2011 Annual Meeting

WELCOME

Shattuck Plaza Hotel, Berkeley, CA September 30 – October 1,, 2011

Pacific Earthquake Engineering

2011 Annual Meeting

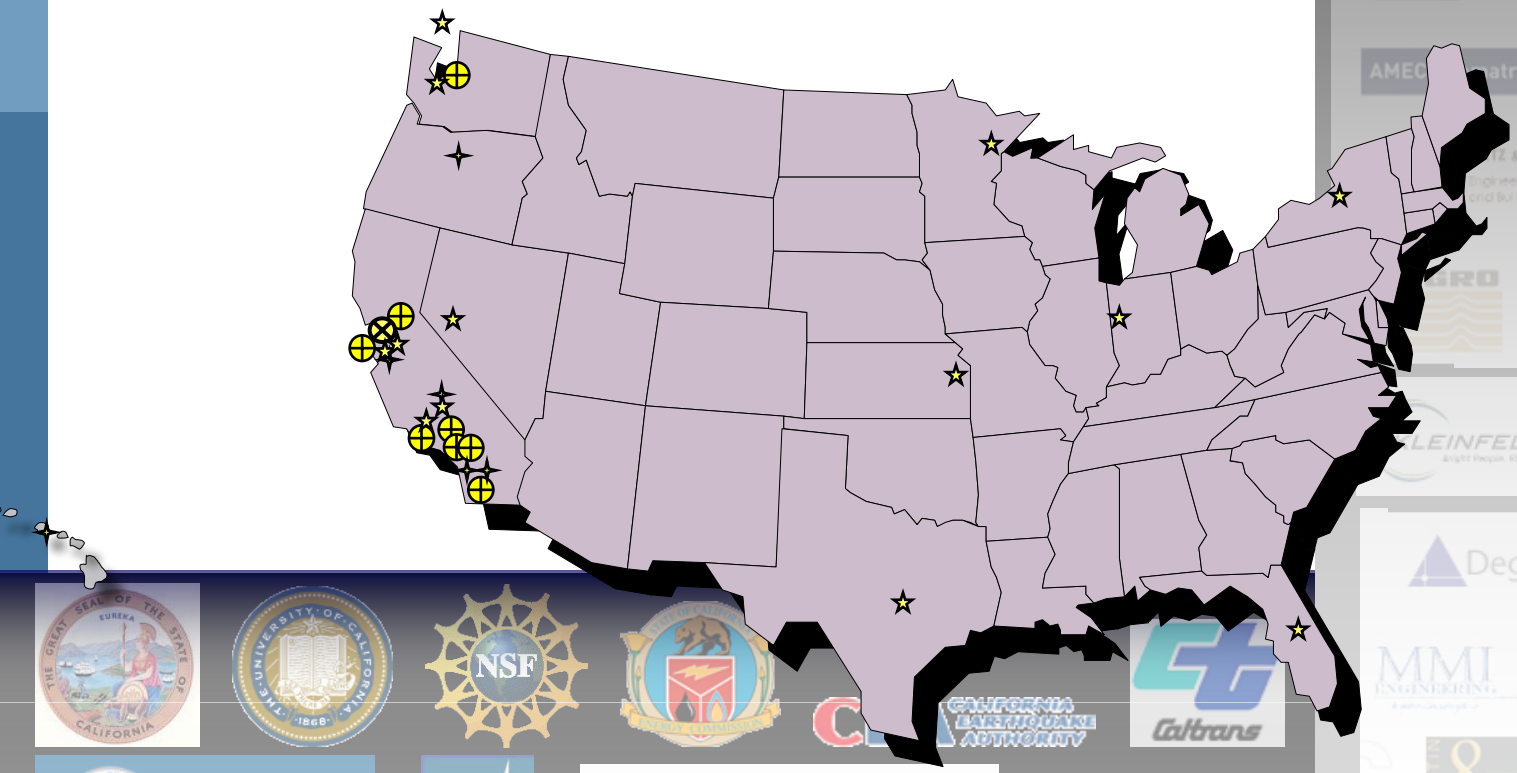
Stephen Mahin

Director, PEER

Professor of Structural Engineering, UC Berkeley

Shattuck Plaza Hotel, Berkeley, CA September 30 – October 1,, 2011

PEER is a strong university, government, professional and industry alliance



NSF

FEMA

PG&E

EPRI ELECTRIC POWER RESEARCH INSTITUTE

LA DBS DEPARTMENT OF BUILDING AND SAFETY

Caltrans

BART

The Charles Pankow Foundation

Geosyntec consultants

Earth Mechanics, Inc.

Risk Management Solutions

BL Schmid Consulting Structural Engineering

Degenkolb

Exponent

Wiss, Janney, Elstner Associates, Inc.

FORELL/ELSESSER ENGINEERS, INC. Structural Engineers

Pacific Earthquake Engineering Research Center

Regions of High Seismic Activity

PEER

Pacific Earthquake Engineering Research Center

PEER

Oregon State University joins PEER !

Oregon State University Corvallis, Oregon

Congratulations!

PEER

PEER's Mission

- Advance and apply performance-based earthquake engineering tools to meet the needs of various stakeholders
- Problem-focused, multi-disciplinary research built upon foundation of engineering and scientific fundamentals
- Close partnerships with government, industry and engineering professionals
- Strong national and global research collaborations
- Commitment to education at all levels

PEER

Education, Outreach and Training

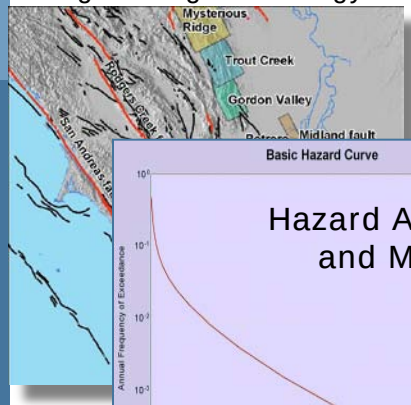
Disseminating Research Findings and Promoting Multidisciplinary Understanding

- Support for K-12 programs
- Research Experiences for Undergraduates (NSF-PEER)
- Continuing education:
  - Research to practice
  - New professionals
- International collaborations for faculty and students
  - Center for Urban Earthquake Engineering, Tokyo Tech
  - Tongji University & others
  - Young Researcher Forums
- National Information Service for Earthquake Engineering (NISEE)

PEER

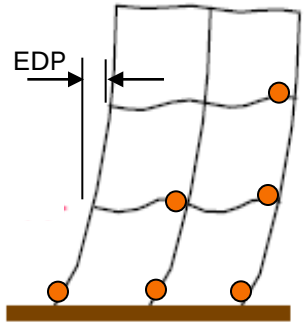
Our DNA: Integrated PBEE methodology

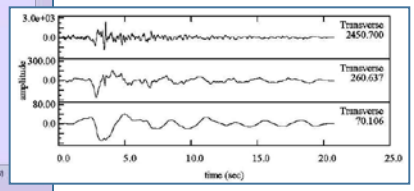
Engineering Seismology



Hazard Analysis and Mapping

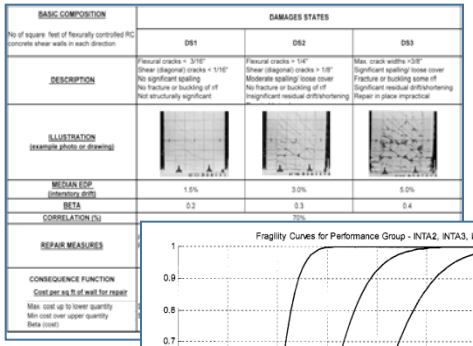
HPC simulation

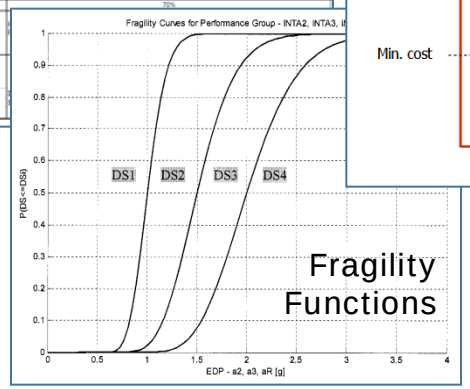




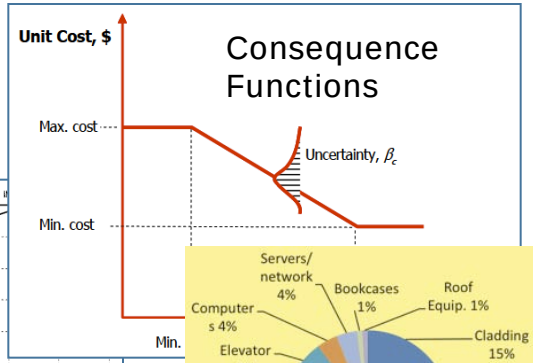
Ground motion selection and scaling

Performance Databases

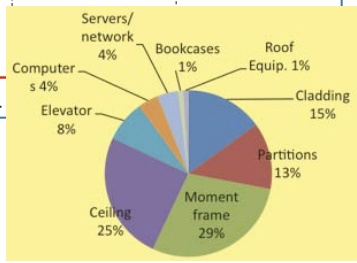




Fragility Functions



Consequence Functions



Loss Assessment

Seismic Hazard Analysis	Response Analysis	Damage Analysis	Loss Analysis
$\lambda(im)$	$G(edp \mid im)$	$G(dm \mid edp)$	$G(dv \mid dm)$
IM: intensity measure	**EDP**: Engineering Demand Parameter	**DM**: Damage Measure	**DV**: Decision Variable

