

Purdue-Mexico Workshop on Sustainability
April 29 - 30, 2013

Reducing the Impact of Earthquakes and Tsunamis on Society

**The GEORGE E. BROWN JR., NETWORK FOR EARTHQUAKE
ENGINEERING SIMULATION (NEES)**

Professor Julio Ramirez
NEEScomm Center Director, NEES Chief Officer
Purdue University



NEES



PURDUE UNIVERSITY
Discovery Park

Outline

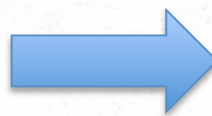
- Seismic Risk
- Seismic Resilience of Regions
- Sustainability and Resilience
- Role of NEES in reducing Seismic Risk





Seismic Risk

- **Seismic Risk:** the potential economic, social and environmental consequences of earthquake events that may occur in a specified period of time



- Probability of occurrence: Building Codes-2% probability of exceeding in 50 years (approximately 2500 year return period)

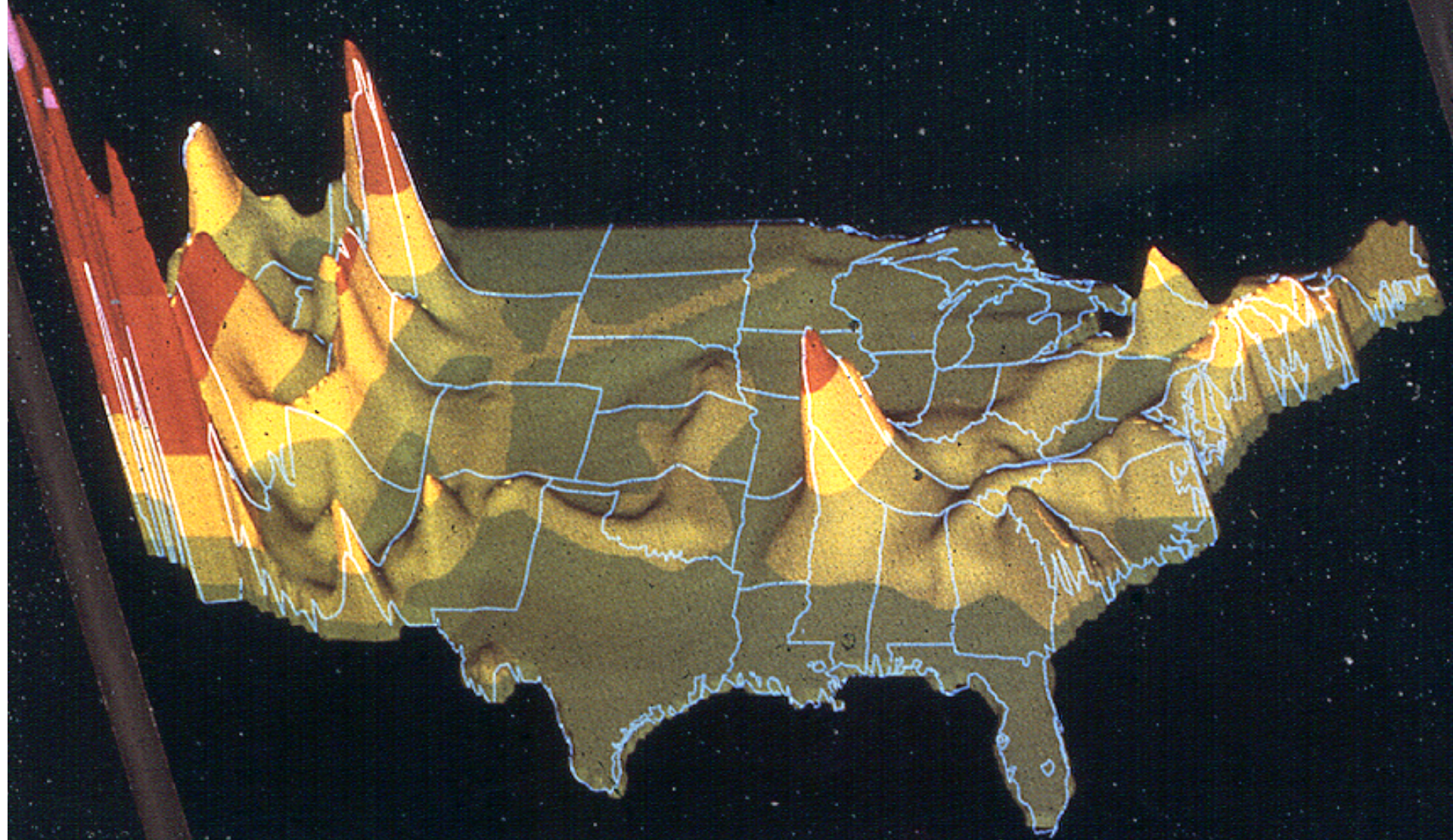


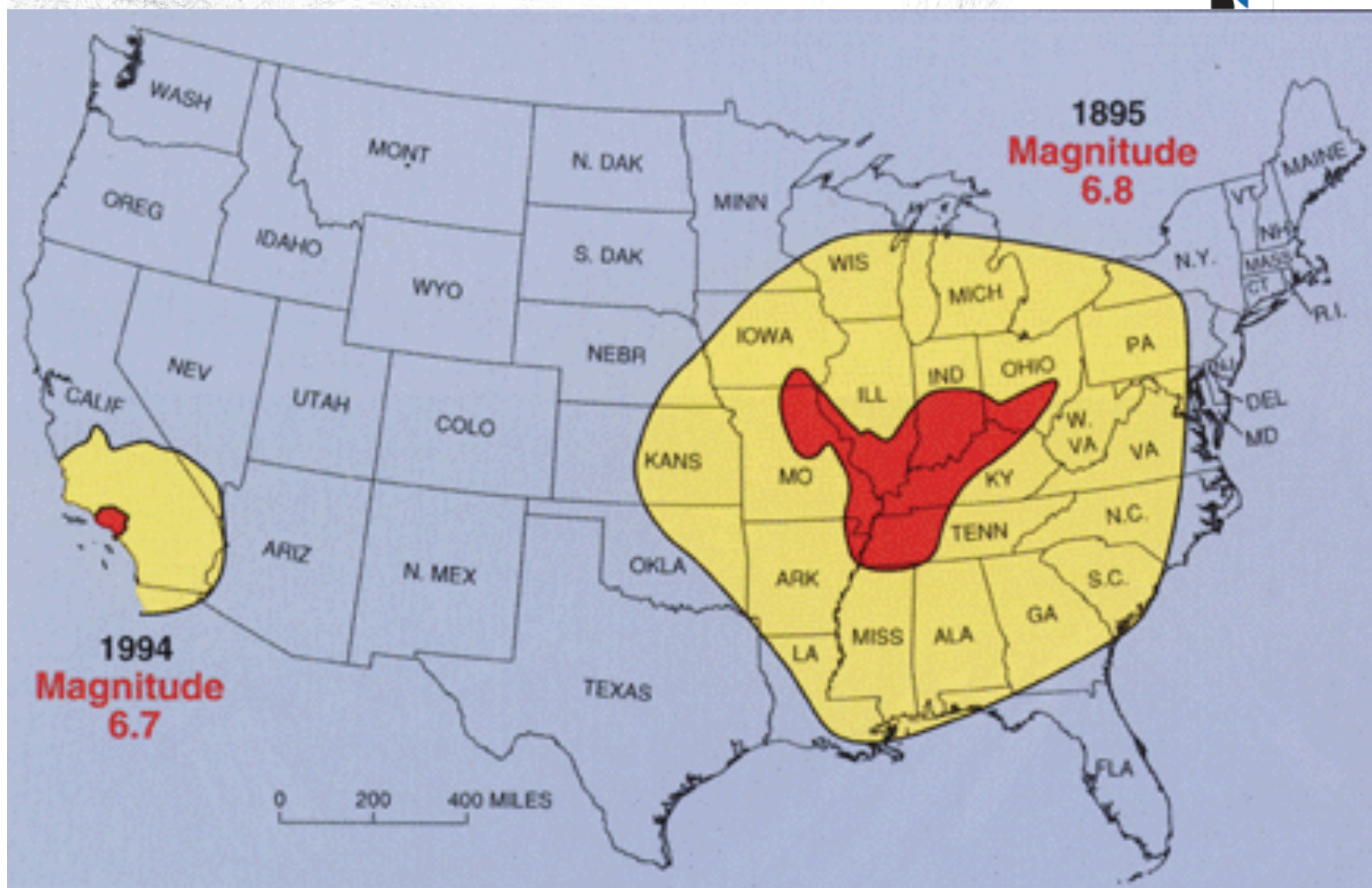
- Consequences
- Reduction of seismic risk has been attempted through active programs that *improve emergency response*, and *improve basic infrastructure*





