

# NEES: The George E. Brown, Jr. Network for Earthquake Engineering Simulation

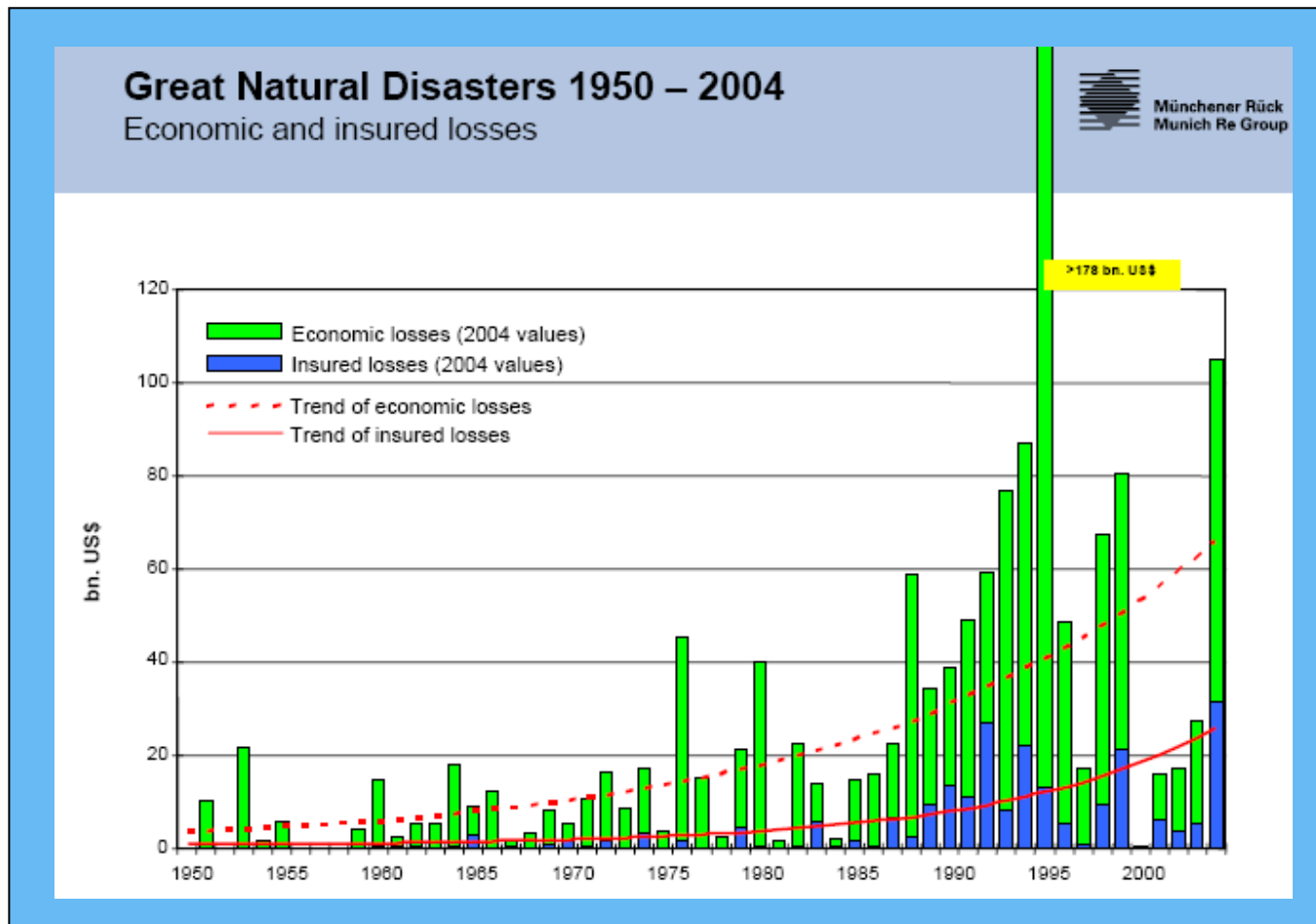


# Solving a Complex Problem

Earthquake	Date	Magnitude	Number of Deaths
Chile (& tsunami)	May 22, 1960	9.5	4,000 to 5,000
Alaska (& tsunami)	Mar. 28, 1964	9.2	125
Sumatra (& tsunami)	Dec. 26, 2004	9	283,106
Tohoku, Japan (& tsunami)	Mar. 11, 2011	9	15,000+
Michoacan, Mexico	Sept. 19, 1985	8	9,500 (estimates as high as 30,000)
San Francisco	Apr. 18, 1906	7.8	3,000
Sichuan, China	May 12, 2008	7.9	69,180
Taiwan	Sept. 20, 1999	7.7	2,297
Pakistan	Oct. 8, 2005	7.6	80,361
Tangshen, China	Jul. 27, 1976	7.5	255,000 (estimates as high as 655,000)
Haiti	Jan. 12, 2010	7	222,570
Loma Prieta	Oct. 18, 1989	6.9	63
Kobe, Japan	Jan. 16, 1995	6.9	5,502
Northridge	Jan. 17, 1994	6.7	60

