

2011 Annual Meeting



PEER

WELCOME
ME

Shattuck Plaza Hotel, Berkeley, CA September 30¹– October 1,, 2011

Pacific Earthquake Engineering

2011 Annual Meeting

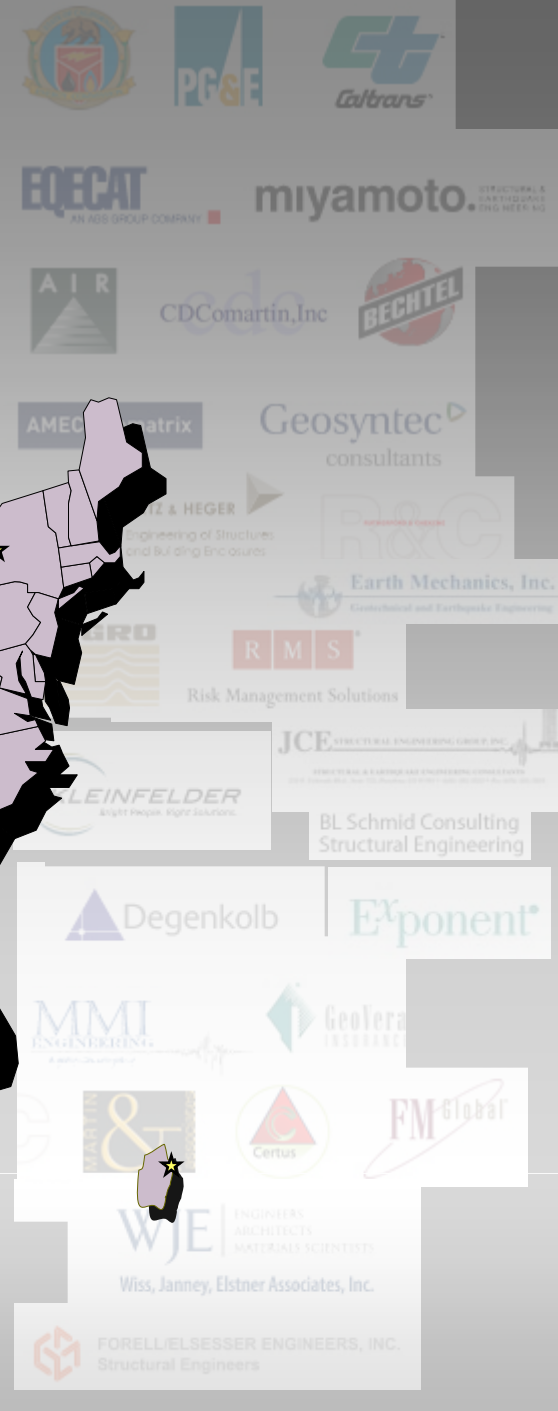
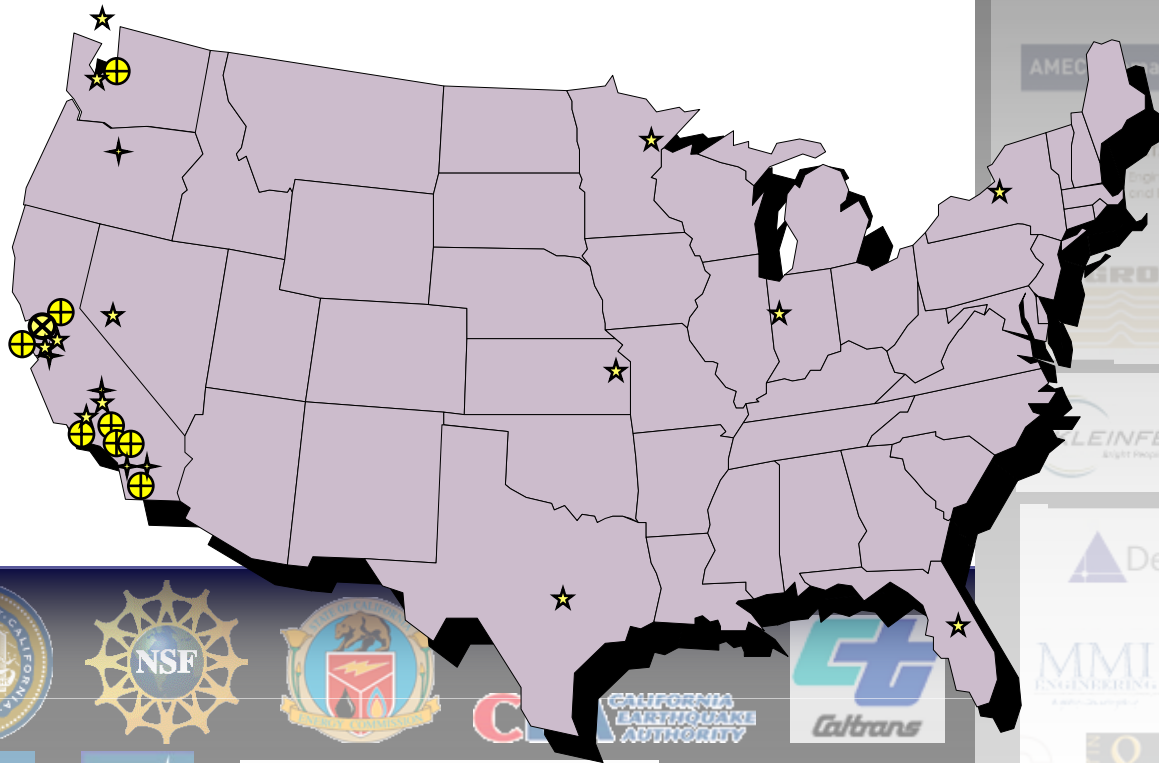


Stephen Mahin
Director, PEER
**Professor of Structural
Engineering, UC Berkeley**

Shattuck Plaza Hotel, Berkeley, CA

September 30²– October 1,, 2011

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



Pacific Earthquake Engineering Research Center

Regions of High Seismic Activity



Pacific Earthquake Engineering Research Center



Oregon State University joins **PEER!**

Oregon State
University
Corvallis, Oregon

Congratulations!