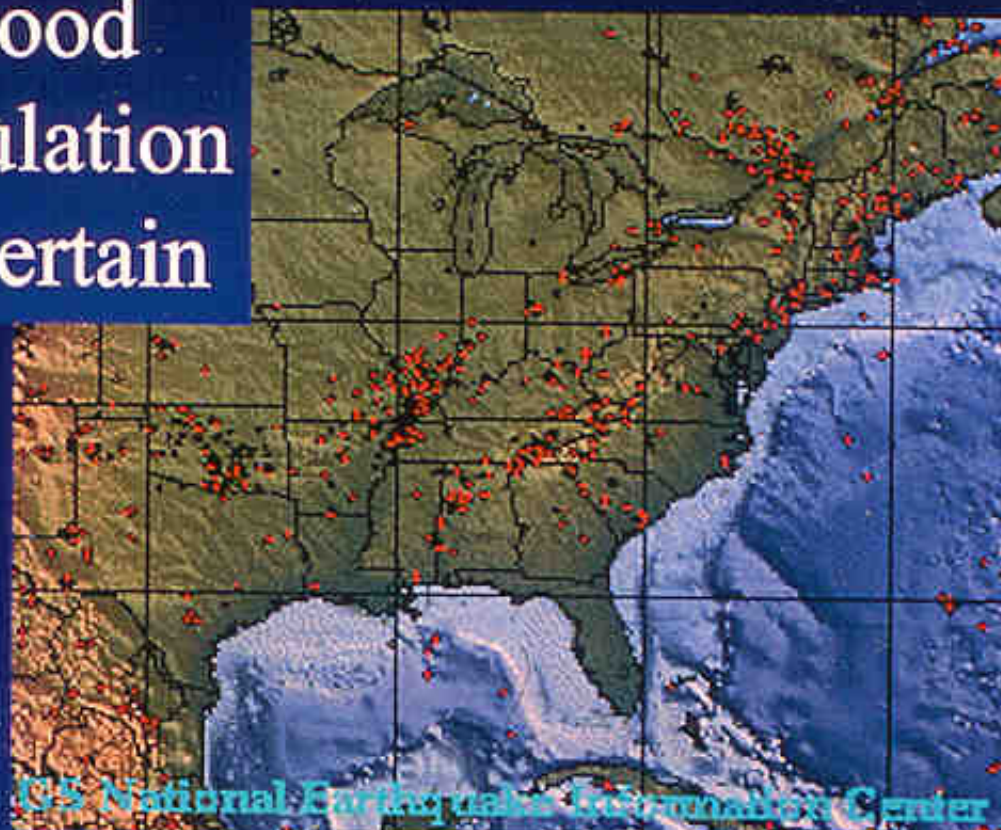
COMPARISON OF SEISMIC RISK







- Risk Poorly Understood
- Large Affected Population
- Ground Motion Uncertain



US National Earthquake Information Center

Natural Disaster Resilience

Capacity to respond to and recover from natural disasters

Economically, socially and environmentally resilient regions are composed of resilient individuals, organizations and communities