Source: USGS <http://earthquake.usgs.gov/eqcenter/top10.php>

# Societal Losses Are Enormous (and increasing)



1995  
Kobe: \$100 billion

1999  
Izmit: \$13 billion  
Taiwan: \$12 billion  
Typhoon Bart  
Hurricane Floyd  
Swiss floods

For comparison:  
2005  
Hurricane Katrina  
\$100 billion

Source: Worldwide Natural Disasters: Effects and Trends, Munich Reinsurance 2005

# Mission

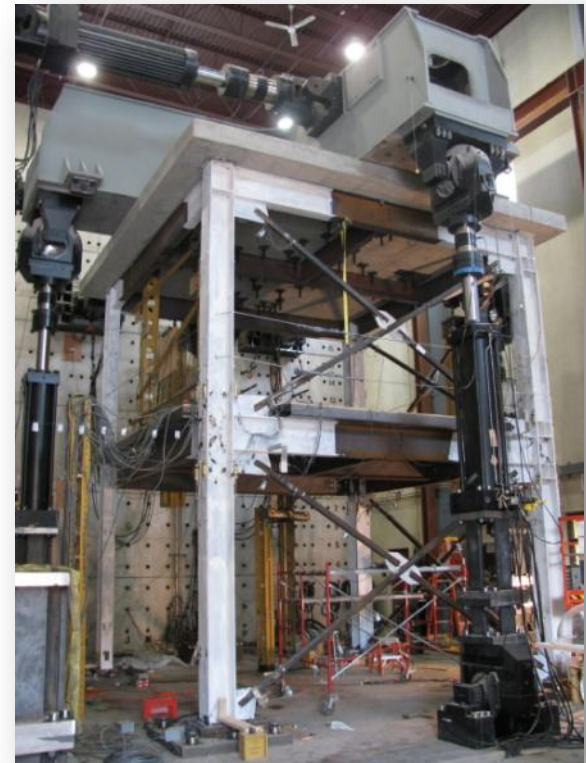


***NEES's mission is to accelerate improvements in seismic design and performance by serving as an indispensable collaboratory for discovery and learning.***



# NEES is a Collaboratory – The First One of its Kind

- ▶ 14 geographically distributed equipment sites
  - \$82 million construction
  - \$20 million annual operations
- ▶ A laboratory without walls
  - Perform research from anywhere
  - Teleobservation
  - Teleoperation
- ▶ Meant to revolutionize the way engineers do research
- ▶ Decade long initial operation plan, 2004–2014+



[www.nees.org](http://www.nees.org)

Oregon State University

University of Minnesota

University of California Berkeley

University of Illinois- Urbana

University of California Davis

University of Buffalo

University of California Santa Barbara

Cornell University

University of California Los Angeles

Rensselaer Polytechnic Institute

University of California San Diego

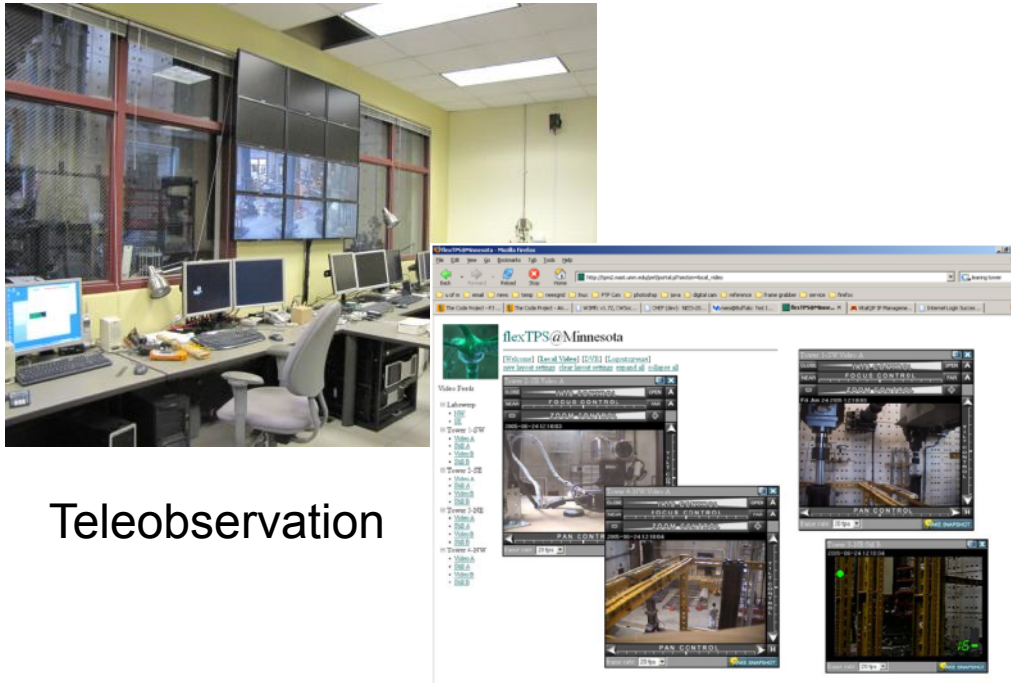
University of Nevada Reno

University of Texas Austin

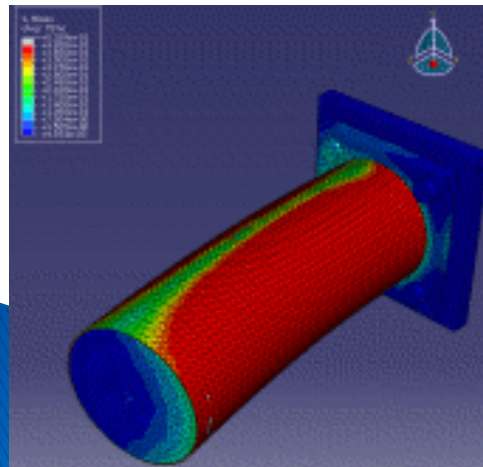
Lehigh University



# Cyberinfrastructure



Teleobservation



Numerical Simulation

**NEES Project Warehouse**

Collaborative Research: Dynamic Behavior of Slickensided Surfaces

Project Experiments Team Members More

warehouse search GO

**PI(s):** [Ross Boulanger, James Duncan](#)

**Dates:** March 01, 2004 - February 28, 2006

**Facility:** [University of California at Davis](#)

**Organization(s):** University of California at Davis, Virginia Polytechnic Institute

**Description:** This project consists of a series of centrifuge tests that were performed using the UC Davis geotechnical centrifuge. The purpose of these tests was to measure the amount of displacement that occurs during earthquake shaking along a preformed slickensided... [\(more\)](#)