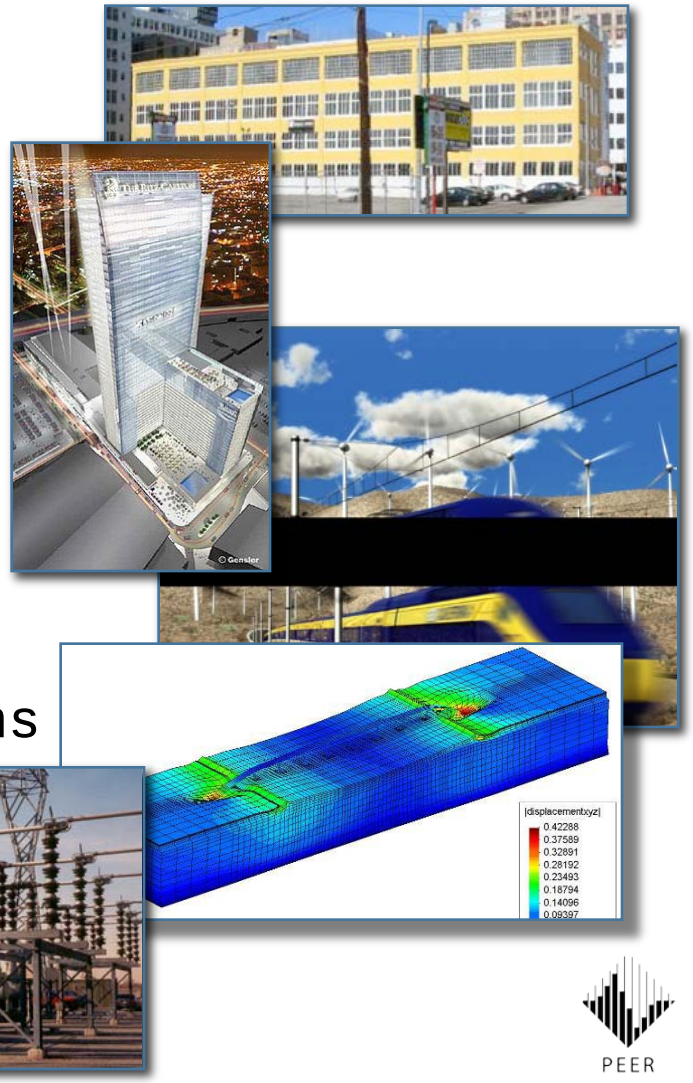
$$\lambda(DV > dv) = \int_{im}\int_{dm}\int_{edp} G(dv \mid dm)\, dG(dm \mid edp)\, dG(edp \mid im) \left| d\lambda(im) \right|$$

Probabilistic Assessment of:

- ✓ Cost of repair and loss of function
- ✓ Downtime
- ✓ Casualties
- ✓ *Embodied energy*

Applications of PBEE

- Buildings
  - Vulnerable existing buildings
  - New and existing tall buildings
  - Sustainable and resilient buildings
- Transportation Systems
  - Highway networks and bridges
  - High-speed rail systems
  - Ports and harbors
- Lifeline systems
  - Electrical power distribution systems
  - Nuclear power plants
  - LNG storage facilities



PEER

Applications of PBEE

- New Buildings
  - Design guidelines for tall buildings in seismic zones
  - Sustainable and natural hazard resilient buildings

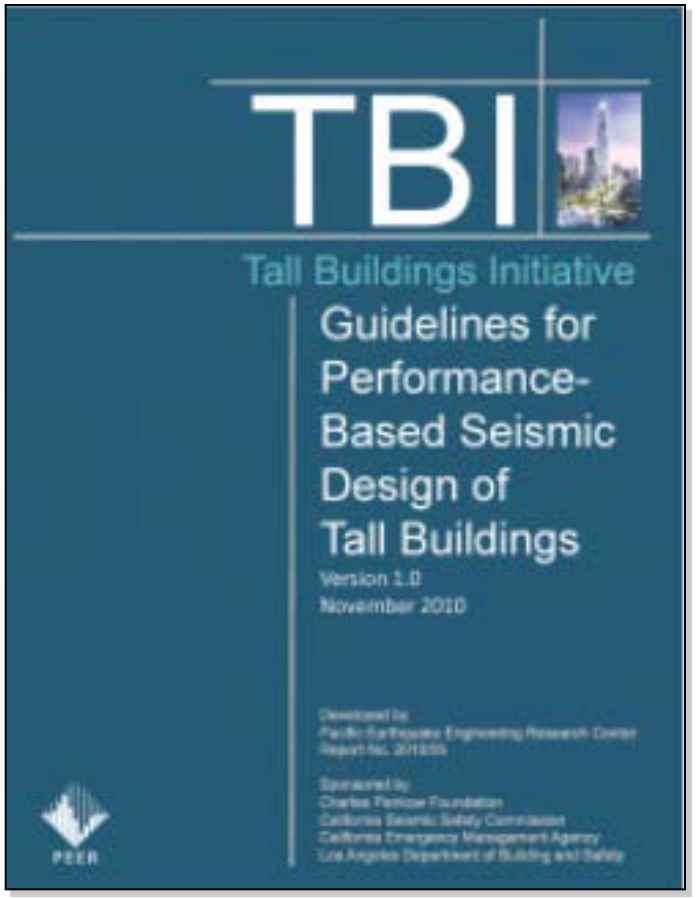
- Advanced dynamic analysis procedures
- Soil-structure interaction
- Innovative structural systems
- Vulnerability of existing tall buildings

- Seismic isolation
- Re-centering systems
- Testing and modeling of improved components and systems
- Comparative PBEE studies
- Socio-economic studies

PEER

Award – Tall Building Initiative

2011 Excellence in Structural Engineering Award



Research Category – Large Projects

SEAONC

PEER

Applications of PBEE

- New Buildings
  - Design guidelines for tall buildings in seismic zones
  - Sustainable and natural hazard resilient buildings

- Advanced dynamic analysis procedures
- Soil-structure interaction
- Innovative structural systems

- Seismic isolation
- Re-centering systems
- Testing and modeling of improved components and systems
- Comparative PBEE studies
- Socio-economic studies

PEER

Applications of PBEE

- Existing Buildings:
  Risk Assessment and Reduction for Existing Tall Buildings

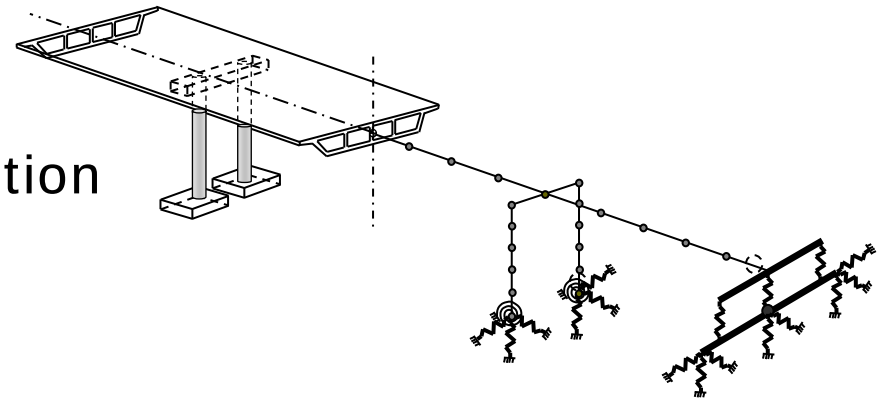
Many tall buildings in California's urban cores are build in the 1970s and 1980s using code provisions known to have serious deficiencies -- large number of steel moment frame buildings

