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UC San Diego
JACOBS SCHOOL OF ENGINEERING
Structural Engineering

DesignSafe Cyberinfrastructure for Research in Natural Hazards Engineering

*Tim Cockerill, Ph.D.
Texas Advanced Computing Center
The University of Texas at Austin*

***Joint Researcher Workshop
UC San Diego, Lehigh & SimCenter***

***December 16-17, 2019
University of California, San Diego***



LEHIGH NHERI
Real-Time Multi-Directional Testing Facility



SIMCENTER
COMPUTATIONAL MODELING
AND SIMULATION CENTER







DESIGNSAFE-CI



NHERI: NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE

DesignSafe Cyberinfrastructure for Research in Natural Hazards Engineering



Tim Cockerill, Ph.D.

*Deputy Project Director, DesignSafe
Director of User Services, TACC
Texas Advanced Computing Center (TACC)
University of Texas at Austin*



What is DesignSafe?

- A web-based research platform that provides tools to manage, analyze, and understand critical data for natural hazards research

DesignSafe Vision

- A cyberinfrastructure (CI) that is an integral part of research discovery
 - Provide a platform for data sharing/publishing
 - Enable research workflows and access to high performance computing (HPC)
 - Deliver cloud-based tools that support the analysis, visualization, and integration of diverse data types
- Amplify and link the capabilities of natural hazards researchers in the US and abroad





- DesignSafe cyberinfrastructure
- Seven experimental facilities
- RAPID reconnaissance facility
- Computational modeling and simulation center (SimCenter)
- Coordinating Office (NCO)





Research Workbench ▾

- Data Depot
- Workspace
- Recon Portal
- SimCenter Research Tools
- User Guides

Learning Center ▾

NHERI Facilities ▾

NHERI Community ▾

About

Help ▾

Search DesignSafe



Learn how to
Start Using DesignSafe

Browse the Data Depot's
Published Data Sets

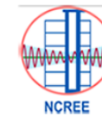
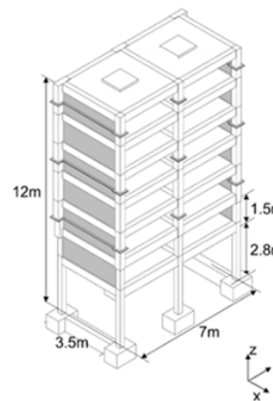
Join the conversation in
DesignSafe's Slack Channel

Learn more about
NHERI, the NCO & DesignSafe



**NHERI Five-Year
Science Plan**

used research
network that
al tools needed to
understand critical
research.



3-D and first storey plan view of test specimens

QuakeCoRE/NCREE Blind Prediction Competition

The QuakeCoRE center in New Zealand, in collaboration with the National Centre for Research on Earthquake Engineering (NCREE) in Taiwan and DesignSafe in the US, is excited to announce a competition to predict the response of reinforced concrete (RC) structures with torsional irregularities to earthquake shaking. Expressions of interest are due by 5 pm on May 01, 2019 (New Zealand time).

[FIND MORE NEWS IN THE NEWSROOM](#)

DesignSafe Research Workbench

- Data Depot Data Repository
 - Private space (My Data)
 - Collaboration space (My Projects) for data sharing and ultimate publishing
 - Publicly accessible space (Published) for curated data from My Projects
 - Publicly accessible space (Community Data) for uncurated data
- Discovery Workspace
 - Apps/tools for computational simulation, data analysis, etc. with access to files in Data Depot
- Reconnaissance Portal: discover published reconnaissance data