**Sponsor:** NSF - 0324499, 0321789 [\(view\)](#)

**Website(s):** NEES at University of California [\(view\)](#)  
Virginia Polytechnic Institute [\(view\)](#)

**Equipment:** [View Details](#)

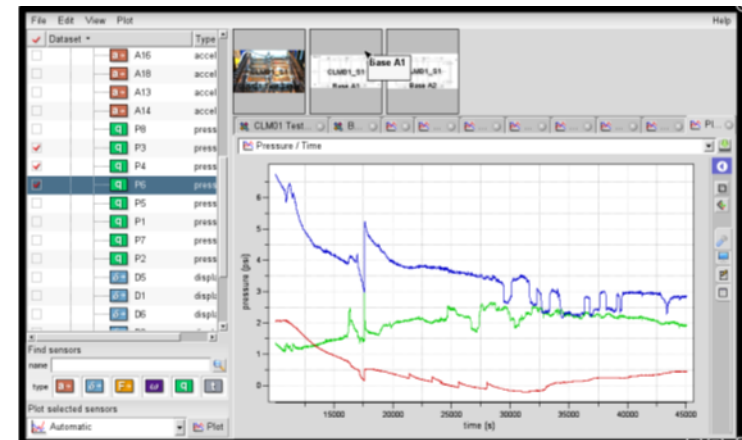
**Tools:** INDEED

**Publications:** [Christopher Meehan, James Duncan, Ross Boulanger, "UCD/CGMDR-05/03 Collaborative Research: Dynamic Behavior of Slickensided Surfaces - Centrifuge Data Report for CLM01" \(view\)](#)  
[Christopher Meehan, James Duncan, Ross Boulanger, "UCD/CGMDR-05/04 Collaborative Research: Dynamic Behavior of Slickensided Surfaces - Centrifuge Data Report for CLM02" \(view\)](#)

1000 Views  
100 Downloads

**Curation progress:**  
Discovered existence of final report so completed curation and republished the PRPP.  
Complete - 08/26/2009

Data Repository



Data Viewing



# Engaging Researchers from Around the World (160+ projects)

With thousands of users at any point in time, the distribution of users shows the global reach of the network and its cyberinfrastructure in the war to mitigate earthquake and tsunami risk!



**NEES Sites**



## NEEScomm

- Data Repository
- Computational Simulation
- Community Support



*Cornell University*



*University of California, Davis*



*University of Texas, Austin*



*Rensselaer Polytechnic Institute*



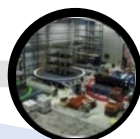
*University of California, Los Angeles*



*University of Minnesota*



*University of Illinois at Urbana - Champaign*



*University at Buffalo*



*Lehigh University*



*University of California, Berkeley*



*University of Nevada, Reno*



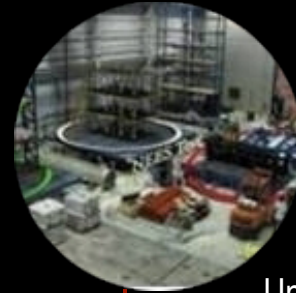
*Oregon State University*



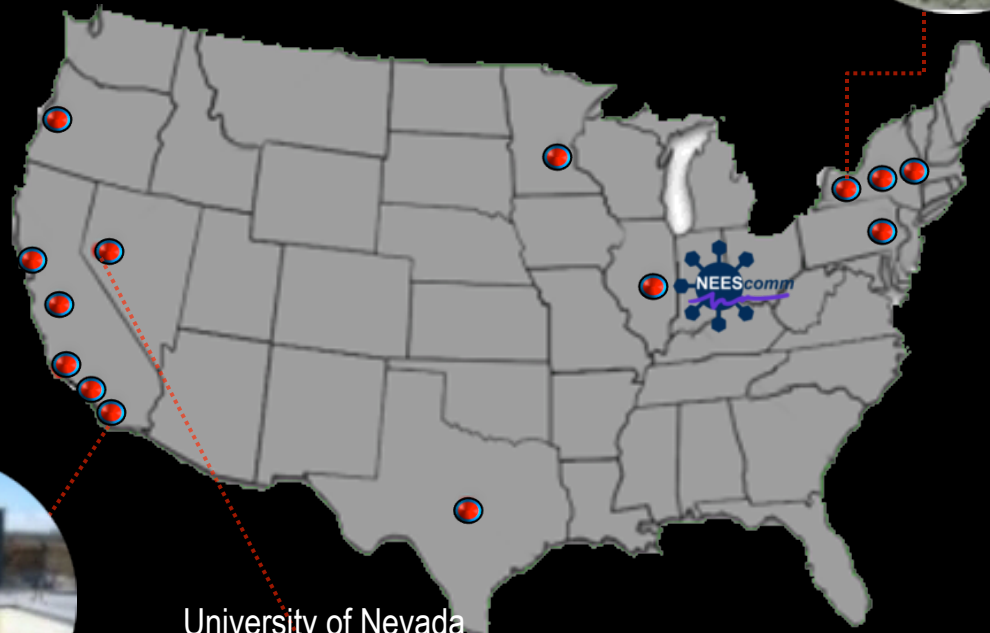
*University of California, Santa Barbara*