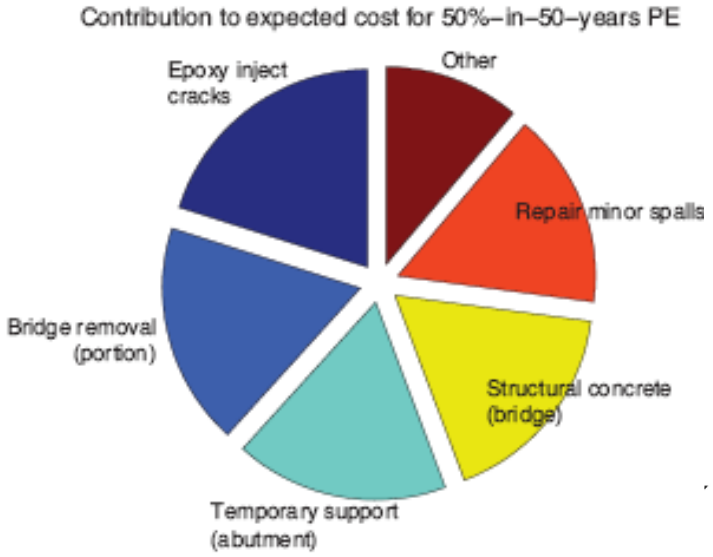
PEER

Applications of PBEE

Transportation Systems

- Highway bridges
  - Accelerated Bridge Construction
    - Precast columns
  - New technologies
    - High performance materials
      - Fiber reinforced, hybrid concrete & ECC
    - Self-centering columns
    - Seismic isolation
    - Rocking foundations
    - Damage-resistant foundations
  - Advanced analysis for SSI & liquefaction
  - Refining PBEE techniques





Applications of PBEE

- **Transportation Systems**
  - High-speed rail systems

- Bayesian network systems for design and post-event emergency management, including dependencies on electric grid
- Seismic isolation
- Spatially varying motions
- Fault crossing studies
- Early warning systems
- Vehicle dynamics during earthquakes

PEER

Applications of PBEE

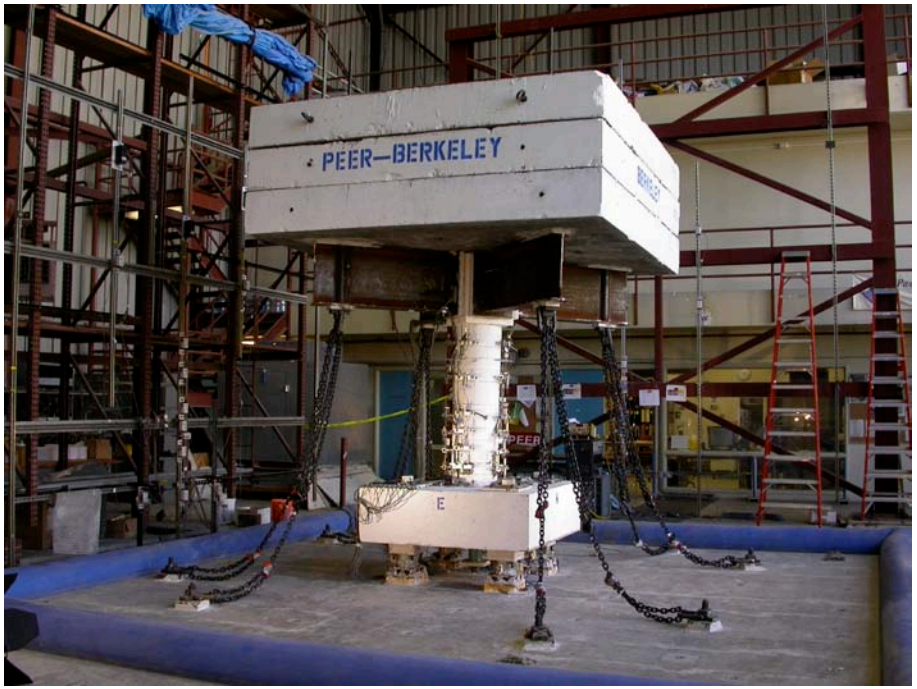
- **Transportation Systems**
  - High-speed rail systems

- Bayesian network systems for design and post-event emergency management, including dependencies on electric grid
- Seismic isolation
- Spatially varying motions
- Fault crossing studies
- Early warning systems
- Vehicle dynamics during earthquakes

PEER

Pursuing Fundamental Knowledge:
Behavior of Reinforced Concrete Columns

Tests undertaken to validate concepts and numerical models used in PBEE



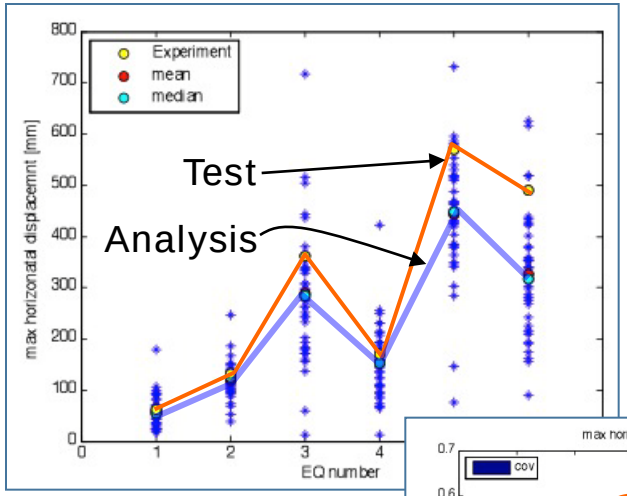
Reduced-scale 3D tests of conventional circular and rectangular columns, self-centering columns, rocking columns (PEER)

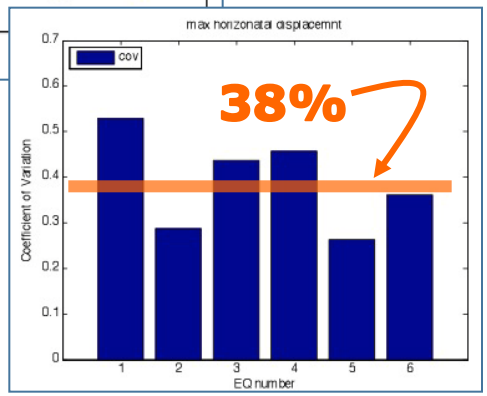
Full-scale 1D tests of circular column - Jose Restrepo, PI (PEER, Caltrans, UNR, FHWA, NEES@UCSD, NEES & NSF)

PEER

Pursuing Fundamental Knowledge: Behavior of Reinforced Concrete Columns

Tests undertaken to validate concepts and numerical models used in PBEE





41 expert teams participated

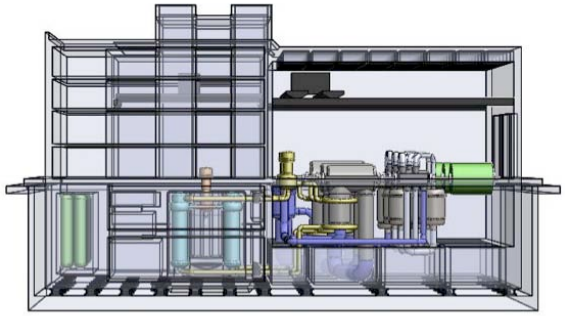
PEER-NEES RC Column Blind Analysis Contest - 2010

Full-scale 1D tests of circular column - Jose Restrepo, PI (PEER, Caltrans, UNR, FHWA, NEES@UCSD, NEEScomm & NSF)

PEER

Applications of PBEE

- Lifeline systems
  - Electrical power distribution systems
  - Nuclear power plants
  - Fuel storage facilities



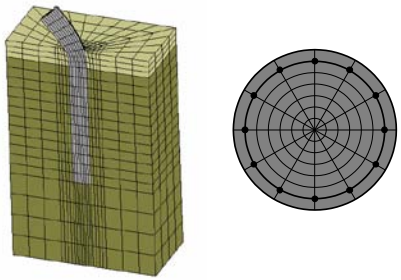
Goal: To improve safety and reliability of Lifelines Systems