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

Education, Outreach and Training

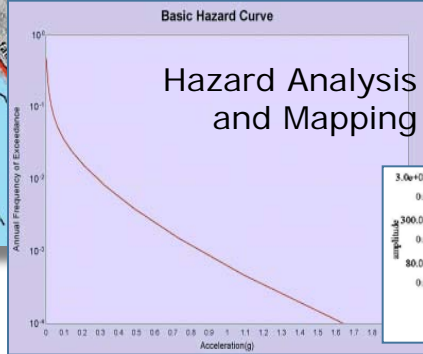
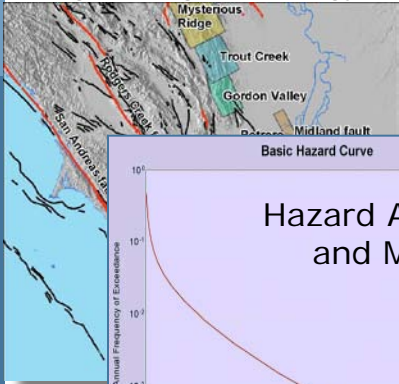
Disseminating Research Findings and Promoting Multidisciplinary Understanding

- 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)

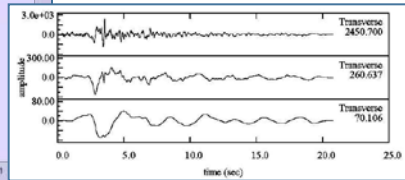
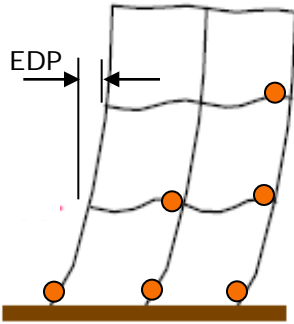


Our DNA: Integrated PBEE methodology

Engineering Seismology



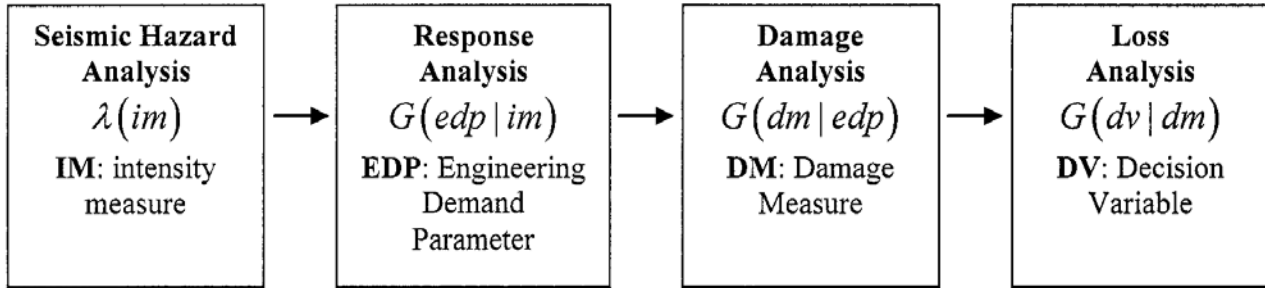
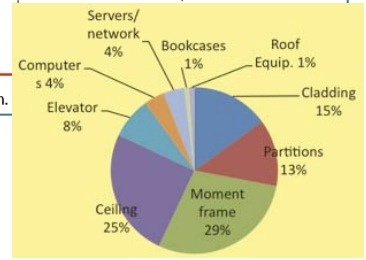
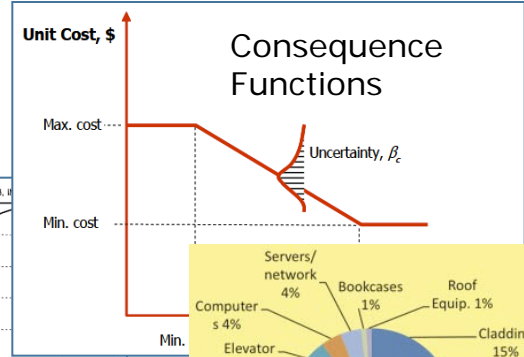
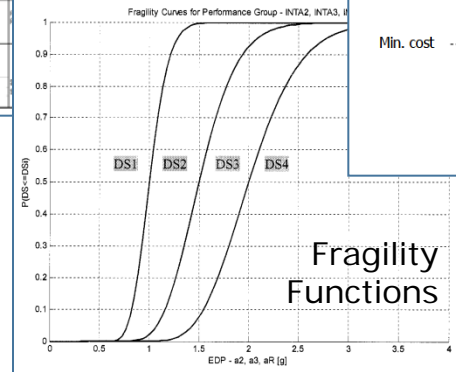
HPC simulation



Ground motion selection and scaling

Performance Databases

BASIC COMPOSITION	DAMAGES STATES		
	DS1	DS2	DS3
No. of square feet of flexurally controlled RC concrete shear walls in each direction			
DESCRIPTION	Flexural cracks < 1/16" (shear diagonal cracks < 1/16") No significant scaling. No failure or buckling of hot structurally significant	Flexural cracks < 1/4" (shear diagonal cracks < 1/8") Moderate scaling/ loose cover. No failure or buckling of insignificant residual deterioration	Max. crack widths > 3/8" Significant scaling/ loose cover. Fracture or buckling some of significant residual deterioration. Repair in place impractical
ILLUSTRATION (example photo or drawing)			
MEDIAN EDP (intensity, gR)	1.5%	3.0%	6.0%
BETA	0.2	0.3	0.4
CORRELATION (ρ)		0.30	
REPAIR MEASURES			
CONSEQUENCE FUNCTION (Cost per sq ft of wall for repair)			
Max. cost up to lower quantity			
Min. cost over upper quantity			
Data source:			

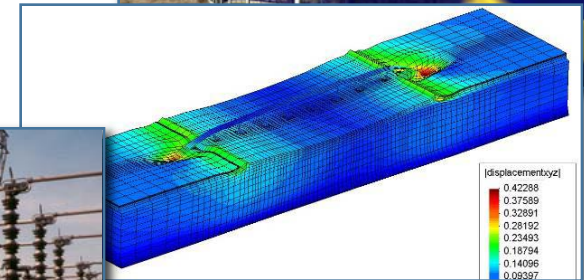
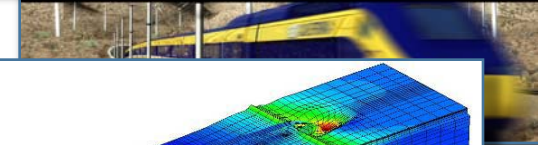
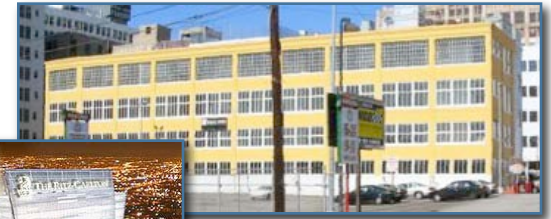


- Probabilistic Assessment of:**
- ✓ Cost of repair and loss of function
 - ✓ Downtime
 - ✓ Casualties
 - ✓ Embodied energy

$$\lambda(DV > dv) = \int \int \int G(dv | dm) dG(dm | edp) dG(edp | im) d\lambda(im)$$

