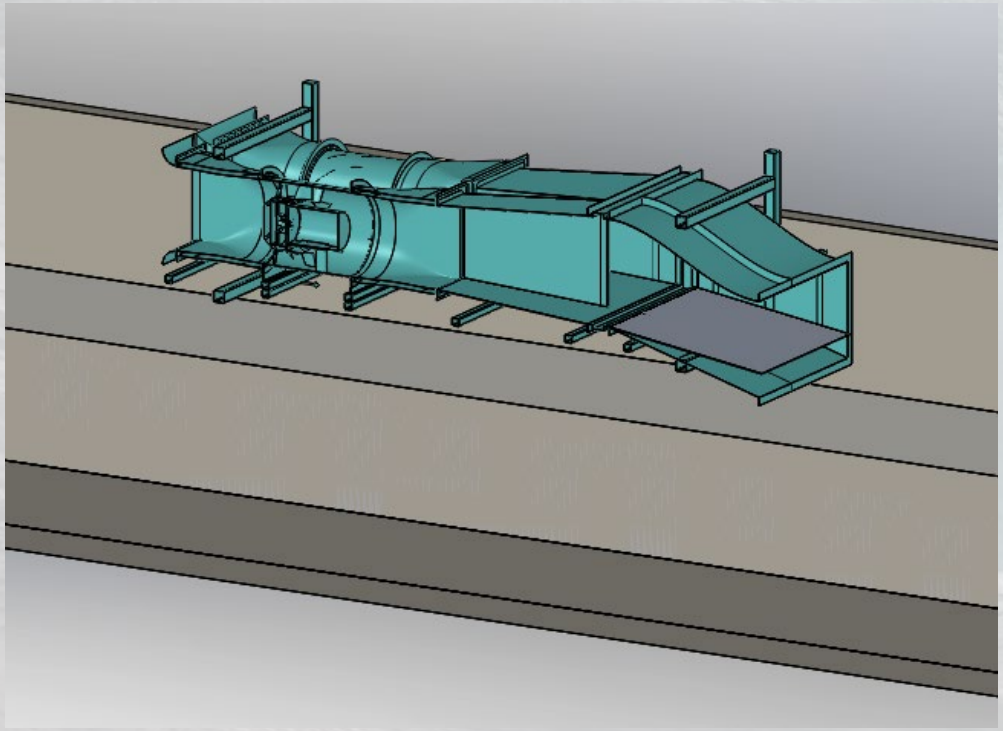


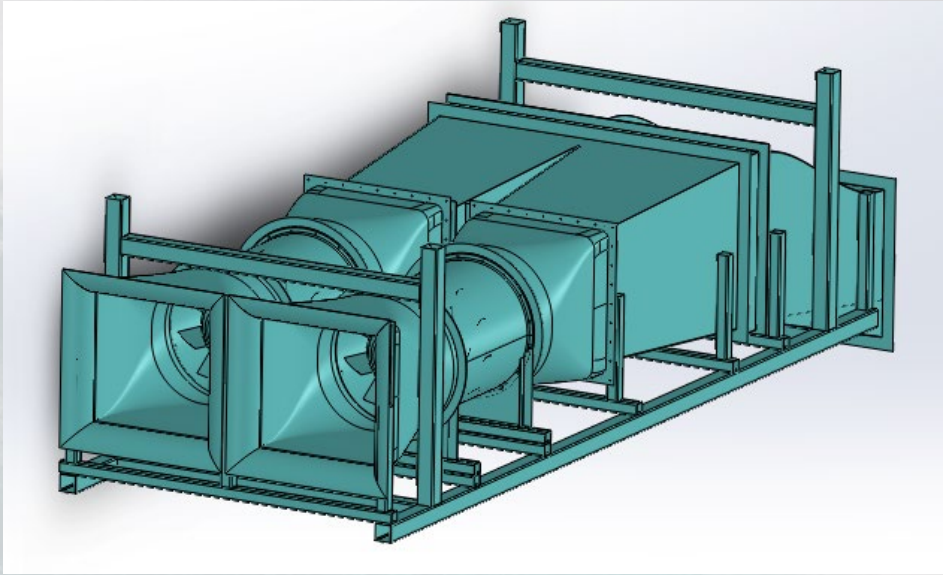


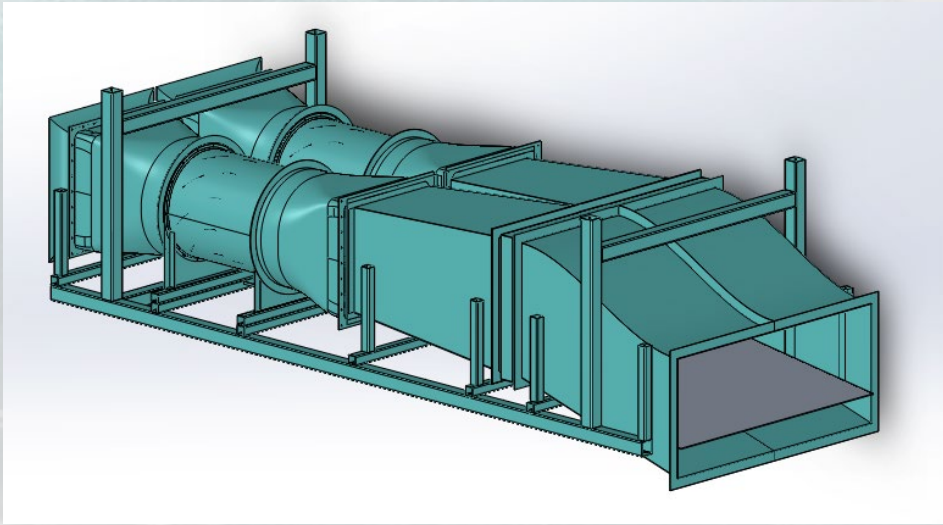
Large Wave Flume – Wind generation system

Specifications

- Maximum speed: 50 mph (22.35 m/s)
- Number of fans: 2
- Outlet dimensions: 9’ W x 2’-6” H to 9’ W x 4’ H