Data Depot: My Projects

DATA DEPOT

+ Add

My Data

My Projects

Shared with Me

Box.com

Dropbox.com

Google Drive

Published

Find in My Projects



Rename

Move

Copy

Preview

Download

Move to Trash

Project ID	Project Title	PI	Last Modified
PRJ-2440	Ridgecrest, CA earthquake, July 4, 2019	Scott Brandenburg	9/11/19 8:56 AM
PRJ-2531	TxDoT - Seismic Vulnerability and Post-Event Actions	Patricia Clayton	8/29/19 1:36 PM
PRJ-1716	NHERI TallWood Project_Task 4a	Shiling Pei	8/29/19 9:31 AM
PRJ-1437	Simulation Test Project	Ellen Rathje	8/28/19 2:31 PM
PRJ-2466	DesignSafe-QuakeCoRE Cyberinfrastructure Workshop	Ellen Rathje	8/27/19 2:53 AM
PRJ-1729	NHERI@UTexas Nonintrusive Sinkhole 3D-Imaging Workshop	Kenneth Stokoe	8/21/19 10:34 AM
PRJ-2504	Vorticity-Advection-RODSEX experiment	Steve Elgar	8/19/19 1:27 PM

***A space to share files/data/results with collaborators
and to eventually publish for public use***

Data Curation Philosophy








- Allow users to easily store, share, document, and publish data throughout the life of a research project
- Flexible data models and interactive curation
 - Allows researchers to decide how to represent their research
 - Support different types of data
 - Consider what is needed for data to be understandable by others for data reuse



DesignSafe Data Models

Structured, yet flexible, data models for different types of research

-  **Experimental Project**
For physical work, typically done at an experimental facility or in the field.
-  **Simulation Project**
For numerical and/or analytical work, done with software.
-  **Hybrid Simulation Project**
For work using both physical and numerical components.
-  **Field Research Project**
For work done by observation in areas affected by a natural hazard.
-  **Other Project**
For work other than the project types above.

Curation

- Define categories
- Categories assigned to files/folders
- Relate categories to organize data

Curation Process

PRJ-2363
SILTS AND

PI
CoPIs
Project Type
Awards
Keywords

Earthquake-indu
exhibiting either
soils, which are
and not in the fr
centrifuge mode
containing all of

Working Direc

Main / Experime

☒ Name

☐ .ipynb_

☐ 020720

☐ 020720

☐ 02072018@092140@112100@64.4rpm.txt

Relate Data

JZB01

Report

Digital Data Report ↑ ↓ Remove

-- Choose a Report --

Model Config

Structural Model ↑ ↓ Remove

Sensor

Pluck Testing ↑ ↓ Remove

Event Pluck Testing ↑ ↓ Remove

-- Choose an Event --

Sensor

Consolidation on Hydraulic Press ↑ ↓ Remove

Event Consolidation on Hydraulic Press ↑ ↓ Remove

-- Choose an Event --

18.0 MB 5/28/19 10:24 AM

Publication Preview

1 Add Experiments | 2 Add Categories | 3 Relate Data

	Size	Last modified
	--	5/28/19 10:25 AM

Save

Curation Process

Working Directory Curation Directory Publication Preview 1 Add Experiments | 2 Add Categories

Main / Experiment JZB01

☒ Name

☐ .ipynb_checkpoints

-- Select a Collection -- Save

☐ 02072018@092140.bin

Slow Data from Spin 5 (Administered Dynamic Shaking) Remove Slow Data Remove

-- Select a Event File Tag -- Save

-- Select a Collection -- Save

☐ 02072018@092140@112100@64.4rpm.bin

Fast Data from Spin 5 (Dynamic Shaking Data) Remove Fast Data Remove

-- Select a Event File Tag -- Save

-- Select a Collection -- Save

☐ 02072018@092140@112100@64.4rpm.txt

Fast Data from Spin 5 (Dynamic Shaking Data) Remove Fast Data Remove

-- Select a Event File Tag -- Save

-- Select a Collection -- Save

Working Directory Curation Directory Publication Preview Prepare to Publish

Report | Data Processing

Experiment | JZB01

Experiment Type Centrifuge

Authors Buenker, Jason; Brandenburg, Scott; Eslami, Mohammad; Stewart, Jonathan

Experimental Facility Center For Geotechnical Modeling, UC Davis

Equipment Type 9m Radius Dynamic Geotechnical Centrifuge

Date of Experiment 08-21-2017 — 02-08-2018

Date of Publication (Appears when published)

DOI (Appears when published)

License(s) (Appears when published)

This experiment tested three structures resting on a fine-grained soil layer consisting of non-plastic silt blended with bentonite. A sequence of earthquake ground motions was applied to the model container. Measurements included acceleration, displacement, pore pressure, bending strain, axial strain, and shear wave velocity.