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



Applications of PBEE

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



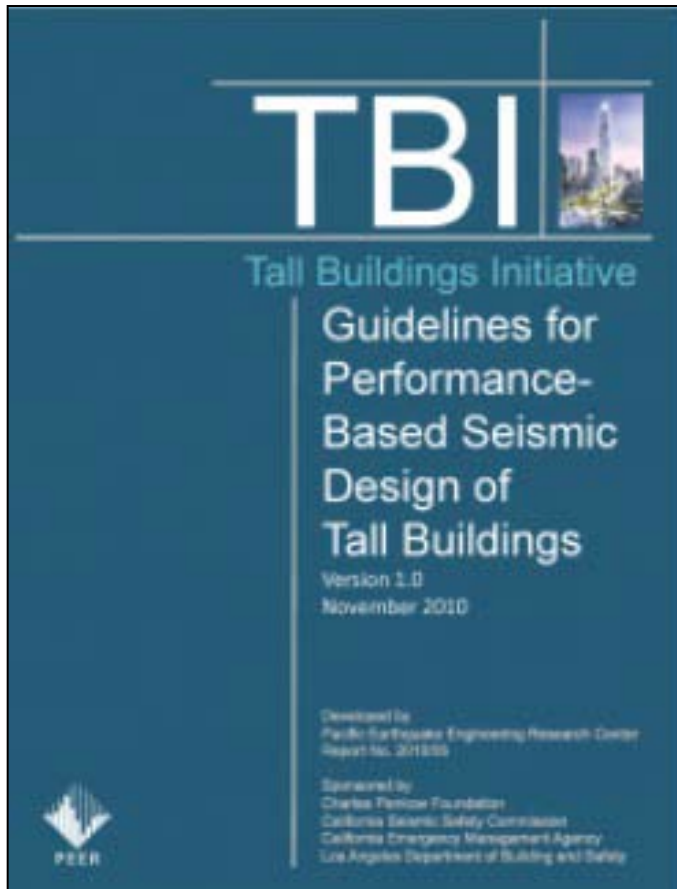
- ❖ Advanced dynamic analysis procedures
- ❖ Soil-structure interaction
- ❖ Innovative structural systems
- ❖ Vulnerability of existing tall buildings

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



Award – Tall Building Initiative

2011 Excellence in Structural Engineering Award



Research Category – Large Projects

SEAONC



Applications of PBEE

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



- ❖ Advanced dynamic analysis procedures
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Applications of PBEE

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

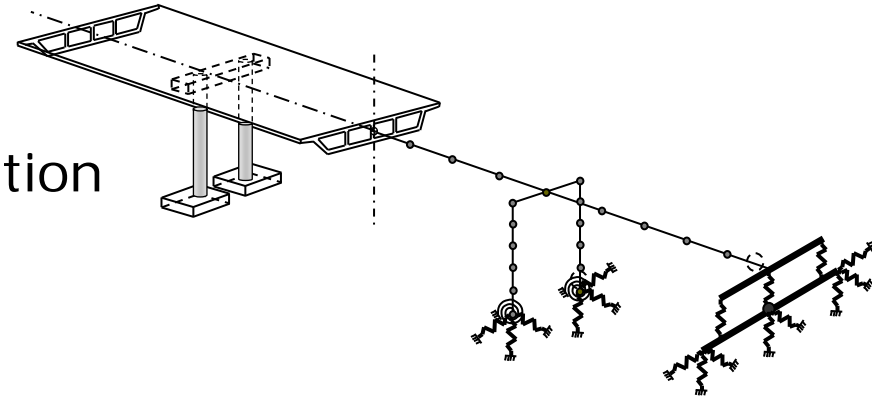


Many tall buildings in California's urban cores are built in the 1970s and 1980s using code provisions known to have serious deficiencies -- large number of steel moment frame buildings

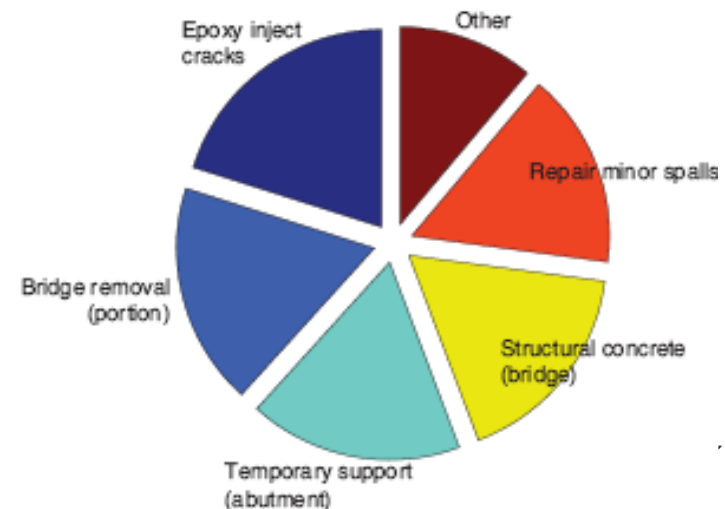
Applications of PBEE

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



Contribution to expected cost for 50%-in-50-years PE



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

Applications of PBEE

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



- ❖ Bayesian network systems for design and post-event emergency management, including dependencies on electric grid
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Pursuing Fundamental Knowledge: Behavior of Reinforced Concrete Columns

Tests undertaken to validate concepts and numerical models used in PBEE



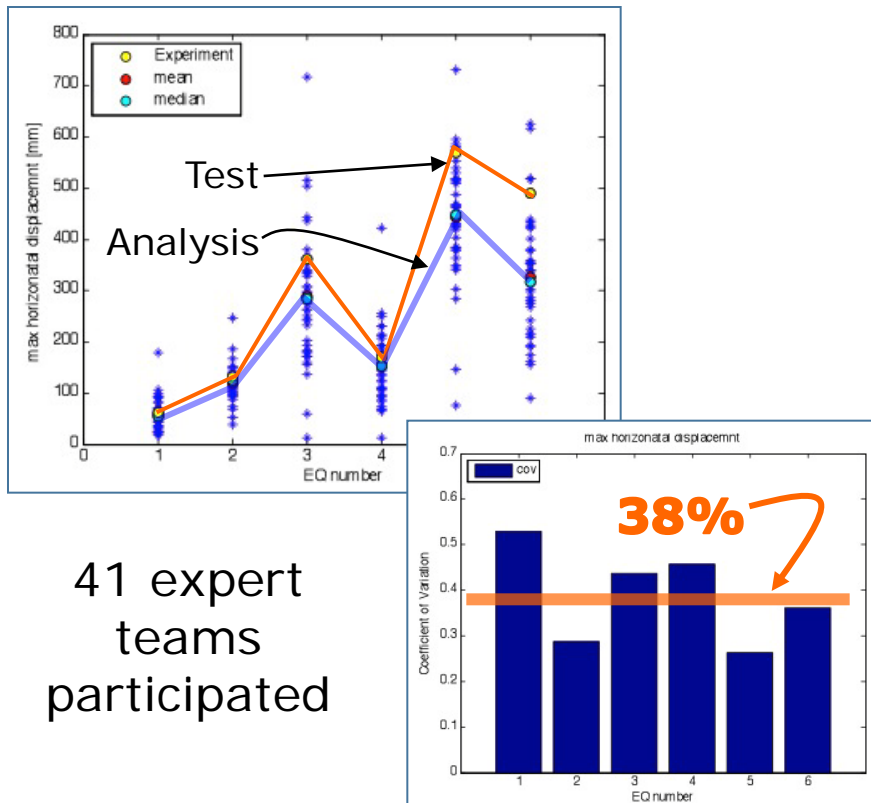
Reduced-scale 3D tests of conventional circular and rectangular columns, self-centering columns, rocking columns (PEER)