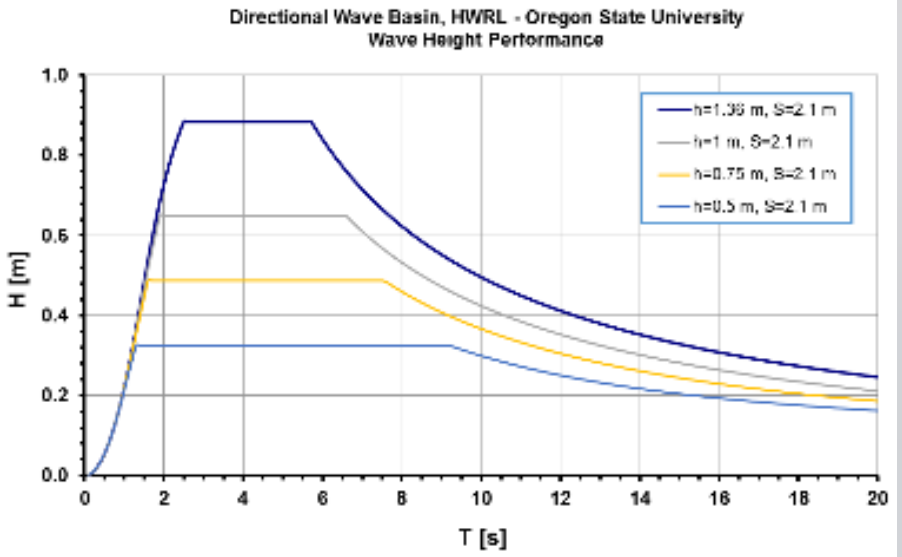


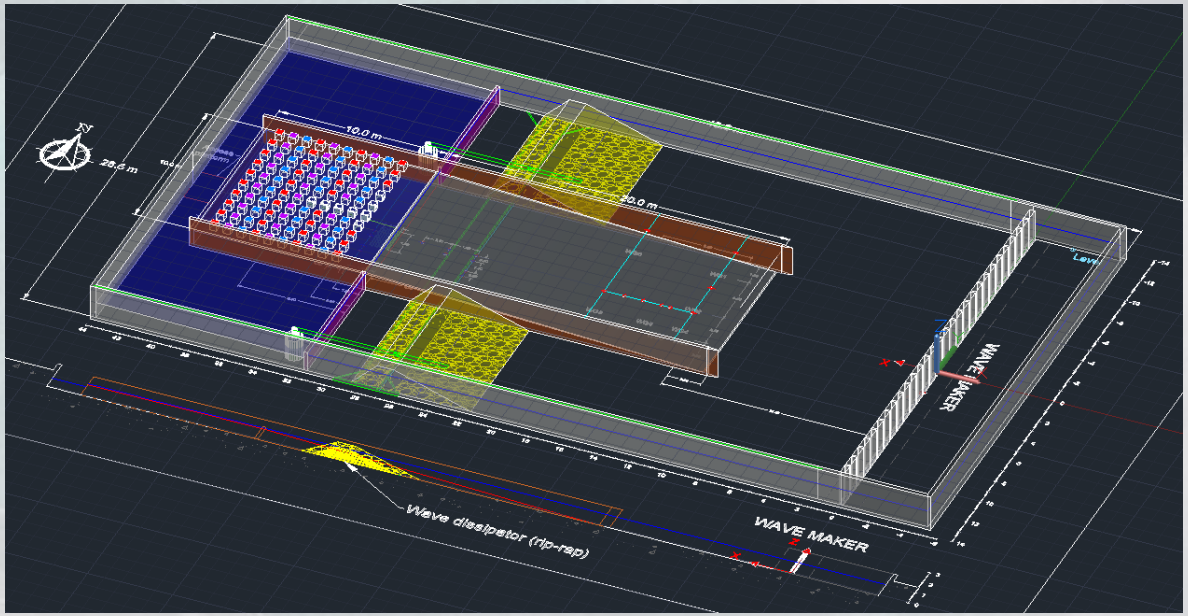


Directional Wave Basin

Specifications

- Length: 48.8 m (160 ft)
- Width: 26.5 m (87 ft)
- Height: 2.1 m (7 ft)
- Max water depth: 1 m (3.1 ft) for tsunami, 1.36 m (4.46 ft) for wind/storm waves
- Beach: 1:10 removable steel beach
- Piston-type, vertical hinge (snake-type) wavemaker
- 30 electrical actuators, 29 paddles, 2.1 m stroke