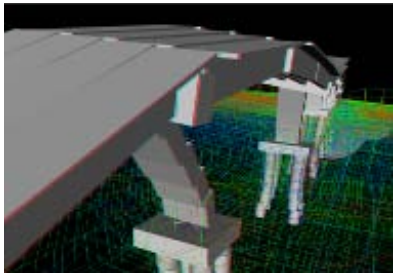
More than 120 projects have been initiated

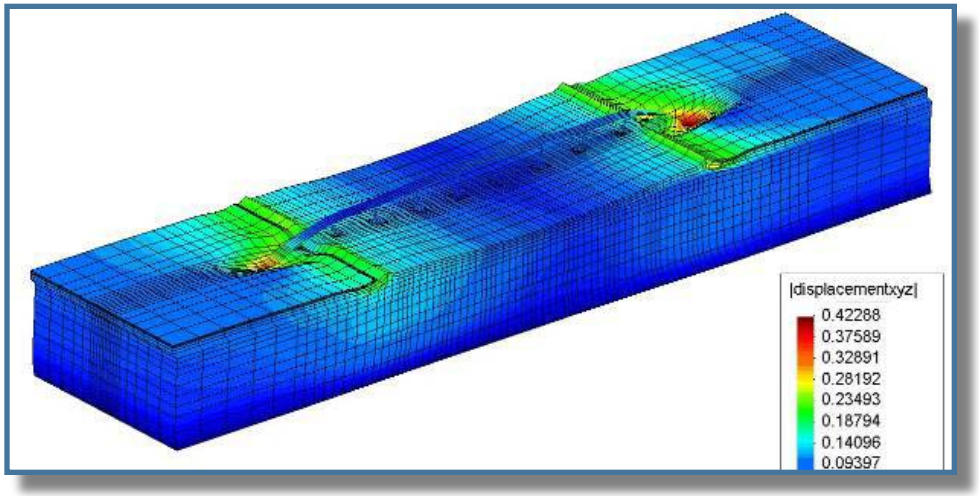
PEER

Enabling Technology: High Performance Simulation

OpenSees - Open Source, object oriented framework for seismic simulation of geotechnical and structural models







New Development Efforts by PEER:

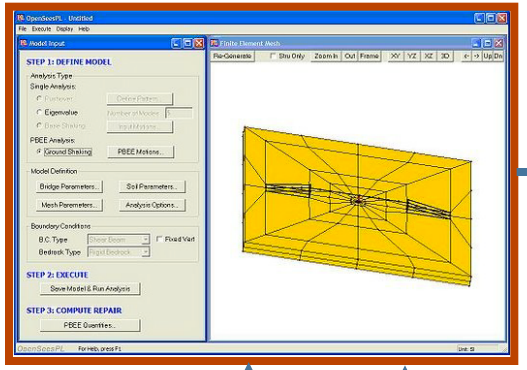
- Optimization and reliability analyses
- New elements
- Graphical user interfaces
- Integrated PBEE tools

http://opensees.berkeley.edu or NEES.org

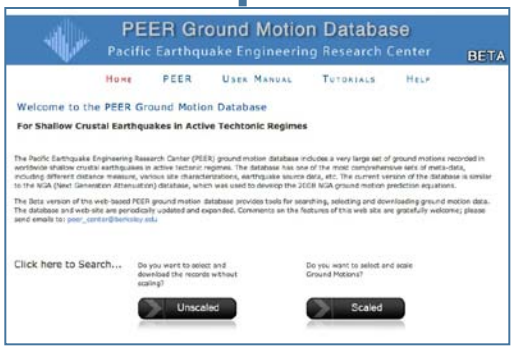
PEER

OpenSees PBEE

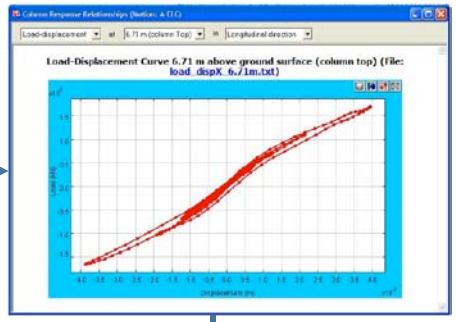
- Integration of tools and methodologies