Report | Digital Data Report

An interactive Jupyter notebook that describes Experiment JZB01.

Main / Experiment JZB01

UCLA_ModelJZB01_DataReport.ipynb 844.7 kB

Model Configuration | Structural Model

→ Sensor Information | Centrifuge (consolidation)

→ Event | Fast Data from Spin 5 (Dynamic Shaking Data)

→ Event | Slow Data from Spin 1 (Structure 1 Tipped Over)

→ Event | Slow Data from Spin 2 (Structure 1 Tipped Over)

Data Depot Search

DATA DEPOT

+ Add

My Data
My Projects
Shared with Me
Box.com
Dropbox.com
Google Drive
Published
Community Data

[Curation Tutorials](#)
[Curation Guidelines](#)
[Learn About the Data Depot](#)

liquefaction



Rename



Move



Copy



Preview



Preview Images



Citation



Download



Move to Trash

[← Back to all publications](#)

42 Results found for **liquefaction**

Publication Type

☐ Experimental ☐ Simulation ☐ Hybrid Simulation ☐ NEES ☐ Other

Publication Title	Author	Publication Description	Keywords	Date of Publication
LEAP-Asia-2018: Stress-strain response of Ottawa sand in Cyclic Torsional Shear Tests (Experimental)	Ueda, Kyohei	View Description	Cyclic Torsional Shear, Liquefaction resistance, Ottawa sand, Stress-strain response	12/4/2018
UNDERGRADUATE RESEARCH EXPERIENCE (REU), NHERI 2018: THE LIQUEFACTION POTENTIAL OF GROUND MODIFIED BY POORLY BUILT RAMMED AGGREGATE PIERS (Other)	Re, Abigail	View Description	Mobile Shakers, Rammed Aggregate Pier, Multi-Mode Device, Free-Free Resonant Column, Modified Effort Compaction, Liquefaction	8/9/2018
Next Generation Liquefaction (NGL) Partner Dataset - Boring Log Viewer (Other)	Brandenberg, Scott	View Description	Liquefaction, Database, Boring Log	3/11/2019



Published Dataset

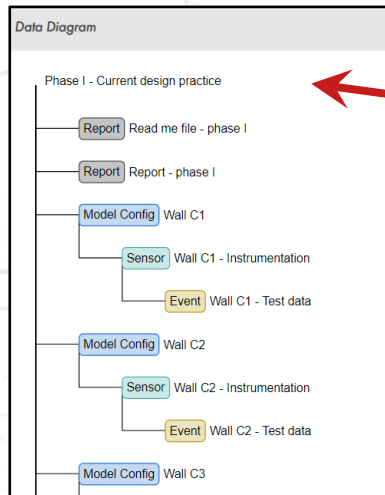
DATA DEPOT

+ Add

Published

Community Data

Help



walls



Rename

Move

Copy

Preview

Download

Move to Trash

PRJ-1648 | UNIVERSITY OF AUCKLAND LIGHTLY REINFORCED CONCRETE WALL TESTS

PI

Henry, Rick

DOI

10.17603/ds2-tshe-kd83

Project Type

Experimental

Keywords

Reinforced Concrete, Wall, Seismic Design, Minimum Vertical Reinforcement, Plastic Hinge Region, Reinforcement Buckling, Reinforcement Fracture, Concrete Design Standards

A series of experimental tests of large-scale lightly reinforced concrete walls were conducted at the University of Auckland. The test were used to investigate minimum vertical reinforcement provisions and formed the basis for revisions to the New Zealand Concrete Structures Standard (NZS 3101:2006 (A3)) and the US Building Code Requirements for Structural Concrete (ACI 318-19). This dataset summarizes the results from the 11 tested walls including all sensor data (load cell, LVDT, string-pot displacement gauge, displacement transducer and strain gauge). Detailed instrumentation plan, loading protocol, test sequences, test observations and photos that were taken throughout the testing are also provided. The dataset is intended to serve as a reference for future work, as well as an open resource to be used in future research.