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

Pursuing Fundamental Knowledge: Behavior of Reinforced Concrete Columns

Tests undertaken to validate concepts and numerical models used in PBEE



41 expert
teams
participated



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

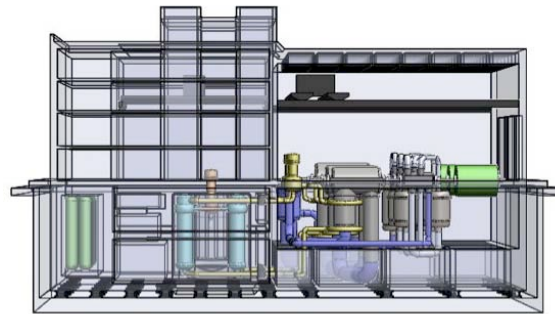
**PEER-NEES RC Column Blind Analysis
Contest - 2010**



PEER

Applications of PBEE

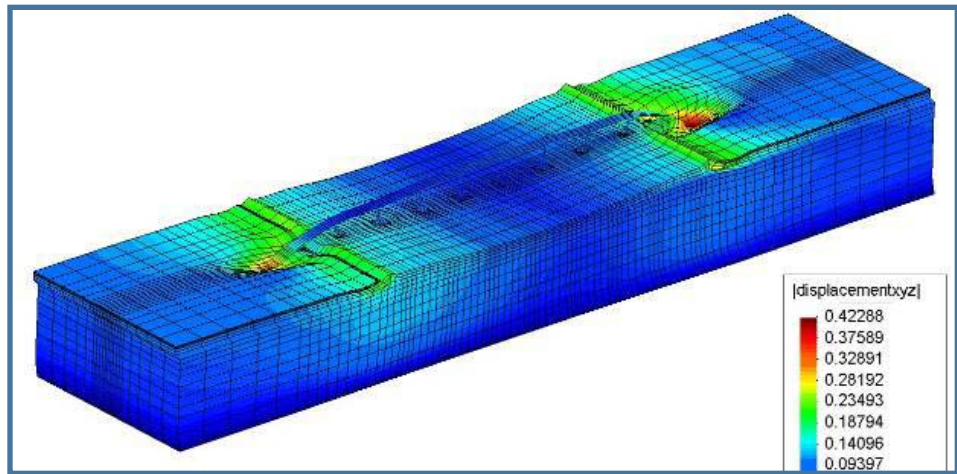
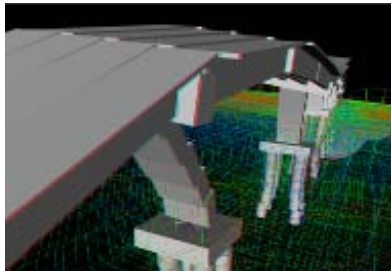
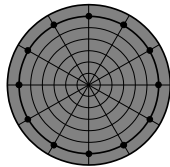
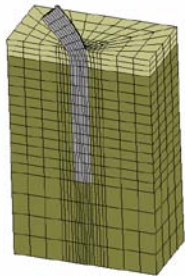
- Lifeline systems
 - Electrical power distribution systems
 - Nuclear power plants
 - Fuel storage facilities



Goal: To improve safety and reliability of Lifelines Systems
More than 120 projects have been initiated

Enabling Technology: High Performance Simulation

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



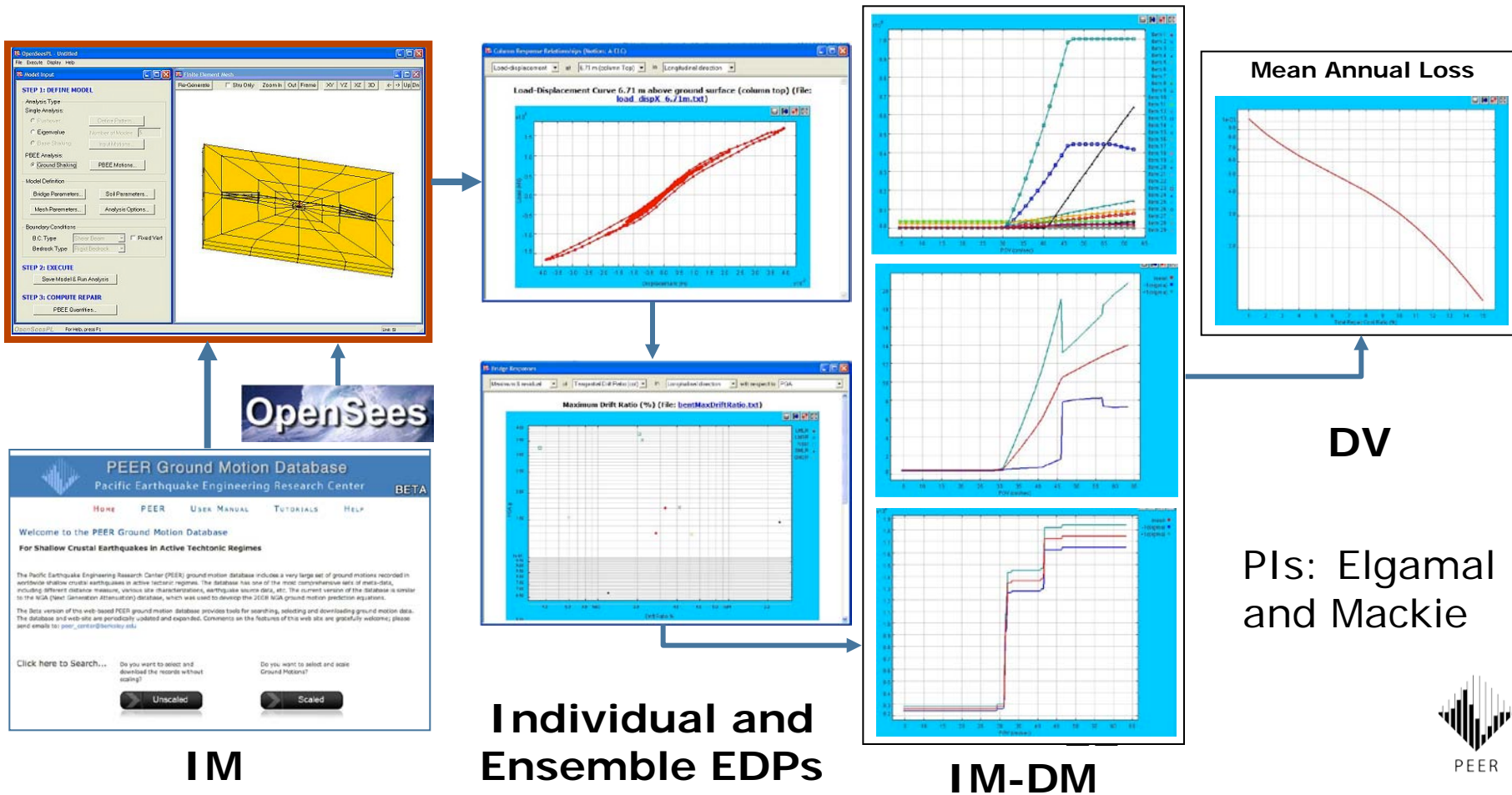
New Development Efforts by PEER:

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

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

OpenSees PBEE

Integration of tools and methodologies



Partnering with NEEScomm

Integrating High Performance Simulation with NEEShub

NEEShub
George E. Brown, Jr. Network for Earthquake Engineering Simulation

Tools & Resources Learning & Outreach Project Warehouse Sites Collaborate Explore

You are here: Home » Resources » Tools » OpenSees Laboratory » Session: 12502 "OpenSees Laboratory (12:14 am)"

OpenSees Laboratory (12:14 am)

Application: OpenSeesLaboratory

OpenSeesLab

NEEShub

A Collection of Tools for Structural/Geotechnical Engineers that use the **Open System** for **Earthquake Engineering Simulation**

The screenshot shows the OpenSeesLab application interface. It features a header with the OpenSees logo and the NEEShub logo. Below the header, there is a navigation menu with options: Tools & Resources, Learning & Outreach, Project Warehouse, Sites, Collaborate, and Explore. The main content area displays the title "OpenSeesLab" and a subtitle "A Collection of Tools for Structural/Geotechnical Engineers that use the Open System for Earthquake Engineering Simulation". The interface includes several panels: a "Response SDOF to Earthquake" panel with input fields, a "Response Time History" panel with a plot of displacement vs. time, and a "Response Spectra" panel with a plot of spectral acceleration vs. period. There are also buttons for "Control" and "Plot".

NEEShub
George E. Brown, Jr. Network for Earthquake Engineering Simulation

Tools & Resources Learning & Outreach Project Warehouse Sites Collaborate Explore


You are here: Home » Resources » Tools » OpenSees Laboratory » Session: 12503 "OpenSees Laboratory (12:15 am)"

OpenSees Laboratory (12:15 am)

Application: OpenSees Interpreter

OpenSees -- Open System For Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center -- 2.2.1

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(Copyright and Disclaimer @ <http://www.berkeley.edu/OpenSees/copyright.html>)

OpenSees > |  **Start here!**

Access to OSG and Teragrid Resources

The screenshot shows the OpenSees Interpreter application interface. It features a header with the OpenSees logo and the NEEShub logo. Below the header, there is a navigation menu with options: Tools & Resources, Learning & Outreach, Project Warehouse, Sites, Collaborate, and Explore. The main content area displays the title "OpenSees Laboratory (12:15 am)" and the application name "OpenSees Interpreter". The interface shows the OpenSees logo and the text "OpenSees -- Open System For Earthquake Engineering Simulation Pacific Earthquake Engineering Research Center -- 2.2.1". Below this, there is a copyright notice: "(c) Copyright 1999,2000 The Regents of the University of California All Rights Reserved (Copyright and Disclaimer @ http://www.berkeley.edu/OpenSees/copyright.html)". At the bottom, there is a prompt "OpenSees > |" with a blue arrow pointing to it and the text "Start here!". On the right side, there is a blue-bordered box containing the text "Access to OSG and Teragrid Resources".

Partnering with NEEScomm

OpenSees "Apps" - User developed tools powered by OpenSees

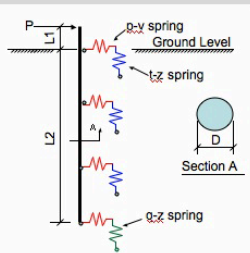
NEEShub
George E. Brown, Jr. Network for Earthquake Engineering Simulation

Tools & Resources Learning & Outreach Project Warehouse Sites Collaborate Explore

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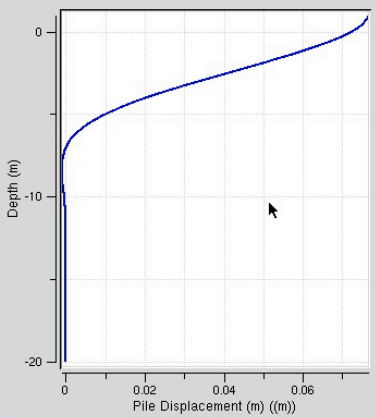
OpenSees Laboratory (12:15 am)

Application: Lateral Pile Analysis



Simulate About this tool Questions?

Result: Pile Displacement



Depth (m)

Pile Displacement (m) (mm)

1 result Parameters... Clear

Pile Properties Soil Properties

P: 3500
L1: 1
L2: 20
fix-Head: yes
diameter: 1

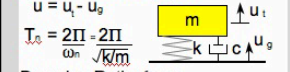
NEEShub
George E. Brown, Jr. Network for Earthquake Engineering Simulation

Tools & Resources Learning & Outreach Project Warehouse Sites Collaborate Explore

You are here: Home » Resources » Tools » OpenSees Laboratory » Session: 12503 "OpenSees Laboratory (12:15 am)"

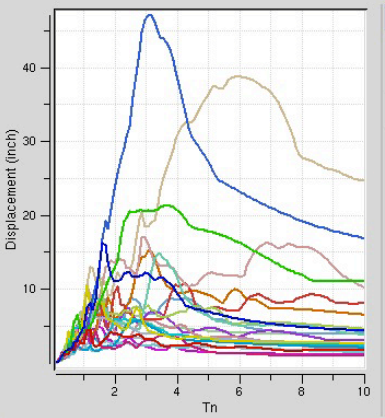
OpenSees Laboratory (12:15 am)

Application: SDOF Earthquake Response



Simulate About this tool Questions?