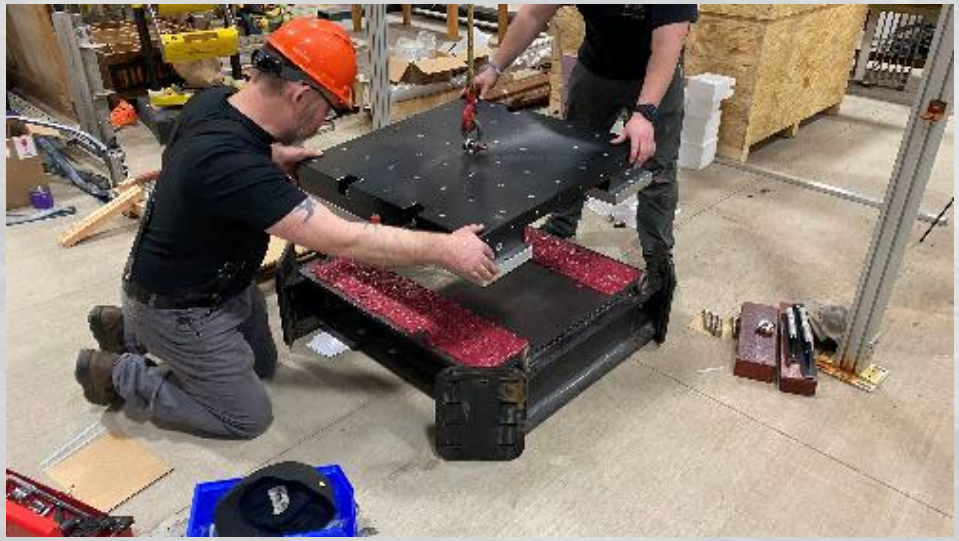




Submersible Force Balance Plate

Specifications

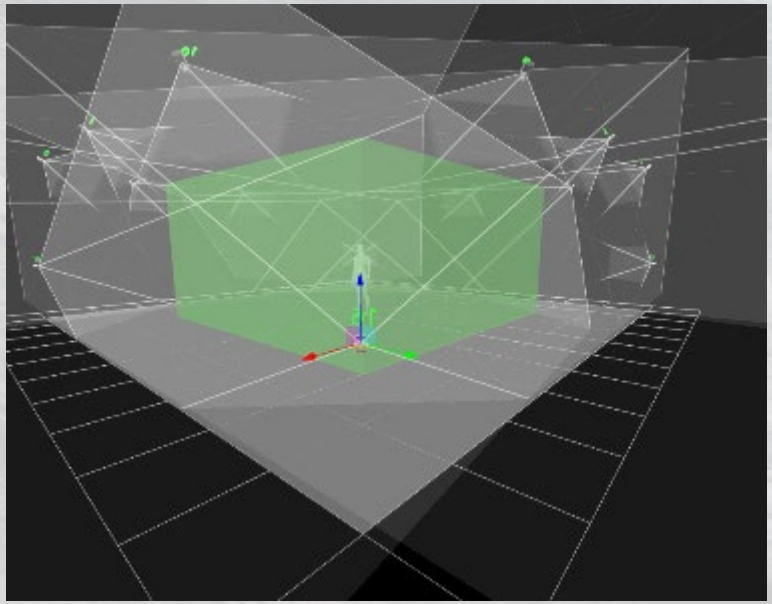
- Length: 813 mm (32 in)
- Width: 813 mm (32 in)
- Height: 100 mm (3.925 in)
- Max water depth: 5 m (IP68)
- Capacity: Fx,y= +/- 27 kN (6 kips), Fz= +/-54 kN (12 kips)
  Mx,y,z ~ +/- 20 kNm (177 kips-in)