View Data Diagram

Experiment | Phase I - Current design practice

Experiment Type

Other

Authors

Lu, Yiqiu; Henry, Rick

Experimental Facility

Other

Equipment Type

Other

Date of Experiment

04-07-2014 — 09-01-2014

Date of Publication

10-07-2019

DOI

10.17603/ds2-3v8q-7k69

License(s)

Open Data Commons Attribution

Six reinforced concrete walls designed with minimum distributed vertical reinforcement in accordance with NZS 3101:2006 (Amendment 2)

Report | Read me file - phase I

Report | Report - phase I

Model Configuration | Wall C1

Sensor Information | Wall C1 - Instrumentation

Event | Wall C1 - Test data

Model Configuration | Wall C2

Make ****your**** data count!

- **Formally publish** data sets in stable data repositories
 - Include data processing scripts, visualizations, etc.
- Data needs a permanent, **digital location (DOI)** not just a URL
 - List curated data sets on your CV
- Formally cite data **in your reference list** of your paper using DOI, citation language as indicated in DesignSafe



PRJ-2432 | BAYESIAN IDENTIFICATION OF A PROTOTYPE NONLINEAR ENERGY SINK DEVICE

PI Lund, Alana
CoPIs Billionis, Ilias; Dyke, Shirley; Song, Wei
DOI [10.17603/ds2-2etk-mr72](https://doi.org/10.17603/ds2-2etk-mr72)
Project Type Experimental
Related Work Lund, A., S.J. Dyke, W. Song, & I. Billionis (In press). Global Sensitivity Analysis for the Design of Nonlinear Identification Experiments. Nonlinear Dynamics.
Keywords Nonlinear Energy Sink, System Identification, Sobol' Sensitivity Analysis, Unscented Kalman Filter

Nonlinear energy sinks devices are structural attachments which have the potential to enhance passive structural control in earthquake-sus structures, similar to tuned mass dampers. These devices are designed to leverage geometric nonlinearities in their construction to extract energy from the primary structure over a wide range of frequencies. Prior to implementing these devices in real-world structures, additional characterization of their behavior and establishment of identification and monitoring techniques is necessary. In this project, the results of w given in the linked publications, we develop a robust method for identifying a prototype nonlinear energy sink device which leverages Sobol analysis to inform the implementation of an unscented Kalman filter identification approach.

Citation

Lund, Alana; Silva, Christian; Dyke, Shirley; Song, Wei; Billionis, Ilias (2019-07-15)
"Bayesian Identification of a Prototype Nonlinear Energy Sink Device." DesignSafe-CI.
<https://doi.org/10.17603/ds2-2etk-mr72>.

[Download Citation](#)

Reconnaissance Portal

Identifying Archived Datasets from Recon Events





Discovery Workspace

- Cloud-based tools and HPC enabled codes (Stampede2)
- Access to files in the Data Depot

WORKSPACE

[Learn About the Workspace.](#)

Simulation [8]	Visualization [7]	Data Processing [2]	Partner Data Apps [5]	Utilities [2]	My Apps [7]
Jupyter 	MATLAB 				

Browsing: erathje

File name

- .ipynb_checkpoints
- .Trash

Select an application from the tray above.

The *Workspace* allows users to perform simulations and analyze data using popular simulation codes including OpenSees, ADCIRC, and OpenFOAM, as well as data analysis and visualization tools including Jupyter, MATLAB, Paraview and VisIt.