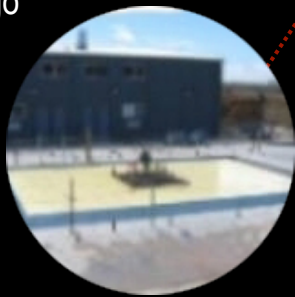
*University of California, San Diego*



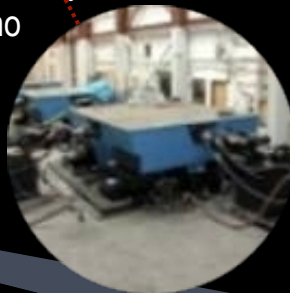
University of Buffalo



University of California  
San Diego



University of Nevada  
Reno



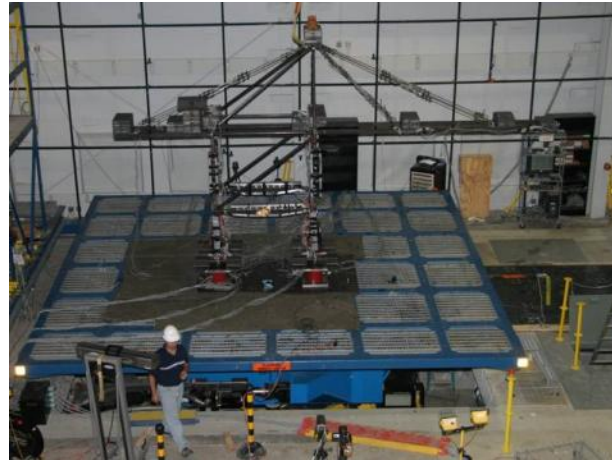
## Shake Tables

Note: Berkeley has a shake table but it isn't NEES funded



# Sample Shake Table Projects

70-ft-tall 23,400-lb  
wind turbine



1/20 scale container crane



Full scale  
straw bale house

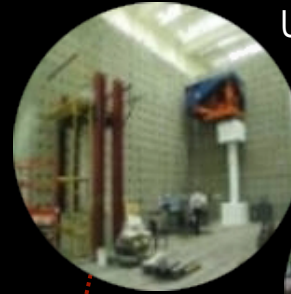


110-ft-long, 200-ton, 4-  
span bridge

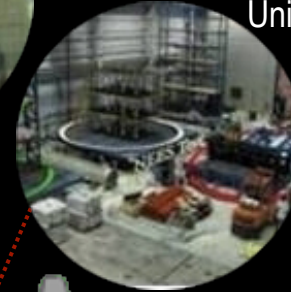
University of Minnesota



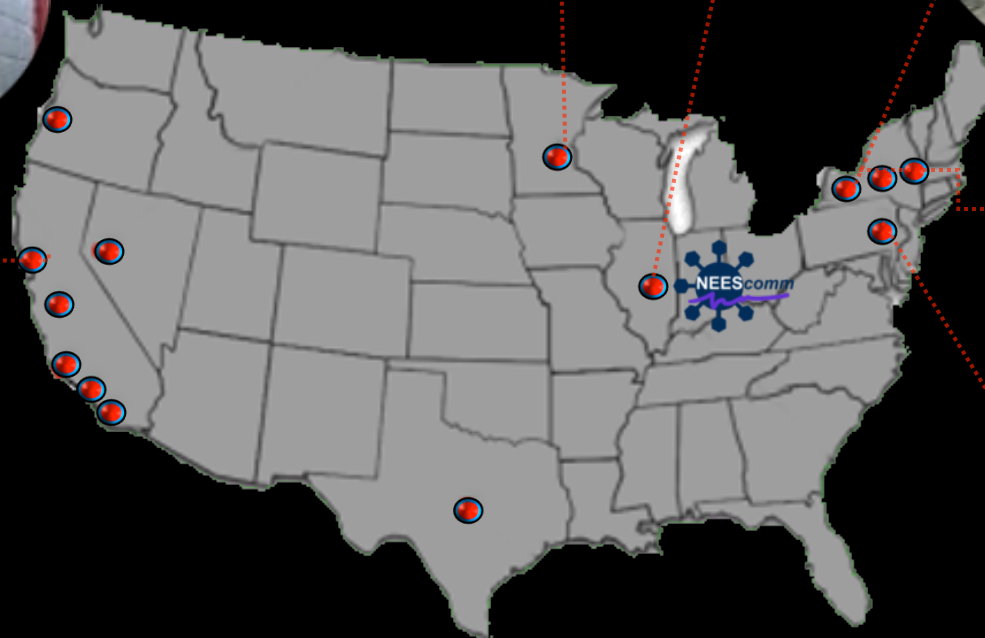
University of Illinois- Urbana



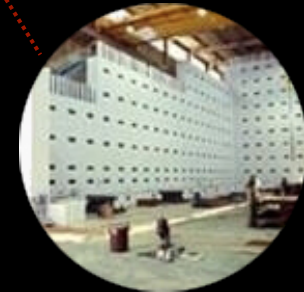
University of Buffalo



University of California  
Berkeley



Cornell University



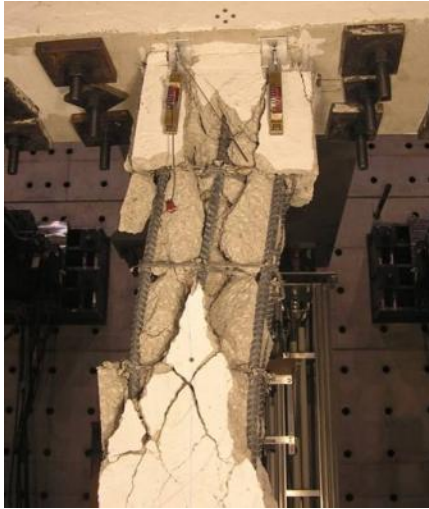
Lehigh University

## Large Scale Testing Facilities

Note: Buffalo is like doublemint gum, you get two labs in one