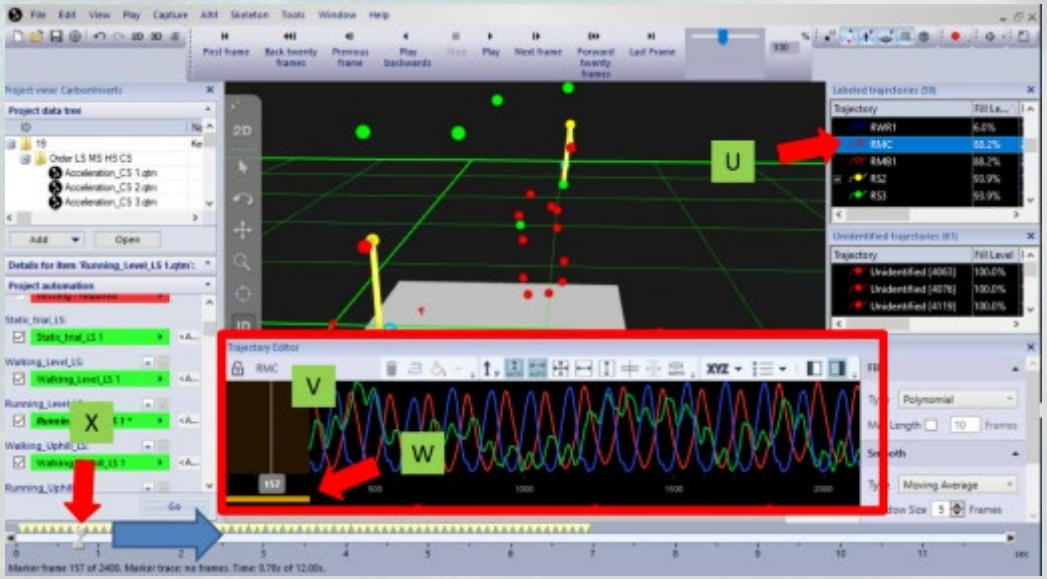


Qualisys Motion Tracking System

Specifications

- Above-water infrared cameras: 4+4
- Underwater blue-light cameras: 6
- 6DOF of rigid bodies





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NHERI Projects

Project: CMMI-1301016
Collaborative Research: Fundamental Mechanics and Conditional Probabilities for Prediction of Hurricane Surge and Wave Loads on Elevated Coastal Structures
Testing Facility: Large Wave Flume
Duration and Dates: 66 testing days, Jun 28-Oct 6 2016
Number of Trials: 450

Project: CMMI-1538190
Collaborative research: Nonlinear Long Wave Amplification in the Shadow Zone of Offshore Islands
Testing Facility: Directional Wave Basin
Duration and Dates: 45 testing days, Jul 7-Sep 7, 2016
Number of Trials: 351

Project: CMMI-1536198
Probabilistic Assessment of Tsunami Forces on Coastal Structures
Testing Facility: Large Wave Flume
Duration and Dates: 80 testing days, Dec 15, 2016-Apr 21, 2017
Number of Trials: 723

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NHERI Projects

Project: CMMI-1635784
Numerical and Probabilistic Modeling of Aboveground Storage Tanks Subjected to Multi-Hazard Storm Events
Testing Facility: Directional Wave Basin
Duration and Dates: 18 testing days, Mar 13-Mar 24 and Apr 14-Apr 27, 2017
Number of Trials: 139

Project: IIP-1621727
Telescopic Structural Flood Walls
Testing Facility: Directional Wave Basin and Large Wave Flume
Duration and Dates: 15 testing days, May 30-Jun 9 (DWB) and Jun 5-Jun 9 (LWF), 2017
Number of Trials: 22 (6+16)

Project: CMMI-1538624
Collaborative research: Non-linear long wave amplification in the shadow zone of offshore islands
Testing Facility: Directional Wave Basin
Duration and Dates: 70 testing days, Jun 26-Oct 2, 2017
Number of Trials: 434

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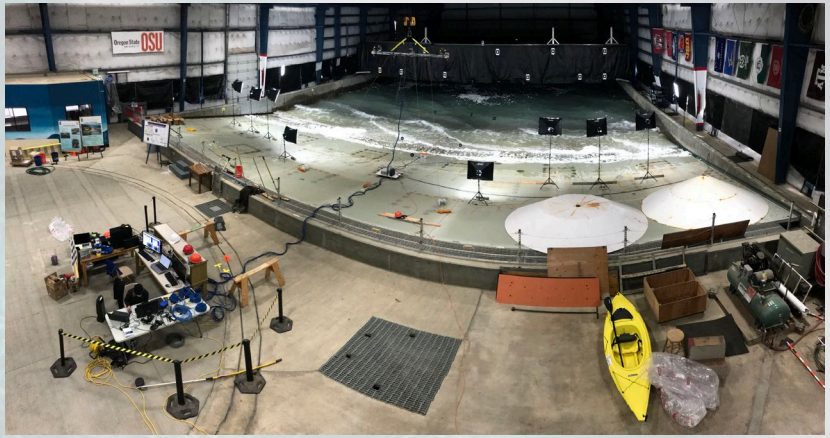
NHERI Projects

Project: CMMI-1552559
CAREER: Advancing multi-hazard assessment and risk-based design to promote offshore wind energy technology
Testing Facility: Large Wave Flume
Duration and Dates: 85 testing days, Sep 20-Oct 23, 2017 and Nov 1, 2017-Feb 16, 2018
Number of Trials: 506