Result: Spectral Response



Displacement (inch)

Tn

1 result Parameters... Clear

Response SDOF to Earthquake

$$m\ddot{u} + c\dot{u} + ku = -\ddot{u}_g(t)$$
$$u = u_t - u_g$$
$$T_n = \frac{2\pi}{\omega_n} = \frac{2\pi}{\sqrt{k/m}}$$
$$\text{Damping Ratio: } \zeta = \frac{c}{2m\omega_n}$$

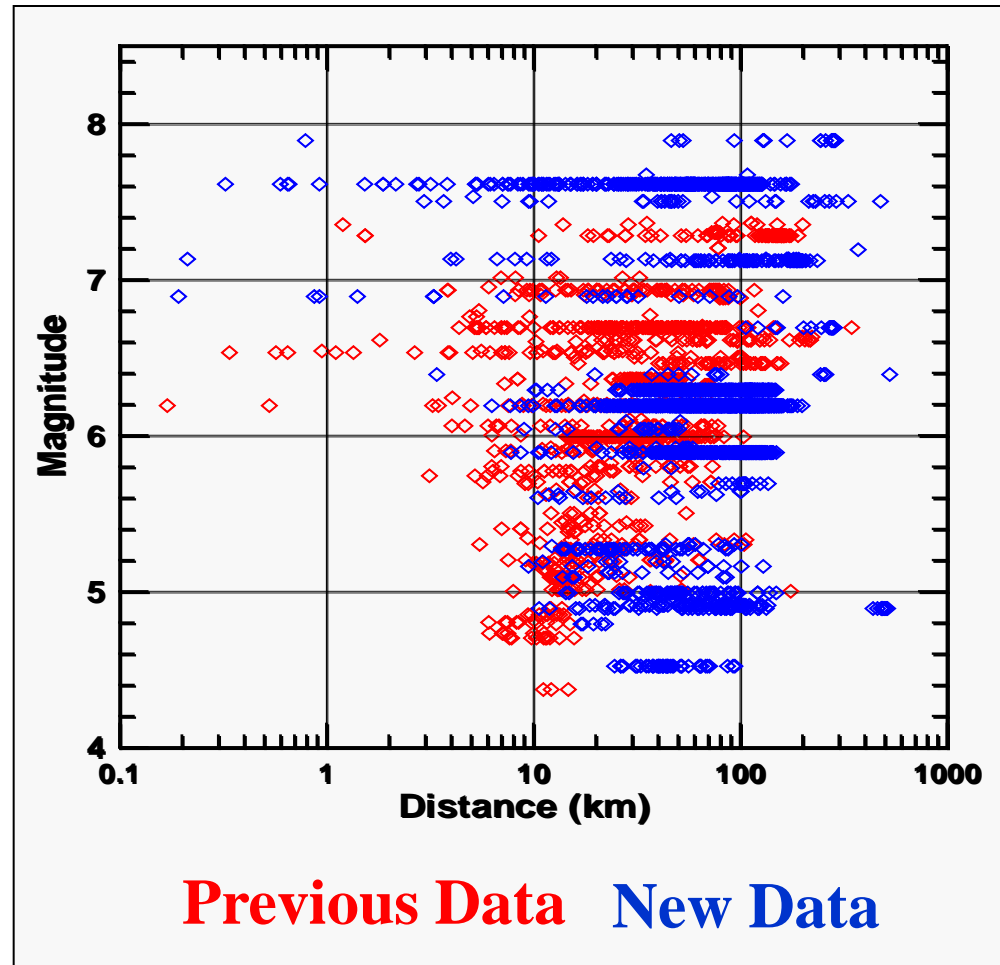
Analysis Type: Spectral Analysis
Source Ground Motions: PEER NGA
Model Earthquake Spectral
Full Directory Path to Records:
Earthquake Name: imperial valley
Min Mag of EQ to search: 6
Max Mag of EQ to search: 7
Soil Type: D
Min PGA of records to search: 0.3
Max PGA of record to search: 0.35

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



NGA East

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

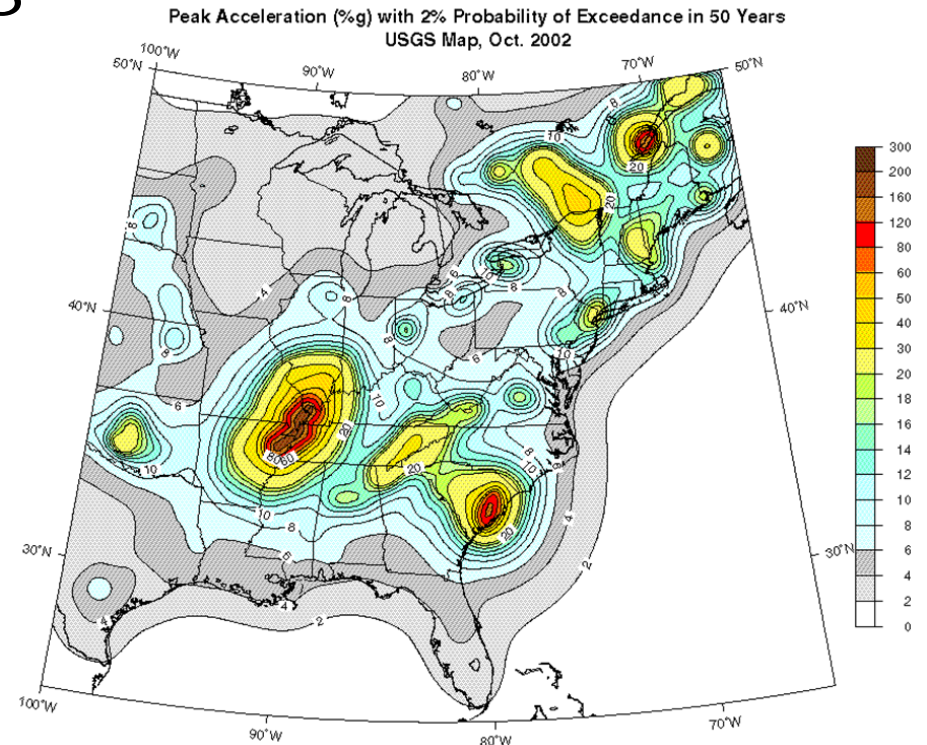
Updating NGA West

- 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

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

The screenshot shows the PEER Ground Motion Database website. The header includes the logo, the title "PEER Ground Motion Database", the subtitle "Pacific Earthquake Engineering Research Center", and a "BETA" badge. A navigation menu contains links for "HOME", "PEER", "USER MANUAL", "TUTORIALS", and "HELP". The main content area starts with a welcome message and a sub-header "For Shallow Crustal Earthquakes in Active Tectonic Regimes". It provides a brief description of the database and its beta version. Below this, there are two buttons: "Unscaled" and "Scaled", each with a "Click here to Search..." label and a question about selecting and downloading records. The "Sponsors" section features logos for PEER, Caltrans, and CGS. A "Disclaimer and Copyright Notice" section is at the bottom, containing detailed legal text.