# Sample Large Scale Facilities Projects



Nonductile concrete columns



Steel concentrically braced frame



Nonstructural systems

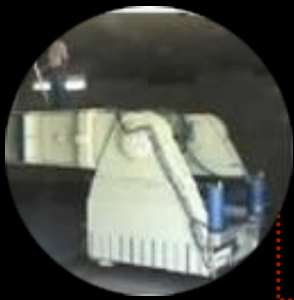


Pipeline crossing fault

# Geotechnical Centrifuges



University of California  
Davis

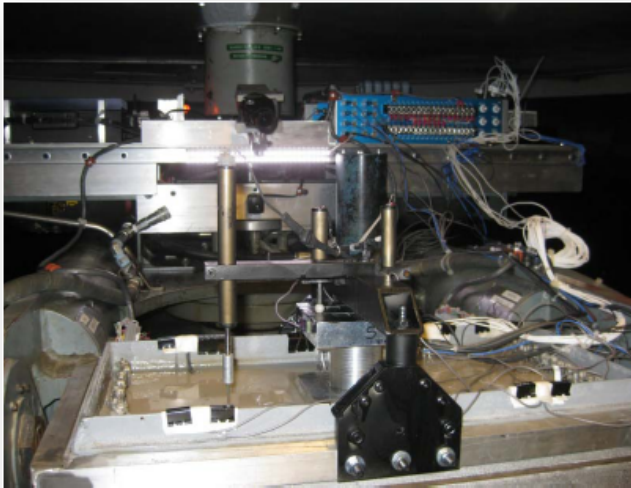


Rensselaer Polytechnic  
Institute



# Sample Centrifuge Projects

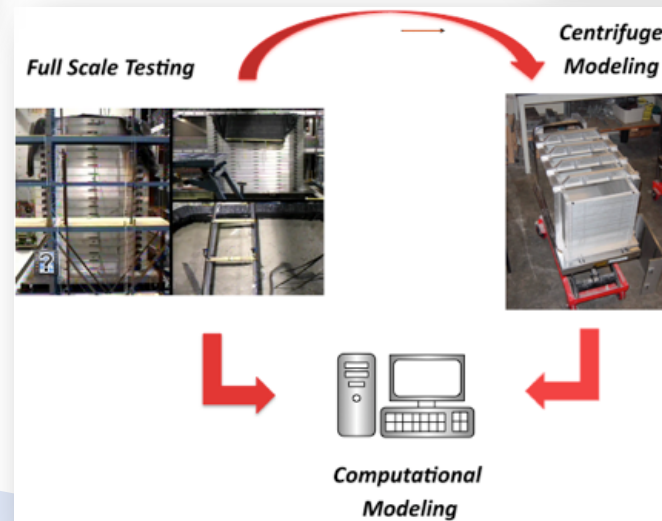
Bio-grout Liquefaction  
Remediation



Scaled models of buildings



Pile testing at Buffalo,  
RPI, E-Defense





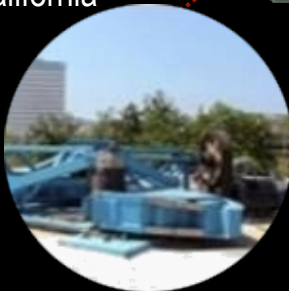
# Field/Mobile Earthquake Engineering Labs



University of California  
Santa Barbara



University of California  
Los Angeles



University of Texas  
Austin



# Field/Mobile Lab Projects



1/4 scale bridge bent

Monitoring Carquinez Bridge

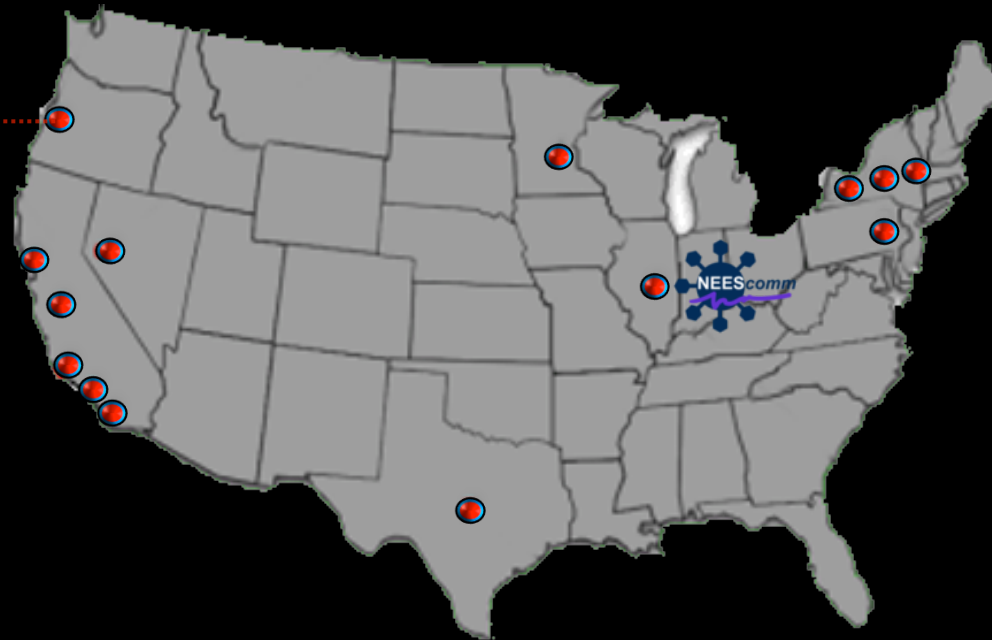
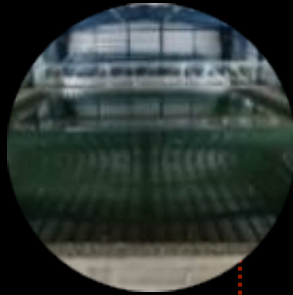