Project: OCE-1735460
Transient Rip Current Dynamics: Laboratory Measurements and Modeling of Surfzone Vorticity
Testing Facility: Directional Wave Basin
Duration and Dates: 30 days, Mar 12-Apr 13, 2018 and Aug 15-Sep 12, 2018
Number of Trials: 132 (30+102)

Project: OCE-1459049
Runups of Unusual Size: Predicting Unexpectedly Large Swash Events
Testing Facility: Large Wave Flume
Duration and Dates: 3+40 testing days, Apr 23-Apr 27, 2018 and Nov-Dec 2018
Number of Trials: 35+

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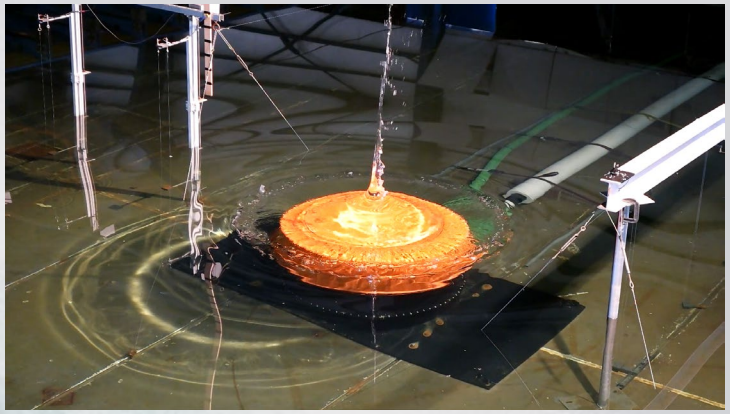
NHERI Projects



Project: CMMI-1563217
Physical modeling of submarine volcanic eruption generated tsunamis
Testing Facility: Directional Wave Basin
Duration and Dates: 50 testing days, Jun 11-Aug 15, 2018
Number of Trials: 667

Project: CMMI-1661015
Collaborative research: Wave, Surge, and Tsunami Overland Hazard, Loading and Structural Response for Developed Shorelines
Testing Facility: Directional Wave Basin
Duration and Dates: 117 testing days, Oct-Dec 2018, Jan-Apr 2019
Number of Trials: 591

Project: OCE-1756449
Collaborative research: Physics of Dune Erosion during Extreme Wave and Storm-Surge Events
Testing Facility: Large Wave Flume
Duration and Dates: 115 testing days, Jan-Feb 2019, May-Sept 2019
Number of Trials: 286

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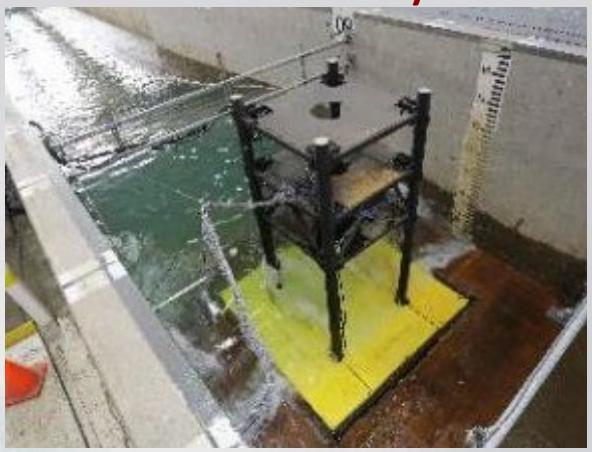
NHERI Projects

Project: CMMI-1726326
Vertical Evacuation Structures Subjected to Sequential Earthquake and Tsunami Loadings
Testing Facility: Large Wave Flume
Duration and Dates: 102 testing days, Oct-Dec, 2019, July-Oct 2020
Number of Trials: 293