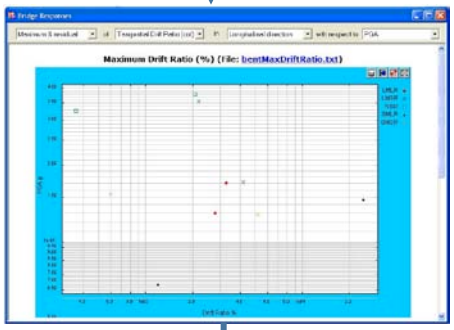


OpenSees

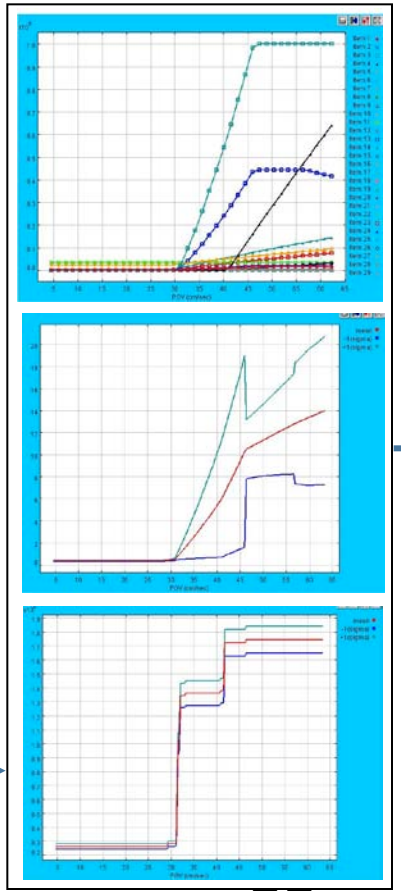


IM

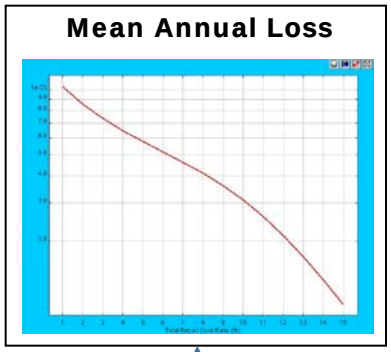




Individual and Ensemble EDPs



IM-DM



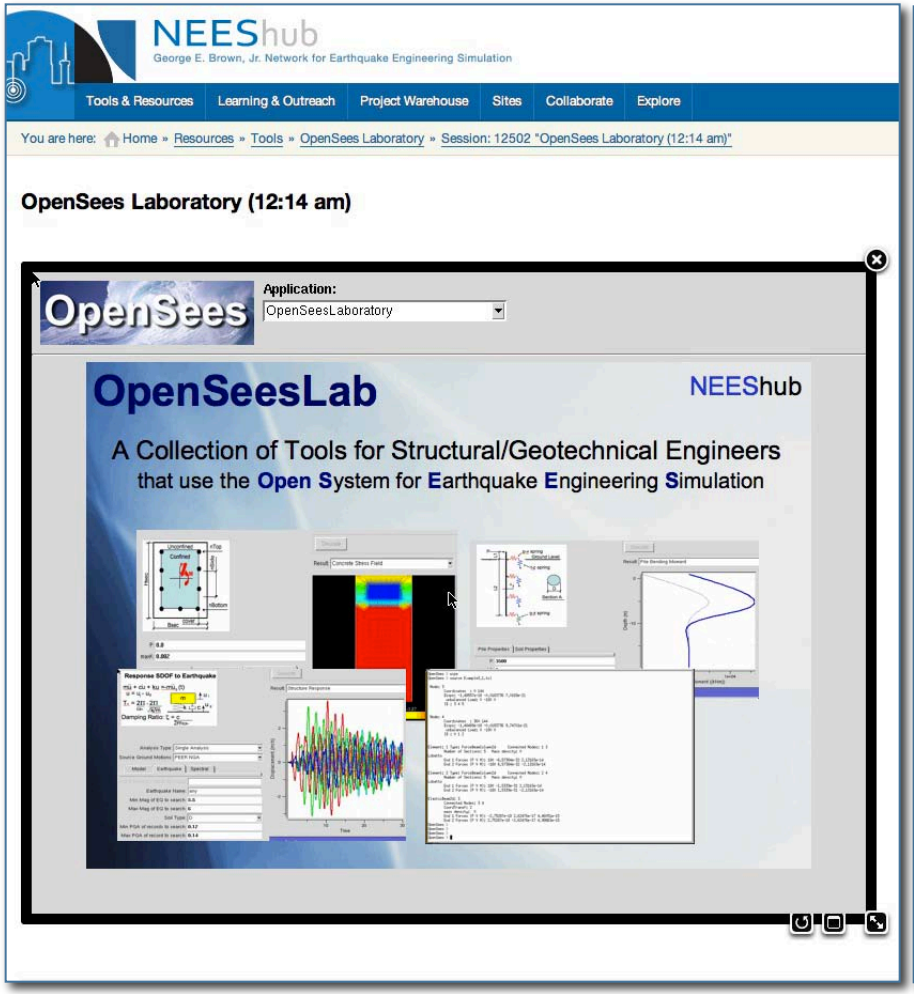
DV

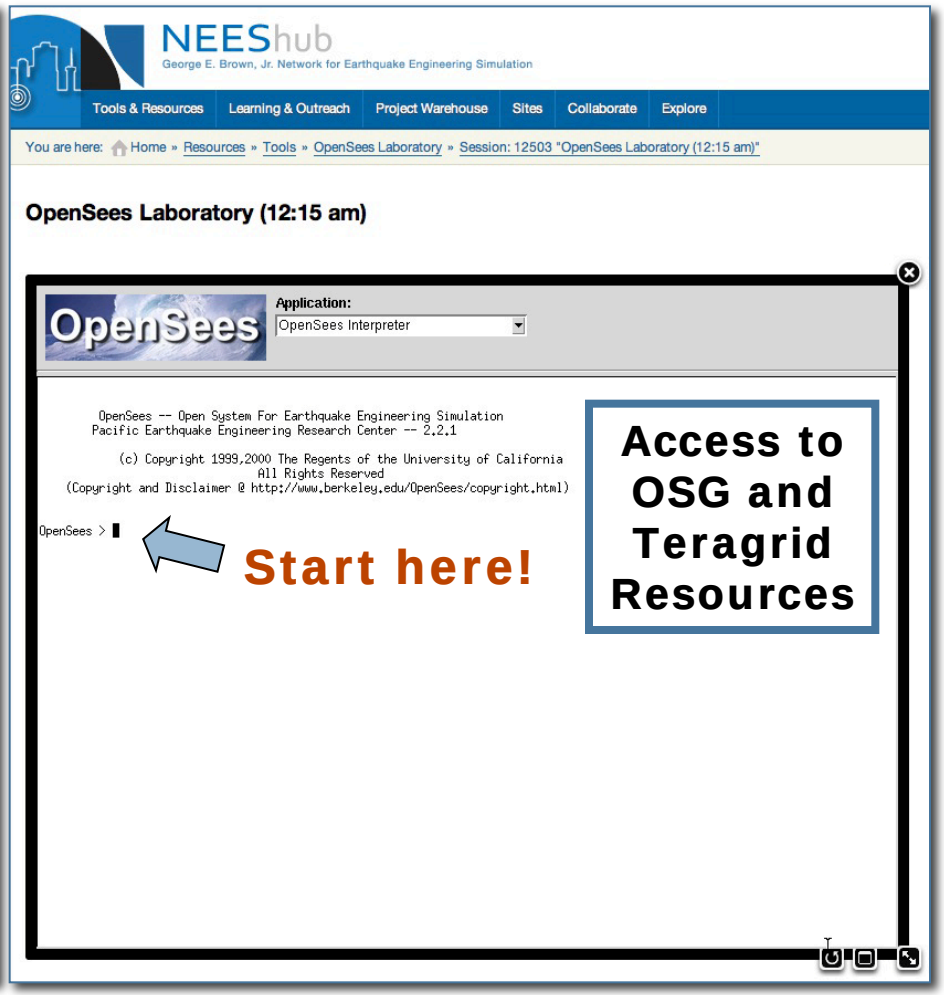
PIs: Elgamal and Mackie

PEER

Partnering with NEEScomm

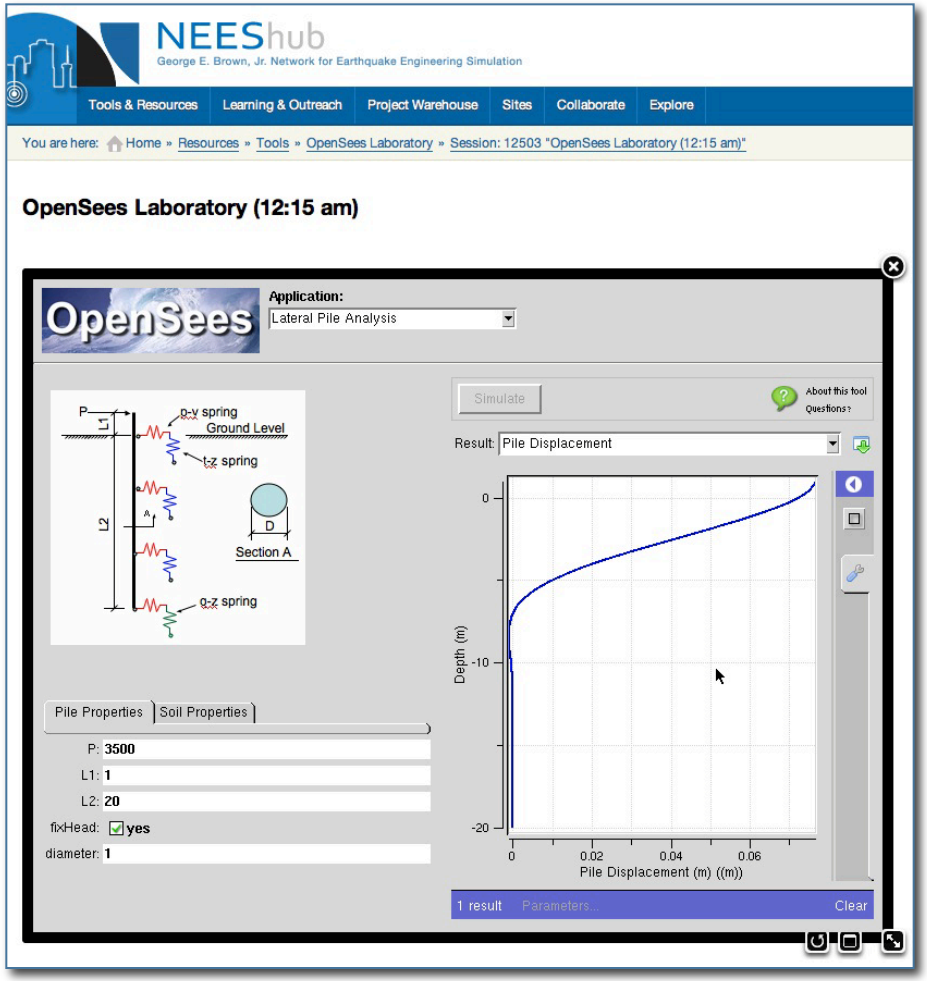
Integrating High Performance Simulation with NEEShub