Testing Retrofit of LAX Theme Building



Soil-foundation-structure-interaction

Oregon State University



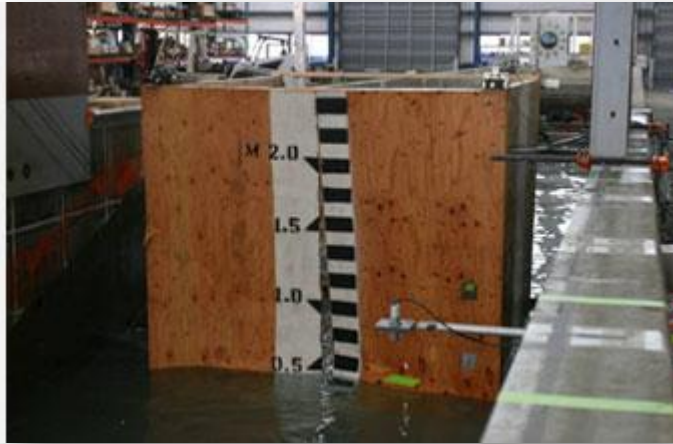
Tsunami Wave Basin





# Some Tsunami Projects

Performance-based tsunami design (large wave flume)



Model of Keystone Harbor



Impact on cylindrical objects (video)