Jobs Status

DesignSafe Discovery Workspace



- Data analysis in the cloud
 - Matlab: data analysis and plots, batch processing
 - Jupyter: electronic notebook that supports Python and R analysis
- Visualization
 - HazMapper: DesignSafe version of “Google Maps”
 - Potree: Create, view, and analyze point cloud data
 - QGIS: geospatial data analysis





Electronic Notebook

ReadWriteCentrifugeBinaryFastData_v_4

File Edit View Insert Cell Kernel Help

Project Name:

Development of validated methods for soil-structure interaction analysis of buried structures

Project Team:

Elnaz Esmaeilzadeh

Funded by:

California Department of Transportation

Instructions:

This code is for writing data to a file.

The user can:

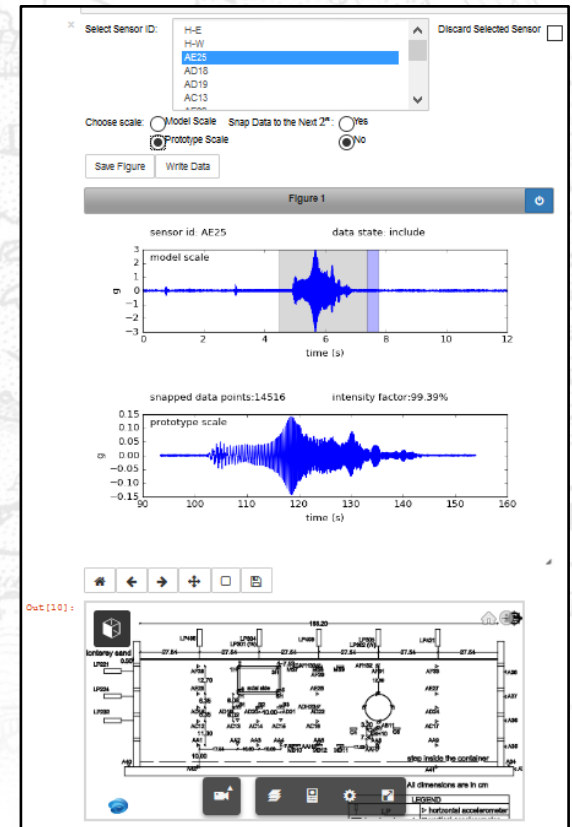
- 1) Discard the sensor data
- 2) Truncate data to a specific time range

```
bwrite = widgets.Button(description='Write Data')
bdiscard = widgets.Checkbox(description='Discard Selected Sensor', value = False)
bsave = widgets.Button(description='Save Figure')
bmodpro = widgets.RadioButtons(description='Choose scale: ', options=['Model Scale', 'Prototype Scale'])
bsnap = widgets.RadioButtons(description='Snap Data to the Next 2s: ', options=['Yes', 'No'], value = 'No')

ccontainer = widgets.HBox(children=[sensor_select, bdiscard])
rcontainer = widgets.HBox(children=[bmodpro, bsnap])
bcontainer = widgets.HBox(children=[bsave, bwrite])
display(ccontainer)
display(rcontainer)
display(bcontainer)

bdiscard.observe(callback.discard)
bmodpro.observe(callback.scaledata)
bsnap.observe(callback.snap)
bwrite.on_click(callback.writedata)
bsave.on_click(callback.savefigure)
callback.truncate()
```