Miyako City, 2011 Iwate Prefecture



Sustainability & Resilience

- Sustainable community development seeks to enhance community resilience
- Resilient Community is able to absorb and/or adapt quickly to change and crisis.
 - Emergency Preparedness
 - Reduce Vulnerability
 - Inform Future Policy
 - Robust Support Social Systems



NEES MISSION

Miyako City, 2011 Iwate Prefecture



I-10 Los Angeles, 1994 Northridge CA

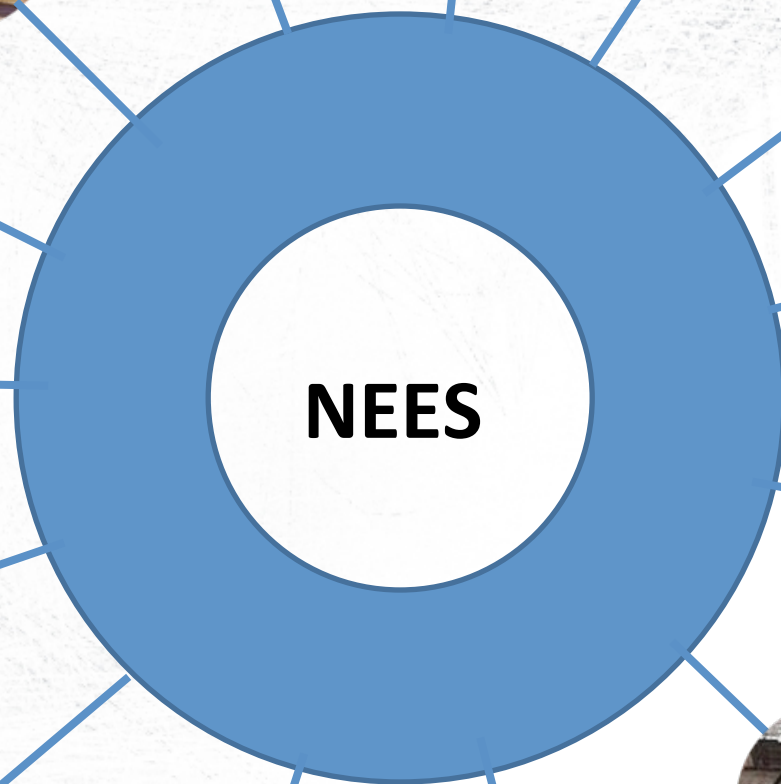


To accelerate improvements in seismic design and performance of the infrastructure **by supporting efforts** to:

- (a) improve PBD Procedures, evaluation methods & strengthening techniques
- (b) develop the next generation of researchers, educators, and engineers

NEES Strategic Plan at nees.org

NEES Experimental Capabilities



Oregon State University

University of Illinois- Urbana

University of Minnesota

Rensselaer Polytechnic Institute

University of Buffalo

Lehigh University

University of California Berkeley

Cornell University

University of California San Diego

University of Nevada Reno

University of Texas Austin

University of California Los Angeles

University of California Santa Barbara

University of California Davis

Damage to CSU Parking Structure Northridge Earthquake 1/17/94



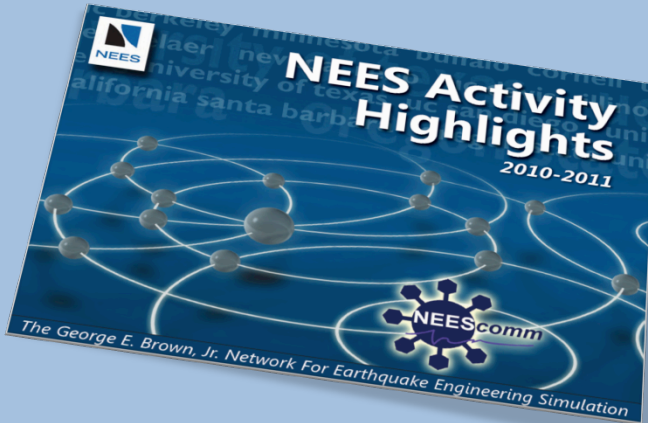
Inadequate performance of floor diaphragms