# International Collaboration: E-Defense

7 story wood frame condominium



Source: John Van de Lindt



Multistory steel frame with energy dissipation

Source: Helmut Krawinkler



# International Collaboration: NCREE






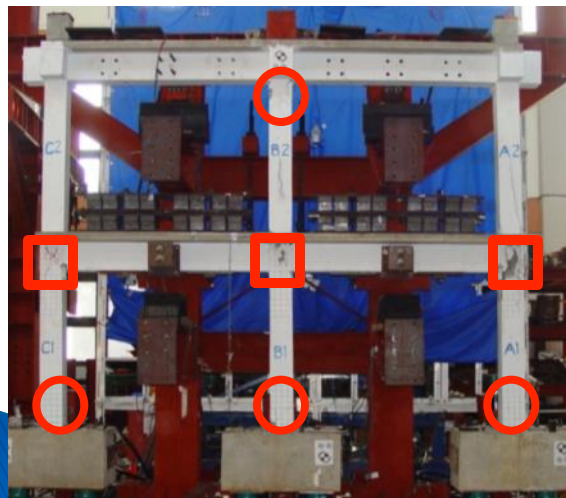
Specimen MCFS



Specimen HCFS

## Failure Modes

-  Shear and axial failure
-  Flexural hinging
-  Joint shear damage



Specimen MUF



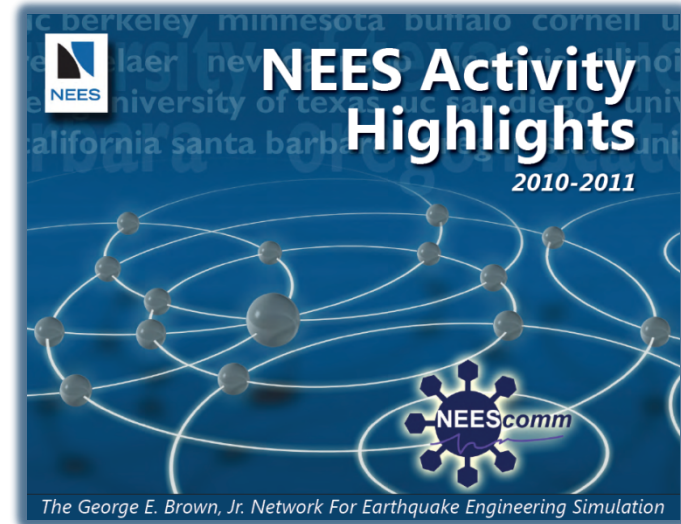
Specimen MUFS

Nonductile concrete frame

Source: Ken Elwood

# Research Results

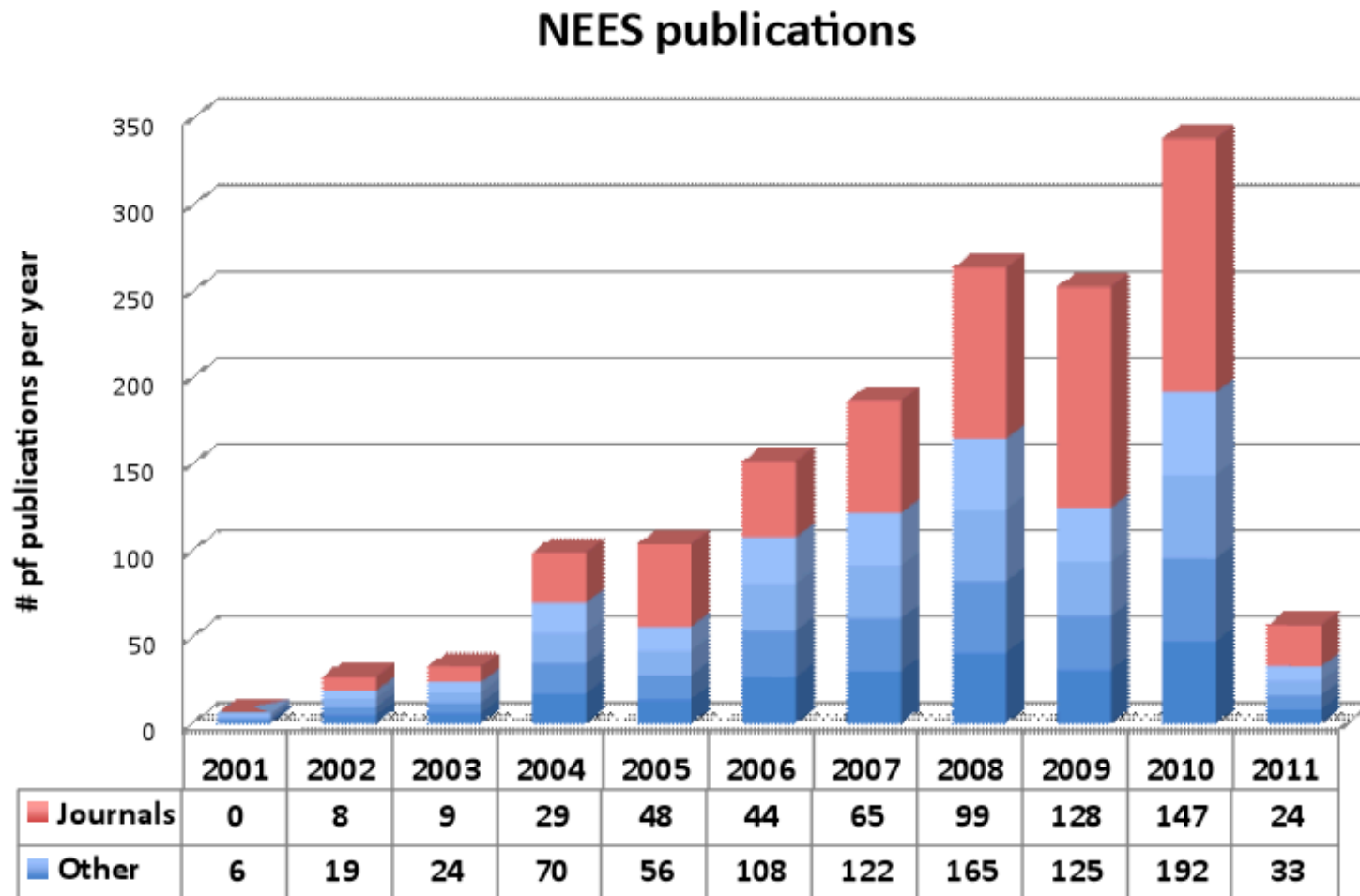
- Half-scale model 3-story parking garage tested on outdoor table at UC San Diego; model weight  $\approx 1,000$  K
- Results give insight into complex interaction between 'jointed' diaphragms and primary lateral load resisting elements



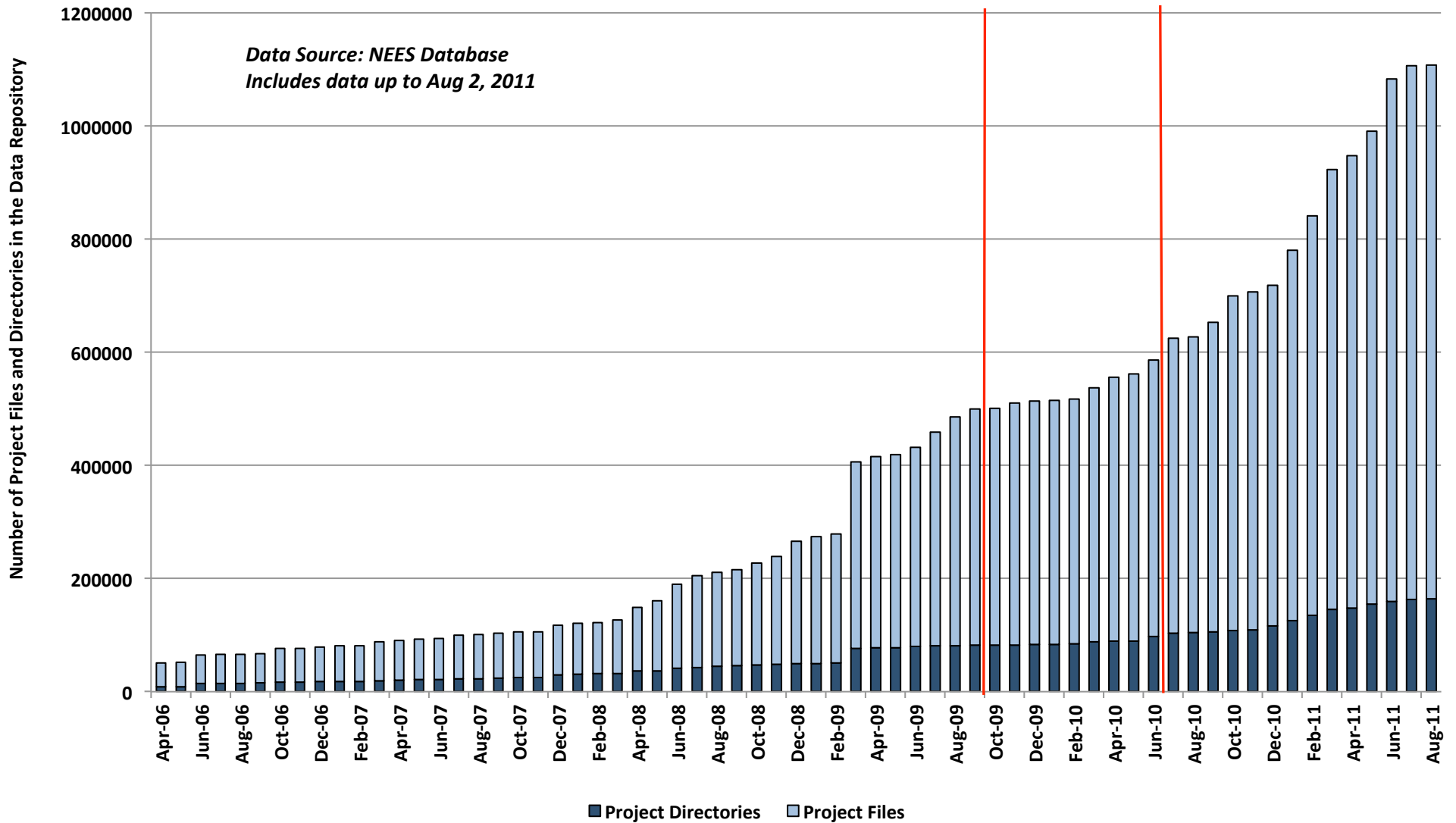
U. Arizona, Lehigh U., NEES@UCSD: NSF, PCI and Pankow Foundation