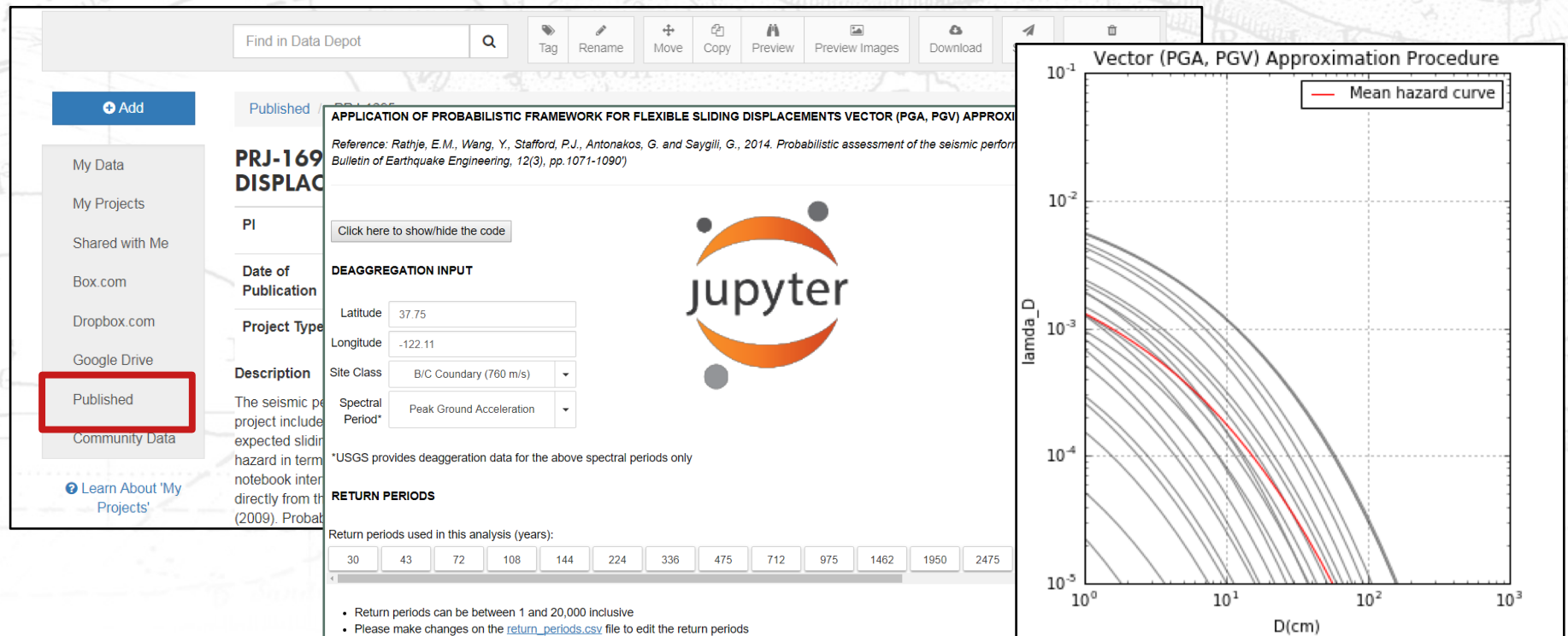
Intensity Factor = $\frac{\sum_{i=1}^N i_i^2(t_i)}{\sum_{i=1}^N i_i^2(t_i)}$ where $1 \leq i_i \leq N$



From Prof. S. Brandenburg, UCLA



Published Scripts to Aid Research to Practice




Recon Portal → Data Depot → Workspace

The screenshot displays the Recon Portal interface, which is divided into several sections:

- Left Sidebar:** Contains a navigation menu with options: "Add", "My Data", "My Projects", "Shared with Me", "Box.com", "Dropbox.com", "Google Drive", "Published", and "Community Data". Below the menu is a "Curation Tutorials" link.
- Main Content Area:** Displays a project titled "2016 Kaikoura Earthquake" with a date of "2016-11-14". Below the title, a red box highlights the "Available datasets" section, which lists:
 - Kaikoura Earthquake Reconnaissance
 - GEER Reconnaissance Report
 - Landslide Inventory
- Right Panel:** Shows the "HazMapper" interface. It includes a "New Layer Group" button and a list of layers for the "Kaikoura Landslide Recon" project. The layers are categorized into "Wartman photos", "Rathje Photos", "Cow Slip Slide", "Coastal Slide", "Leader River Slide", "Image", "Culvert", "GPS tracks", "Rathje Dec 1 2016", "Rathje Dec 3 2016", "UT Landslide Inventory", and "Landslide Inventory".
- Bottom Right:** A text box explains that maps can be created and edited in the Hazmapper and shared with other researchers via the DataDepot. A "Launch Hazmapper" button is located below this text.