Project: CMMI-1825080
Experimental Investigation of Wave, Surge, and Tsunami Transformation over Natural Shorelines
Testing Facility: Large Wave Flume
Duration and Dates: 59 testing days, Oct 2020 – Jan 2021
Number of Trials: 340 trials

Project: CMMI-1933184
Understanding and Quantifying Structural Loading from Tsunami-Induced Debris Fields
Testing Facility: Large Wave Flume
Duration and Dates: 60 testing days, Feb-May, 2021
Number of Trials: 701

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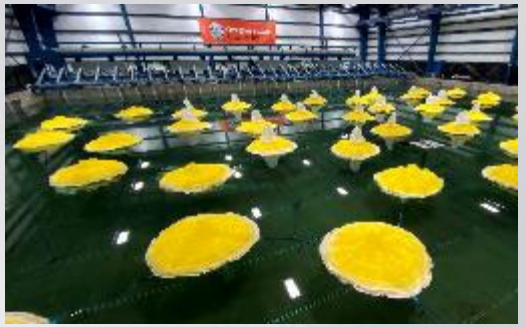
NHERI Projects



Project: IIP-2016199
SBIR Phase I: The Emerald Tutu
Testing Facility: Directional Wave Basin
Duration and Dates: 45+ testing days, June-Aug 2021
Number of Trials: 100+
Testing Facility: Large Wave Flume
Duration and Dates: 15 testing days, June 2022

Project: CMMI-
CAREER: Accelerating Real-time Hybrid Physical-Numerical Simulations in Natural Hazards Engineering with a Graphics Processing Unit (GPU)-driven Paradigm
Testing Facility: Large Wave Flume
Duration and Dates: 20 testing days, July 2022

Project: CMMI-2048616
Infrared Remote Sensing of Cooling Whitecap Foam to Quantify Wave Breaking and Aeration
Testing Facility: Large Wave Flume
Duration and Dates: 15 testing days, Aug 2022

Project: CMMI-2050808
Collaborative research: Hybrid Flow-Sediment-Structure Interaction Analysis of Extreme Scour due to Coastal Flooding
Testing Facility: Large Wave Flume
Duration and Dates: 40 testing days, Aug 2024

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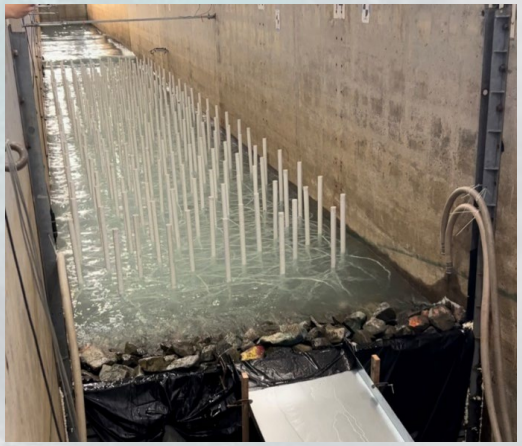
NHERI Projects

Project: CMMI-2215297
MRI: Development of a Shared-Use Experimental Platform to Study Wind, Hydrodynamic, and Biochemical Conditions in the Littoral Zone During Extreme Coastal Storms
Testing Facility: Directional Wave Basin
Duration and Dates: 15+15 testing days, January and April 2023

Project: CMMI-2203131
Collaborative Research: Experimental Quantification of Tsunami-driven Debris Damming on Structures
Testing Facility: Directional Wave Basin
Duration and Dates: 60 testing days, March 2023



Project: CMMI-2110439
Collaborative Research: Understanding Hybrid Green-Gray Coastal Infrastructure Processes and Performance Uncertainties for Flood Hazard Mitigation
Testing Facility: Large Wave Flume
Duration and Dates: 40 testing days, June 2023

Project: CMMI-2131961
Mid-scale RI-1 (M1:DP): National Full-Scale Testing Infrastructure for Community Hardening in Extreme Wind, Surge, and Wave Events (NICHE)
Testing Facility: Large Wave Flume
Duration and Dates: 40 testing days, Sept 2023


HWRL
NSF