PEER Ground Motion Database
Pacific Earthquake Engineering Research Center **BETA**

HOME PEER USER MANUAL TUTORIALS HELP

Welcome to the PEER Ground Motion Database
For Shallow Crustal Earthquakes in Active Tectonic Regimes

The Pacific Earthquake Engineering Research Center (PEER) ground motion database includes a very large set of ground motions recorded in worldwide shallow crustal earthquakes in active tectonic regimes. The database has one of the most comprehensive sets of meta-data, including different distance measure, various site characterizations, earthquake source data, etc. The current version of the database is similar to the NGA (Next Generation Attenuation) database, which was used to develop the 2008 NGA ground motion prediction equations.

The Beta version of the web-based PEER ground motion database provides tools for searching, selecting and downloading ground motion data. The database and web-site are periodically updated and expanded. Comments on the features of this web site are gratefully welcome; please send emails to: peer_center@berkeley.edu

Click here to Search... Do you want to select and download the records without scaling? Do you want to select and scale Ground Motions?

Unscaled Scaled

Sponsors

PEER Caltrans CGS

With special thanks to: **AMEC Geomatrix**

Disclaimer and Copyright Notice

The PEER strong-motion database and the associated flatfiles are still under review, and the documentation is still being developed. They represent a work in progress that is subject to future revisions as a result of the review process and as new information is obtained, or revised interpretations made. They are released in their current version to obtain feedback and comments from the earthquake engineering, seismology, and geology communities worldwide.

The PEER Center, University of California, Berkeley, funding and sponsoring agencies for the PEER ground motion project, and all organizations and individuals who contributed to the compilation, processing, and review of the database and flatfile are not responsible for any inaccuracy or incompleteness of the data, records, and parameters. The user of the database and flatfile assumes the entire responsibility of using them.

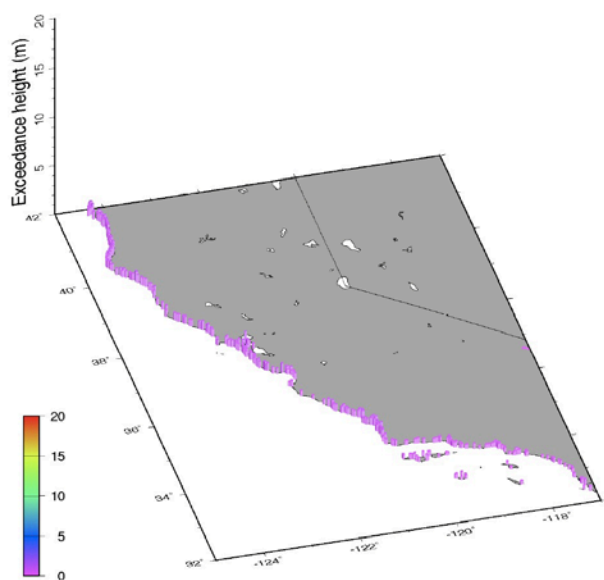
The PEER ground motion database and associated works ("Works") are Copyrighted © 2010, The Regents of the University of California (Regents). All Rights Reserved.

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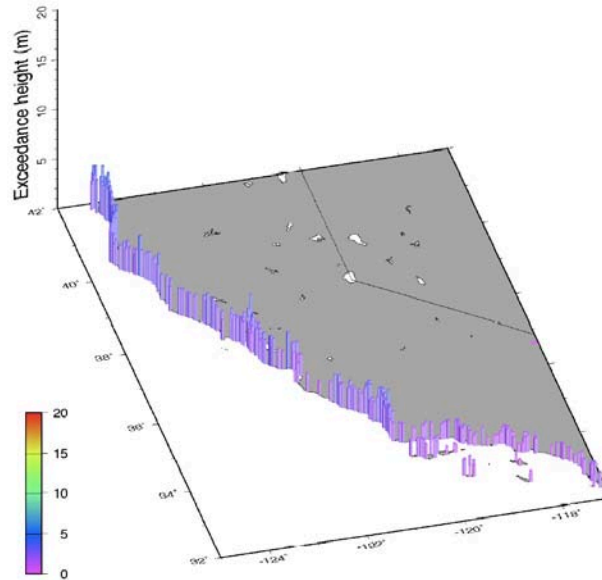
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Earthquake-Related Hazards: Tsunami Engineering Research Group:

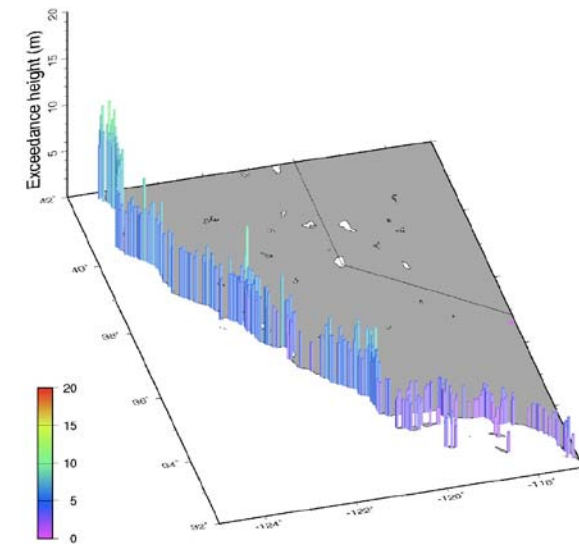
- Probabilistic hazards in a form consistent with ground motion hazard estimates