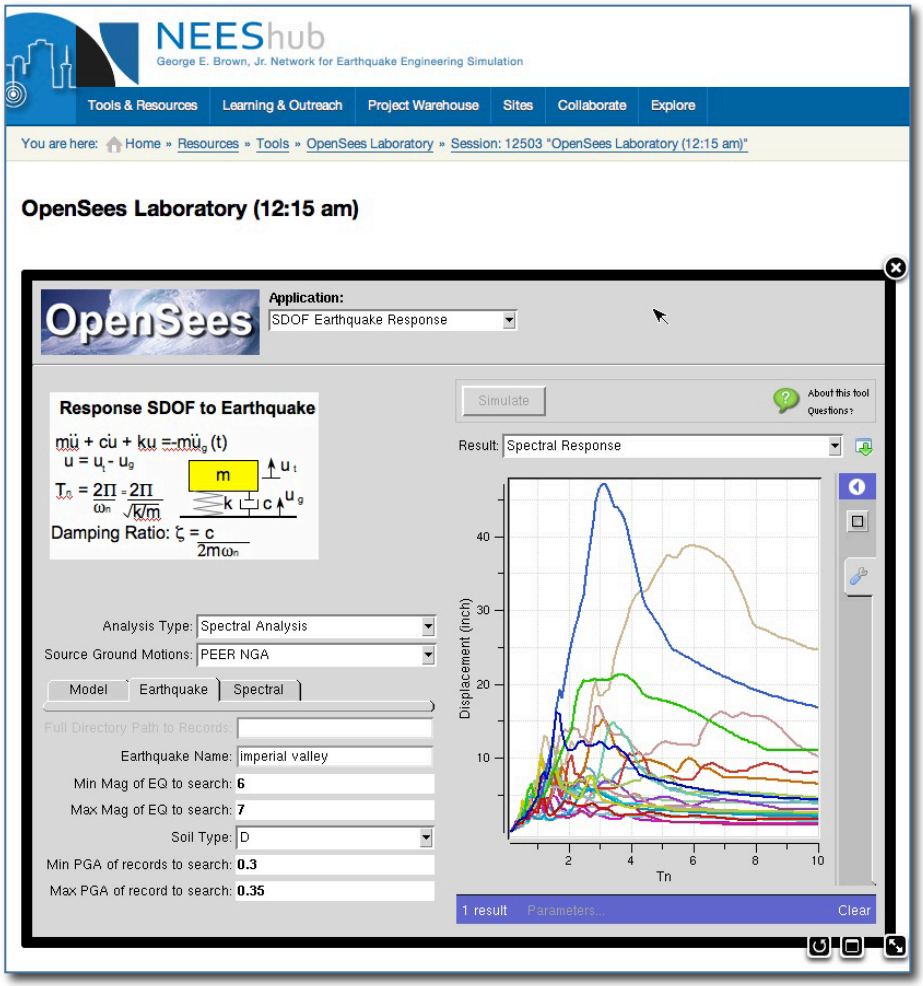




Partnering with NEEScomm

OpenSees “Apps” - User developed tools powered by OpenSees



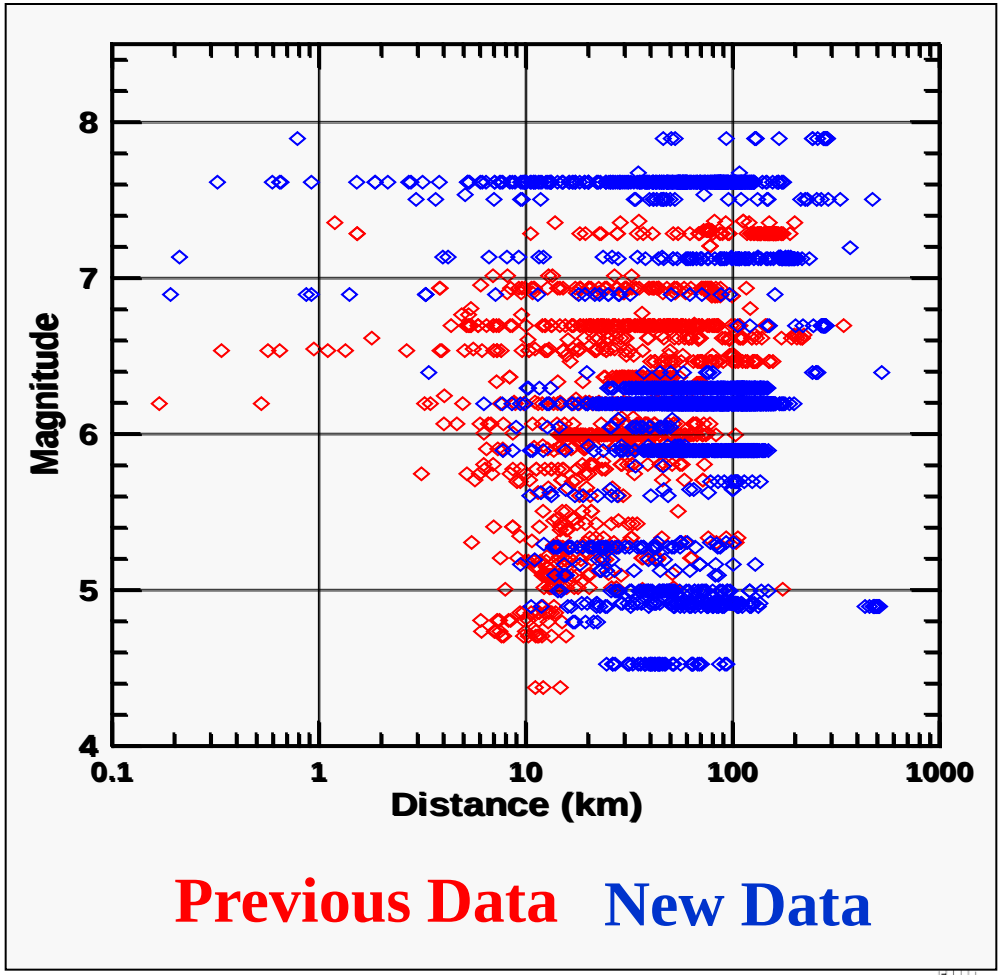


Improved Characterization of Seismic Hazard

NEXT GENERATION ATTENUATION MODEL RESEARCH PROGRAM

NGA West

- Multi-disciplinary team
  - geologists
  - seismologists
  - geotechnical engineers
  - structural engineers
- Database
  - 173 worldwide earthquakes
  - 10,500 uniformly processed records
- Funded by NRC, DOE, EPRI, Caltrans, utilities and other



PEER

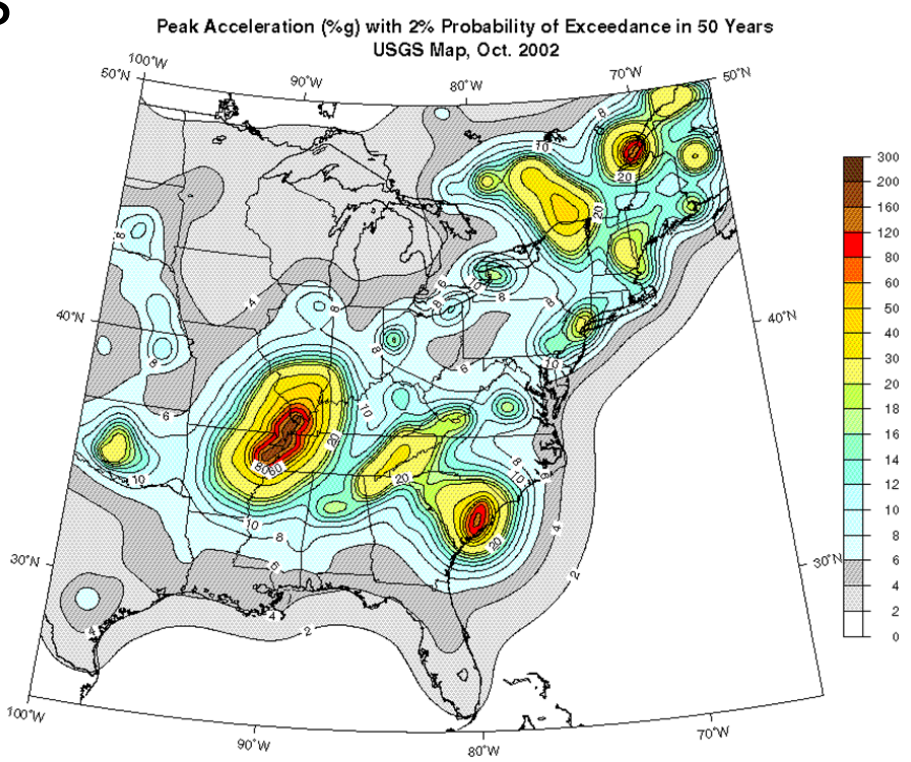
NGA East

- Collaboration with USGS
- Funded by US NRC, DOE, EPRI and others
- PEER leadership and management

Updating NGA West
- Recent earthquake data
- Near-fault directivity effects
- Soil effects
- Vertical motion effects