**Highlights available at [nees.org](http://nees.org)**

# NEES-Community Publications



# Cumulative No. of Project Files & Directories





# Value of the Network

**Integrate-Leverage-  
-Broaden Participation**

### NEES Cyberinfrastructure

The screenshot shows the NEEShub website with the following elements:

- Header:** NEEShub logo, "George E. Brown, Jr. Network for Earthquake Engineering Simulation", and navigation links (Login, Register, About NEES, Sitemap, Feedback).
- Navigation:** Tools & Resources, Learning & Outreach, Project Warehouse, Sites, Collaborate, Explore, Support.
- Main Content:** A large banner for "EDUCATION" with a video player. Below it, a "Network for Earthquake Engineering Simulation" description and a "View Activity Map" link.
- Left Column:** "In the Spotlight" section with links to "Data Turbine 3, 111 and DT Utilities", "FileToRbnb", and "Online Earthquake Performance Evaluation Tool (EPET)".
- Right Column:** "Use NEEShub to..." section with links to "Access NEES projects", "Run simulators", "Learn with earthquake data", and "Share research".
- Bottom Section:** "NEES Project Warehouse" with a search bar and "Advanced Search" link.

**NEES Laboratories**



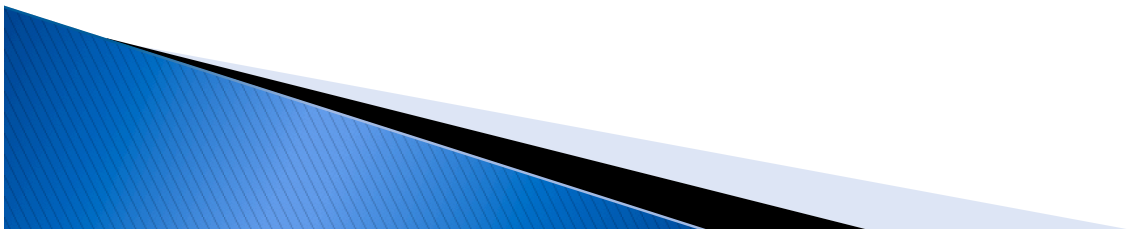
**Community**





# NEESreu Program

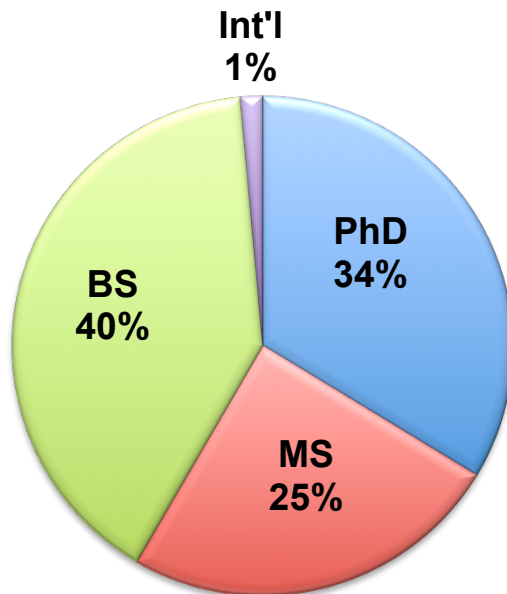
- ▶ Funded by National Science Foundation
  - Goal “develop a diverse, internationally competitive, and globally–engaged science and engineering workforce”
  - Areas: science, technology, engineering & mathematics
  - Engage undergraduates in meaningful research
- ▶ 29 NEESreu students participating this year



# ISSUE: Tracking EOT Impact

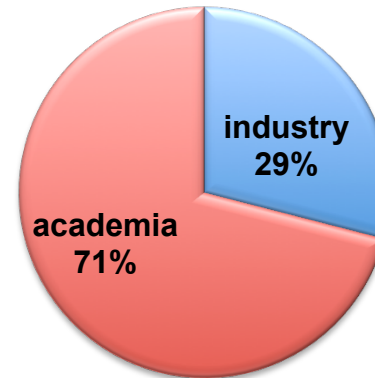
...Students benefiting from NEES

NEES participation (completed degree)

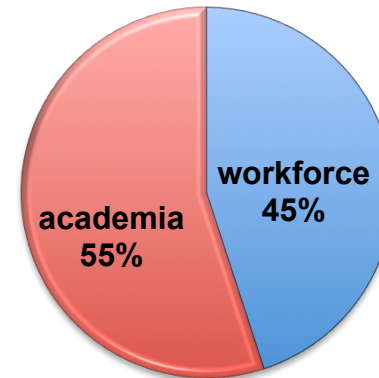


550+ students

Where are they now? PhD



Where are they now? MS



Workforce Development and Research

Field/Mobile Labs  
The homes of Mighty Mouse,  
Thumper and T-rex