72 year



475 year

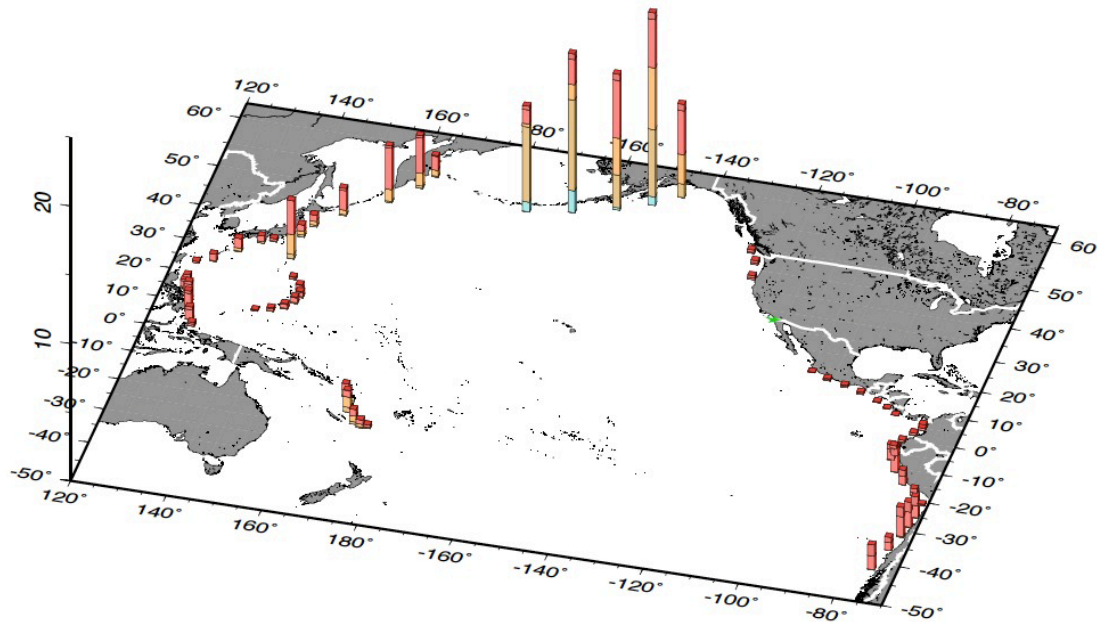


2500 years

Probabilistic Wave Height and Velocity Estimates

Tsunami Engineering Research Group: Probabilistic Tsunami Hazard Analysis

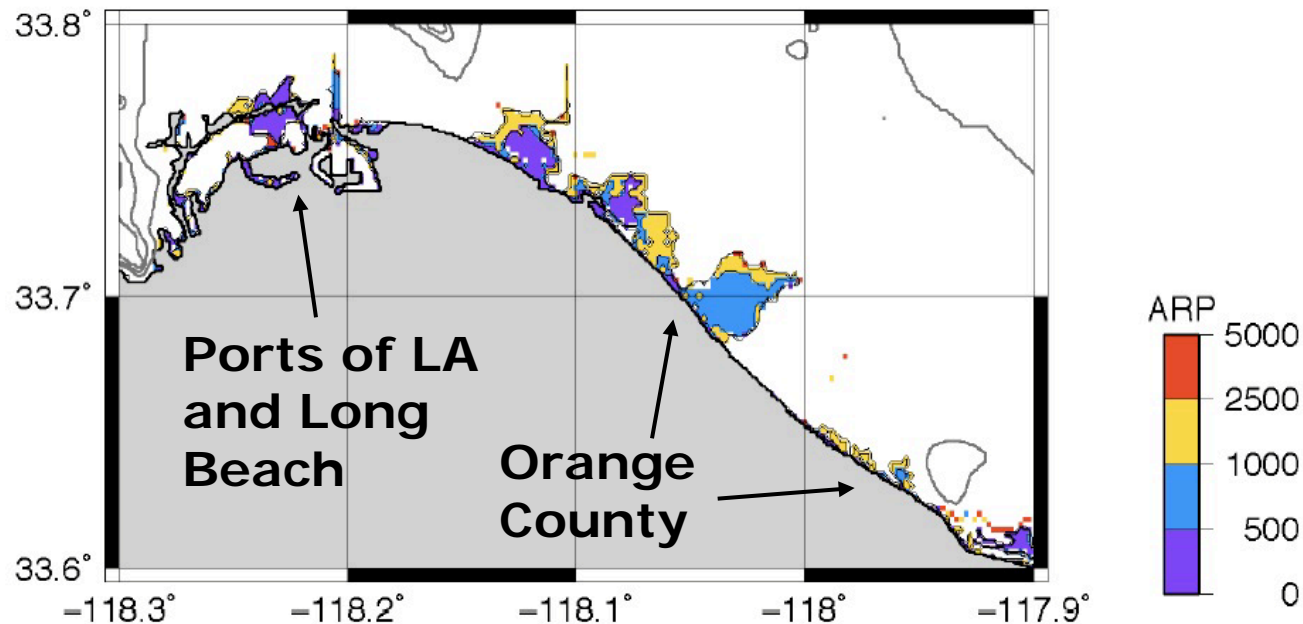
- Probabilistic hazards in a form consistent with ground motion hazard estimates



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

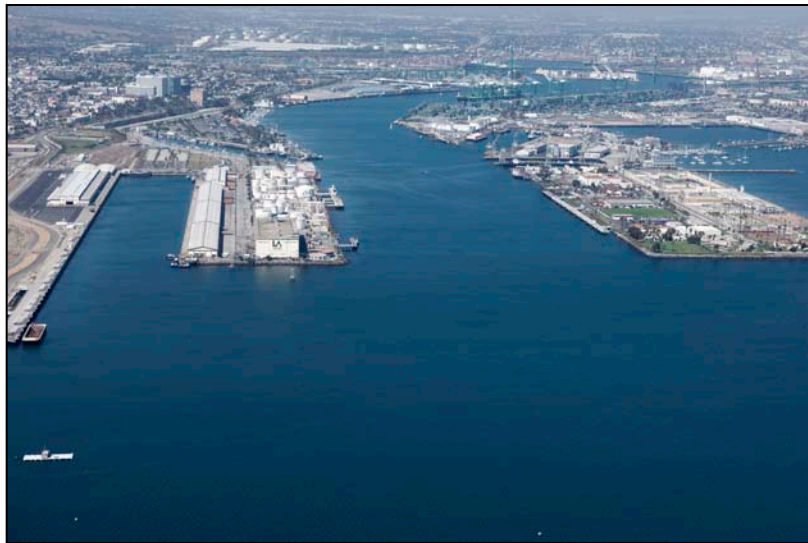
PEER Tsunami Engineering Research Group: Probabilistic Tsunami Hazard Analysis

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



Probabilistic Inundation Maps

PEER Tsunami Engineering Research Group: Risk Assessment and Mitigation



Earthquake-Related Hazards: Fire Following Earthquakes



San Bruno Fire, SF Gate

Aging infrastructure can trigger fires



San Bruno Fire, SF Gate

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

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



Natural disasters cause widespread 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.



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



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.**

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 Resilience	Mark Eberhard (University of Washington)
		PBEE and its applications to Tall Buildings	Jack Moehle (UC Berkeley)
5:00 - 7:00 pm	STUDENT POSTER SESSION AND RECEPTION	LOCATED IN BOILER ROOM & COURTYARD	

SATURDAY October 1, 2011

<i>Time</i>	<i>General Daily Schedule</i>	<i>Session Name</i>	<i>Location</i>
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