Global Earthquake Model (GEM)
- GMPEs for Global Hazard Module

Coming Soon: NGA Subduction



Focuses on seismic criteria for next generation of nuclear power plants

PEER

Enabling Tools: Accessing Ground Motions

Ground Motion Data Sets for PBEE Studies

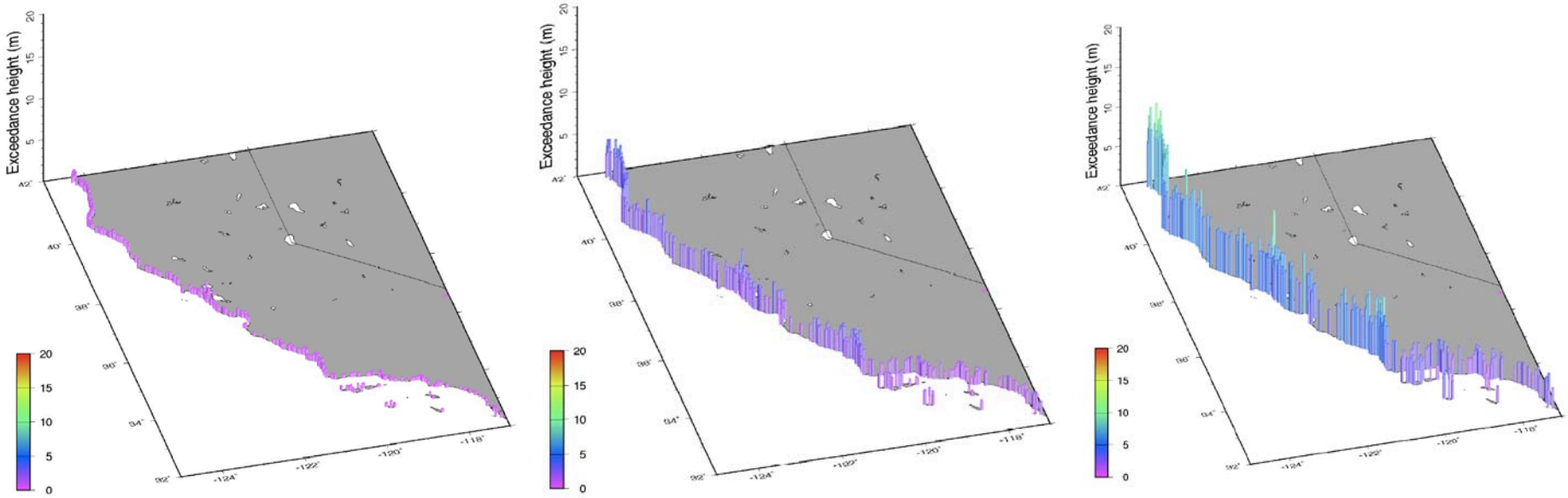
- Scenario Based Motions
  - Broad-Band Motions (M=7, R=10 km, Soil)
  - Broad Band Motions (M=7, R=10 km, Rock)
  - Broad Band Motions (M=6, R=25 km, Soil)
- Pulse-like Motions
- Site Specific Motions for Oakland for 2%, 10% and 50% probabilities of exceedence (Berkeley, Los Angeles and Sacramento coming soon)

PI: Baker

http://peer.berkeley.edu/transportation/publications_data.html

Earthquake-Related Hazards: Tsunami Engineering Research Group:

- Probabilistic hazards in a form consistent with ground motion hazard estimates



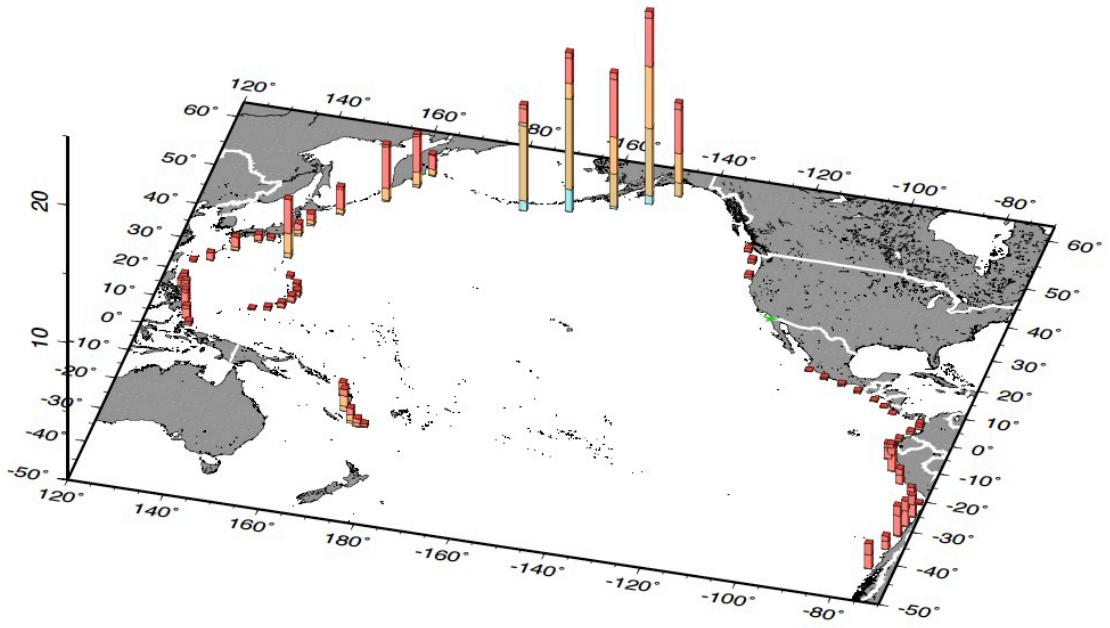
72 year **475 year** **2500 years**

Probabilistic Wave Height and Velocity Estimates

PEER

Tsunami Engineering Research Group: Probabilistic Tsunami Hazard Analysis

- Probabilistic hazards in a form consistent with ground motion hazard estimates

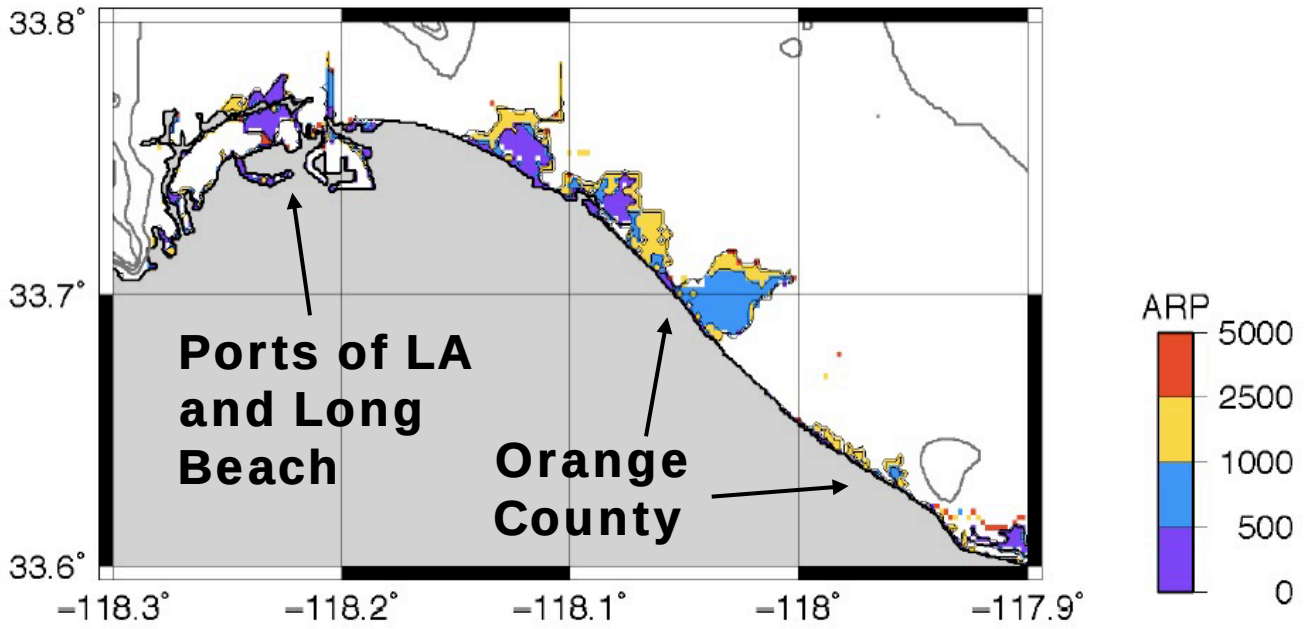


Deaggregatized contribution of sources to tsunami hazard in port of San Diego

PEER

PEER Tsunami Engineering Research Group:
Probabilistic Tsunami Hazard Analysis

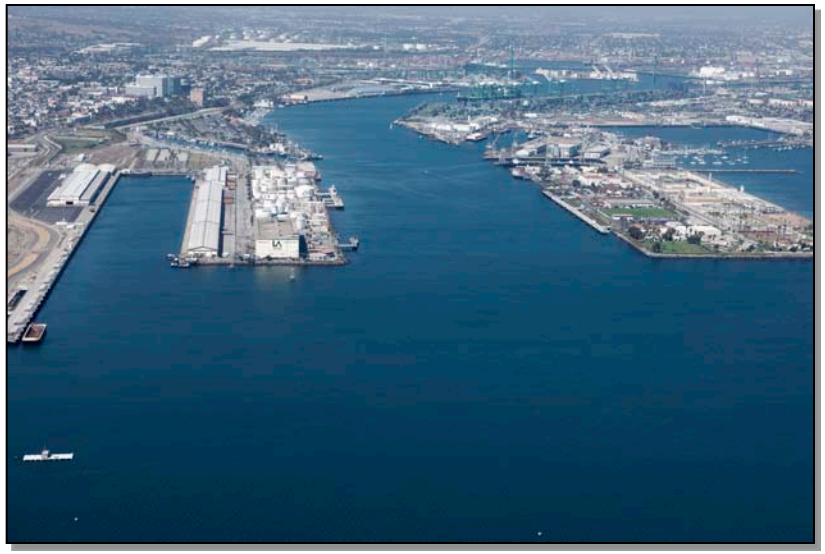
- Probabilistic hazards in a form consistent with ground motion hazard estimates



Probabilistic Inundation Maps

PEER

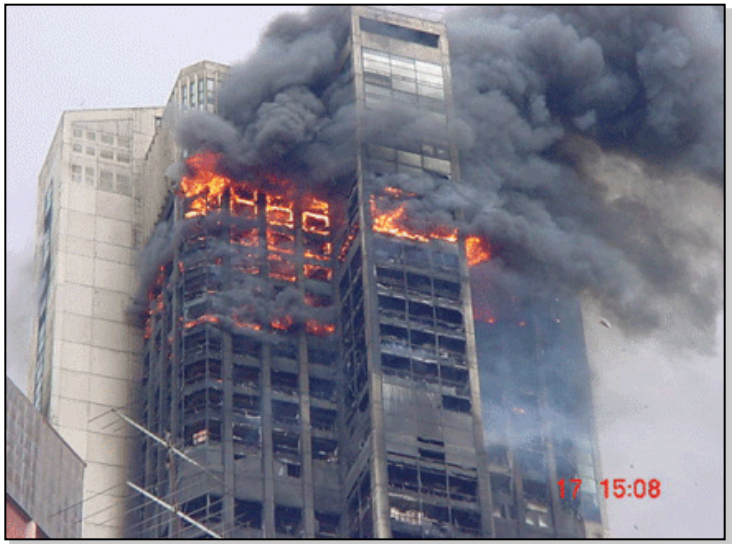
PEER Tsunami Engineering Research Group:
Risk Assessment and Mitigation



Earthquake-Related Hazards: ***Fire Following Earthquakes***

Aging infrastructure can trigger fires

Will resources be available to fight urban fires?



Will earthquake damage prevent effective fire suppression in tall buildings?

New research initiatives on:

- Vulnerability of fuel and water supply systems to earthquakes
- Case studies of fires in tall buildings following earthquakes
- Communications systems for emergency management and recovery

PEER

Earthquake-Related Hazards: Even moderate damage may mean buildings lose their functionality

Natural disasters cause wide-spread moderate damage

Such damage can have substantial long-lasting social, economic and cultural impacts on a city.

Beyond Safety: Issues for Sustainable and Earthquake-Resilient Structures

In *Earthquake Engineering*, our future challenge is to develop new or improved structures that:

- ✓ protect public safety, and are
- ✓ economical, but that
- ✓ can be constructed quickly with minimal disruption to the public and to the environment, and
- ✓ can withstand strong earthquake ground shaking (and other hazards) safely, with little disruption or cost associated with post-earthquake inspections and repairs.

Such approaches are consistent with, and supportive of, emerging trends related to sustainable development and “green” design.

PEER

Beyond Minimum Safety: Disaster-Resilient Structures

Numerous structural concepts possible

- High performance, low carbon materials
- Self-centering structural concepts
- Rocking Foundations
- Next-generation braced and damped systems
- Inertial damping systems
- Seismic Isolation

PEER

Business Interruption (BI)

- Direct BI

Source: www.nytimes.com

Clean room in the Renesas Electronics Microcontroller Manufacturing Facility; Hitachinaka, Ibaraki Prefecture

Two weeks to complete initial damage assessments and begin repairs; partial operation targeted for June 2011

More than 2,000 external contractors have been hired to assist with repair work (Source: http://am.renesas.com)

Courtesy: Carlos Cabrera, RMS

- Contingent BI

General Motors automobile assembly facility in Shreveport, Louisiana

Facility shut down for a week in March due to parts shortages

On April 22nd, Toyota announced that its manufacturing plants in North America were operating at 30% of capacity because of the parts supply situation.

PEER

FRIDAY September 30, 2011			
Time	***General Daily Schedule***	***Presentation Title***	***Speakers***
8:00 - 9:00 am	REGISTRATION / BREAKFAST	LOCATED IN COURTYARD	
9:00 - 10:30 am	PLENARY	Welcome by PEER Director and Selected Guests	**Steve Mahin** (PEER Center & UC Berkeley)
		Implications of Eastern Japan Earthquake of March 2011	**Akira Wada** (Architectural Institute of Japan)
		Engineering Resilience	**Mary Comerio** (UC Berkeley)
10:30 - 11:00am	BREAK		
11:00 - 12:00 pm	PLENARY	The Next Big CA Earthquake	**Janielle Maffei** (California Earthquake Authority)
		Perspectives on Insurance and Financial Aspects of Earthquakes	**Craig Tillman** (WeatherPredict Consulting Inc.)
12:00 - 1:30 pm	LUNCH	LOCATED IN BOILER ROOM & COURTYARD	
1:30 - 3:00 pm	PLENARY	Seismic Hazard Analysis	**Jack Baker** (Stanford)
		Computational Simulation	**Frank McKenna** (PEER Center & OpenSees)
		High Performance Materials	**Claudia Ostertag** (UC Berkeley)
3:00 - 3:30 pm	BREAK		
3:30 - 5:00 pm	PLENARY	Geotechnical PBEE	**Ross Boulanger** (UC Davis)
		Bridge PBEE and Reslience	**Mark Eberhard** (University of Washington)
		PBEE and its applications to Tall Buidlings	**Jack Moehle** (UC Berkeley)
5:00 - 7:00 pm	STUDENT POSTER SESSION AND RECEPTION	LOCATED IN BOILER ROOM & COURTYARD	

PEER

SATURDAY October 1, 2011			
Time	***General Daily Schedule***	***Session Name***	***Location***
8:00 - 9:00 am	REGISTRATION / BREAKFAST		
9:00 - 11:30 pm	CONCURRENT DISCUSSION SESSIONS	**Tall Buildings**	Boiler Room C
9:00 - 11:30 pm	CONCURRENT DISCUSSION SESSIONS	**Dams and Risk Assessment**	Whitecotton Room 6th floor
9:00 - 11:30 pm	CONCURRENT DISCUSSION SESSIONS	**Tsunami**	Crystal Ballroom
9:00 - 11:30 pm	CONCURRENT DISCUSSION SESSIONS	**Nuclear**	Boiler Room B
9:00 - 11:30 pm	CONCURRENT DISCUSSION SESSIONS	**Fire & Lifelines**	Boiler Room A
11:30 - 1:00 pm	LUNCH (starting at 12:15pm will be short summarizing presentations by morning session chairs followed by intro to Transportation Systems Research Program TSRP sessions)		Crystal Ballroom
1:00 - 3:30 pm	CONCURRENT TSRP MEETINGS	**TSRP: Structures**	Crystal Ballroom
1:00 - 3:30 pm	CONCURRENT TSRP MEETINGS	**TSRP: Soils and Foundations**	Whitecotton Room 6th floor
1:00 - 3:30 pm	CONCURRENT TSRP MEETINGS	**TSRP: Simulations**	Boiler Room B
1:00 - 3:30 pm	CONCURRENT TSRP MEETINGS	**TSRP: New Sustainable & High Performance Materials**	Boiler Room A
1:00 - 3:30 pm	CONCURRENT TSRP MEETINGS	**TSRP: Systems**	Boiler Room C
3:30 - 4:00 pm	CONCLUDING PLENARY		Crystal Ballroom

Please participate

- Learn about new research results
- Plan and participate in future research

PEER