Precast Concrete Buildings – Code Changes



NEES



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

NEES Cyberinfrastructure

NEES community of satisfied users, interconnected and more collaborative, continues to grow today with 5700 registered users, and tens of thousands of users from almost to 200 countries in America, Europe and Asia



NEES Sites

NEEScomm

- Data Repository
- Computational Simulation
- Community Support



Cornell University



University of California, Davis



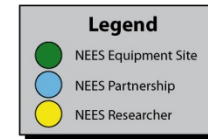
Rensselaer Polytechnic Institute



University of Texas at Austin



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

Emphasis on Data Management

- Stable data management technology that meets the needs of earthquake engineers
 - Infrastructure for data ingestion, re-use, and preservation

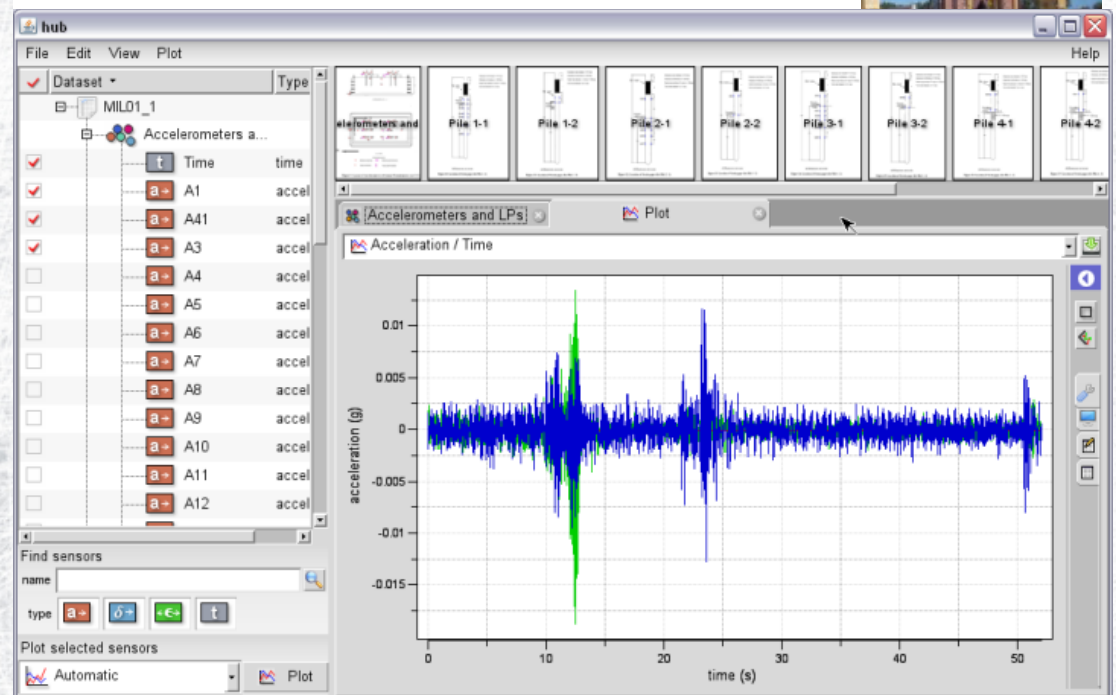
Data Model

Data Ingest

Data Presentation

Data Visualization

NEES Project Warehouse



Website(s):

PBD of New Masonry: NC A ([view](#))

PBD of New Masonry: UT ([view](#))

Resource- Databases

Library contains the following
databases:

- The American Concrete Institute (ACI) Publications Database
 - ACI 369 Circular Column Database
 - ACI 369 Rectangular Column Database
 - ACI 445 Punching Shear Collected Databank
- Database for Structural Control and Monitoring Benchmark Problems
- Performance Database for Reinforced Concrete Columns with Spiral Reinforcement
- Permanently Instrumented Field Sites Database, UCSB
- SAC Steel Project Database
- Shear Wall Database
- The Haiti Earthquake Database
- The Journal of Earthquake Engineering (JEE) Database
- The Shear Wave Velocity Profiles

The screenshot shows the NEEShub website interface. At the top, there's a navigation bar with links like 'About NEES', 'Tools & Resources', 'Learning & Outreach', 'Project Warehouse', 'Simulation', 'Sites', 'Collaborate', 'Explore NEEShub', and 'Support'. Below this, a 'Databases' section is highlighted. It includes a 'What are Databases?' box, a 'Contribute a Resource' box, and a 'Select Resource Type to Navigate' dropdown menu. A table of resources is displayed, with a red circle highlighting the list of resources. The resources listed include ACI 369 Circular Column Database, ACI 369 Rectangular Column Database, ACI 445 Punching Shear Collected Databank, Database for Structural Control and Monitoring Benchmark Problems, Performance Database for Reinforced Concrete Columns with Spiral Reinforcement, Permanently Instrumented Field Sites Database, SAC Steel Project Database, Shear Wall Database, The ACI Publications Database, The Haiti Earthquake Database, The Journal of Earthquake Engineering (JEE) Database, and The Shear Wave Velocity Profiles. The bottom of the page features a 'Community Top Rated Resources' section and a footer with various logos and contact information.

The Haiti Earthquake Database

On January 12, 2010 an earthquake ravaged Haiti (USGS, 2010). In the aftermath of the earthquake, a team of professors and students from Purdue University, the University of Washington, and the University of Kansas went to Haiti. The goal of the team was to evaluate the Priority Index proposed by Hassan and Sözen (1997).

The team took 6,526 photographs of 183 structures. These buildings were constructed using reinforced concrete and concrete masonry units. This database contains these photographs and all other information collected in the field.

NEEShub
a platform for research, collaboration and education
The George E. Brown, Jr. Network for Earthquake Engineering Simulation

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The Haiti Earthquake Database

By Nathaniel Sedra, Marc Eberhard, Ayhan Inanoglu¹, Adolfo Matamoros, Santiago Pujol, Oskar Sveinn Haraldsson, David Alan Lattaro, Steve Laurence Lauer, Bob Lyon, Josh Messamer², Karl Nais³, Jeffrey Rautenberg³, Steve Symthe, Roby Douilly
1. Purdue University

[View Database \(pdf\)](#)

0 Citations
2 questions (Ask a question)
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Category: [Databases](#) Published on: 21 Dec 2010

Abstract

On January 12, 2010 an earthquake ravaged Haiti (USGS, 2010). In the aftermath of the earthquake, a team of professors and students from Purdue University, the University of Washington, and the University of Kansas went to Haiti. The goal of the team was to evaluate the Priority Index proposed by Hassan and Sözen (1997).

The Priority Index is a measure of the vulnerability of buildings to earthquakes, and is calculated as follows:

$$\text{Priority Index} = \frac{\text{Effective Wall Area} + \text{Effective Column Area}}{\text{Total Floor Area}}$$

Effective Wall Area: sum cross-sectional areas of reinforced concrete walls with one tenth of cross-sectional areas of masonry walls (in the direction having the least amount of wall area)
Effective Column Area: half the total cross-sectional area of the columns on the ground floor.
Total Floor Area: total area of all floors above the ground floor.

The team took 6,526 photographs of 183 structures. These building were constructed using reinforced concrete and concrete masonry units. This database contains these photographs and all other information collected in the field.

Thirteen buildings were not surveyed completely because they were not deemed representative. Of the 170 building surveyed in detail, 138 were located in Port-au-Prince and 38 were located in Léogâne. (O'Brien, et al., 2010) The average Priority Index for these buildings is 0.36% with a high of 2.32%, and a low of 0.06%. The number of floors ranged from 1 to 12, with an average close to 2. One hundred and sixteen buildings had 2 or fewer stories. Among them, the average Priority Index was 0.36%. Fifty one of these buildings had light structural damage, while 13 had moderate damage, and 47 had severe damage. For the 54 buildings with more than two stories, the average Priority Index was 0.25%. Of these, 21 had light structural damage, 13 had moderate damage and 20 had severe damage.