Potree Point Cloud Viewer



The screenshot displays the Potree Point Cloud Viewer interface. On the left, a sidebar shows a file browser with a tree structure including folders like 'My Data', 'Trash', 'archive', 'CE31', 'Centr', 'Conte', 'EF_Je', 'erathje', and 'jupyter'. The main view shows a 3D point cloud of a traditional building with multiple tiers and a central tower. On the right, a 'DATA DEPOT BROWSER' panel is visible, showing a 'Select data source' dropdown set to 'My Data' and a 'Browsing:' section with a list of files. Below this, a 'RUN POTREE VIEWER' panel is shown, which includes a 'View pointclouds in Potree format.' section with a link to 'Potree Viewer Documentation' and an 'Inputs' section with a text box for a folder path. A text box is overlaid on the right panel, containing the following text:

Olsen et al. (2017) "Lidar Scans of Reinforced Concrete Building Performance following the April 25, 2015 Nepal Earthquake", DesignSafe-CI [publisher], Dataset, <https://doi.org/10.17603/DS2P082>

Computational Simulation Codes

- OpenSees: FE code for seismic analysis of structures and soil
 - OpenSees Express: runs on a virtual machine
 - OpenSees MP and SP: run on Stampede2 supercomputer
 - Python interpreter OpenSeesPY available through Jupyter
 - STKO (Scientific Tool Kit for OpenSees) and GID: OpenSees pre/post processing
- LS-Dyna: Commercial FE code for structures and soil
 - “Bring Your Own License”, Runs on Stampede2

Computational Simulation Codes

- ADCIRC: storm surge modeling
 - ADCIRC: serial version
 - PADCIRC: parallel version on Stampede2 and Lonestar5
 - PADCIRC + SWAN: includes near shore waves
 - Kalpana available to convert NetCDF to Shapefiles
 - FigureGen available to create images of ADCIRC output
- OpenFOAM: computational fluid dynamics
- Clawpack/GeoClaw: PDE solver for storm surge modeling

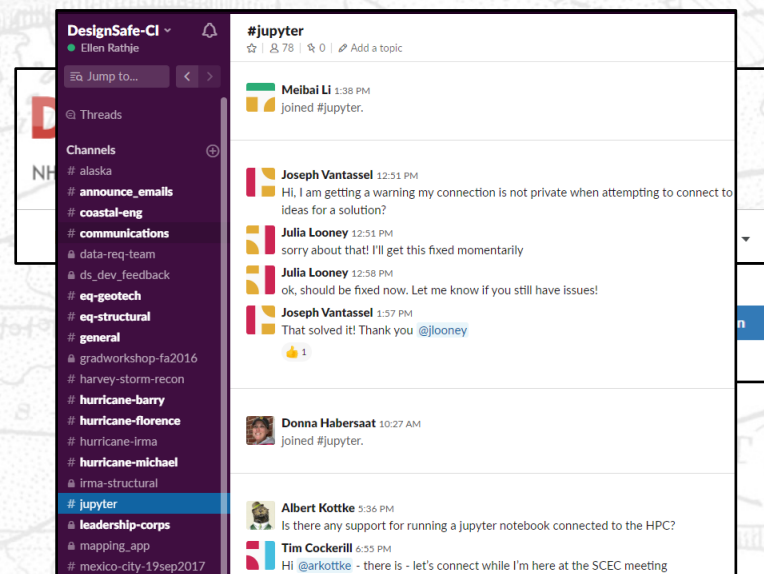
Direct Supercomputer Access

- Are you using an application not available on the portal?
- Are you running jobs that require more nodes?
- You can request a DesignSafe HPC allocation
<https://www.designsafe-ci.org/rw/user-guides/allocations-policy/>

DesignSafe: Open for Business

**Available to the Global Natural Hazards
Research Community**

- Interact with us and the community using the DesignSafe Slack team
- Cite data using DOIs!
- Cite DesignSafe marker paper (Rathje et al. 2017, *Natural Hazards Review*) if you use DesignSafe in your research



Please share your feedback, ideas, experiences!

Tim Cockerill cockerill@tacc.utexas.edu