The data are presented as a spreadsheet, with each row containing the information of a building. When available each row contains the following information for each building: (O'Brien, et al., 2010)

- Date the building was surveyed
- Letter corresponding to survey team
- Building waypoint
- Building latitude and longitude
- Photographs associated with the building. The picture believed to represent the building the best is used as the thumbnail, and if clicked on the others will appear.
- Diagram The diagram shows field sketches and other building survey information
- Number of floors in the building.

(This does not count the ground floor, but counts the roof as a floor)

- Material used for the roof.
- Area of the first floor



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About NEES

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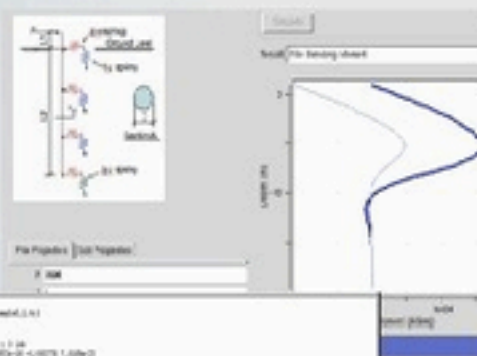
Simulation on NEEShub

Find out more about the Simulation Capabilities on the NEEShub

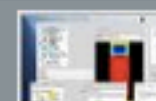
OPENSEES LABORATORY

Simulation tools developed for use with the OpenSees software. There are 3 basic tool types: 1. Tools for submitting OpenSees...

More...



OpenSees



OPENSEES LABORATORY

Simulation tools

developed for use with OpenSees



STRATA

Performs 1D linear-elastic and equivalent-linear site response analyses



FRAME3DD

Static and dynamic structural analysis of 2D and 3D frames with elastic and



SAPWOOD

Seismic Analysis Package for Woodframe Structures

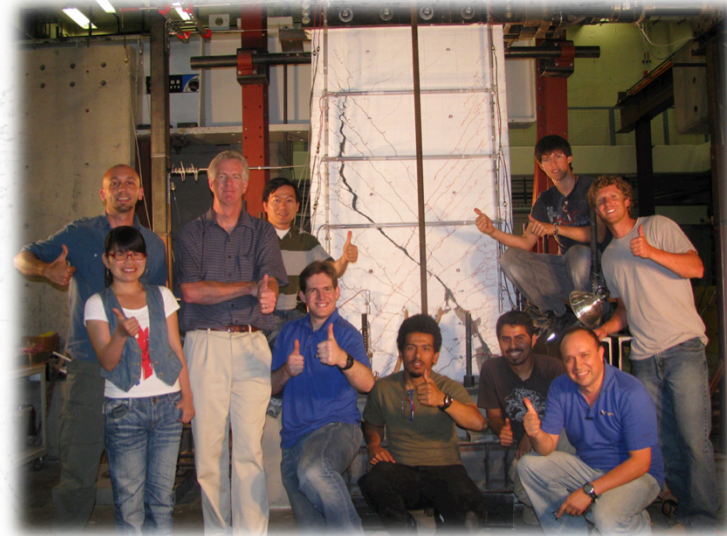
High Performance Computing for Simulation Based Earthquake Engineering



NEES Contributions



A massive tsunami sweeps in to engulf a residential area in Natori, Japan



Research Experience for Undergraduates

Reduce impact of earthquakes and tsunamis on society **by supporting community efforts**

- **+400 research projects**
- **200 PhD's**
- **1700 publications (Feb, 2013)**
- **5700 NEEShub registered users and over 50,000 users last year**
- **+1.9M Data files in the Project Warehouse**

Web Portal at nees.org