

# *Caltrans & PEER Seismic Research Seminar*

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PEER



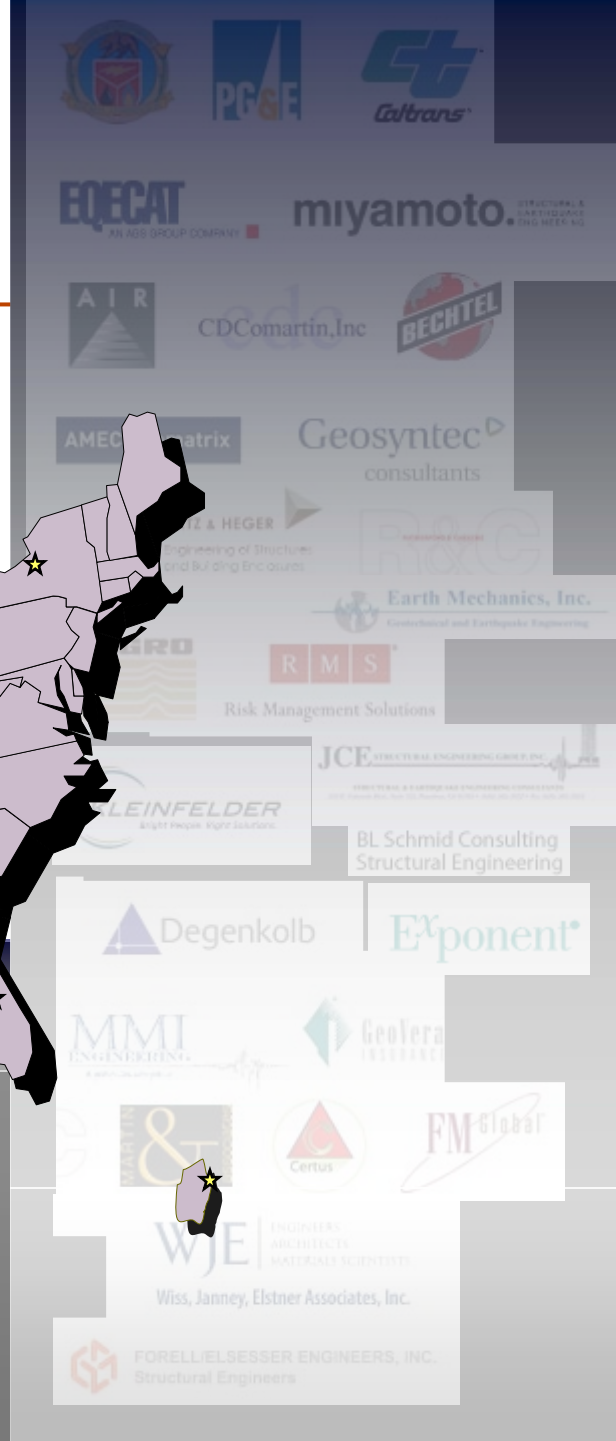
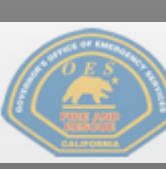
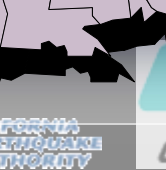
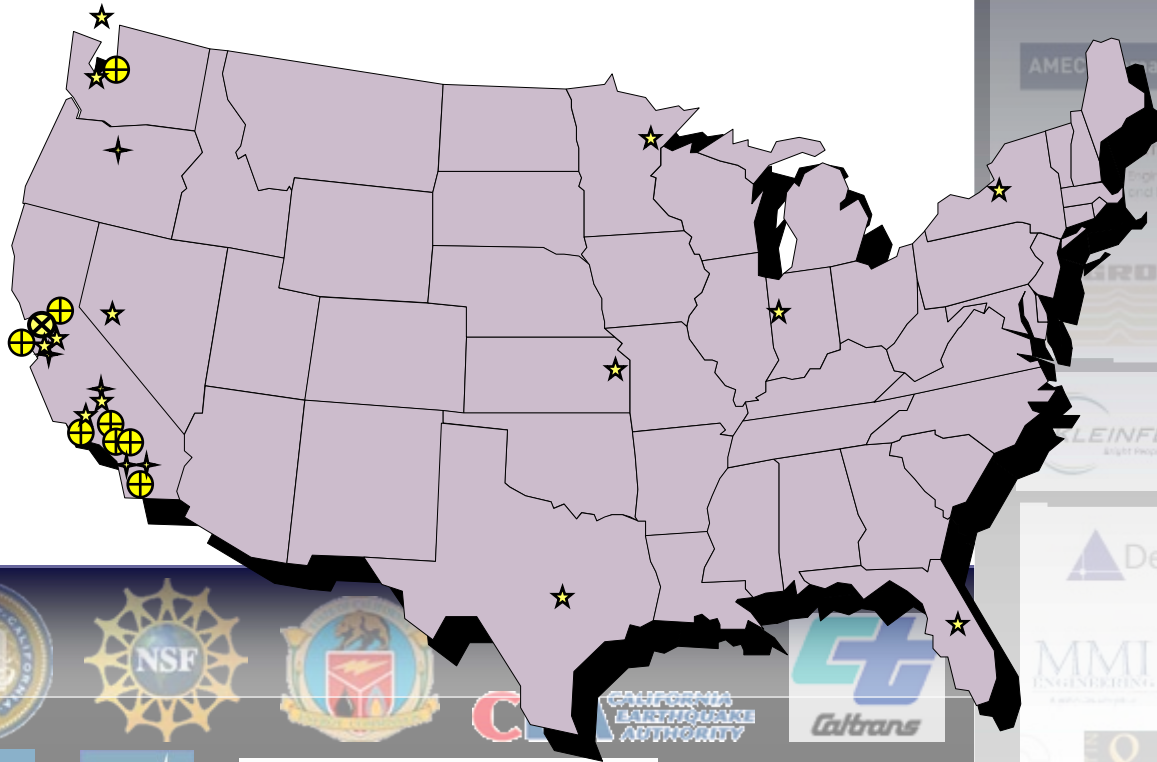
Stephen Mahin

Nishkian Professor of Structural Engineering  
University of California, Berkeley

Director

Pacific Earthquake Engineering Research Center

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

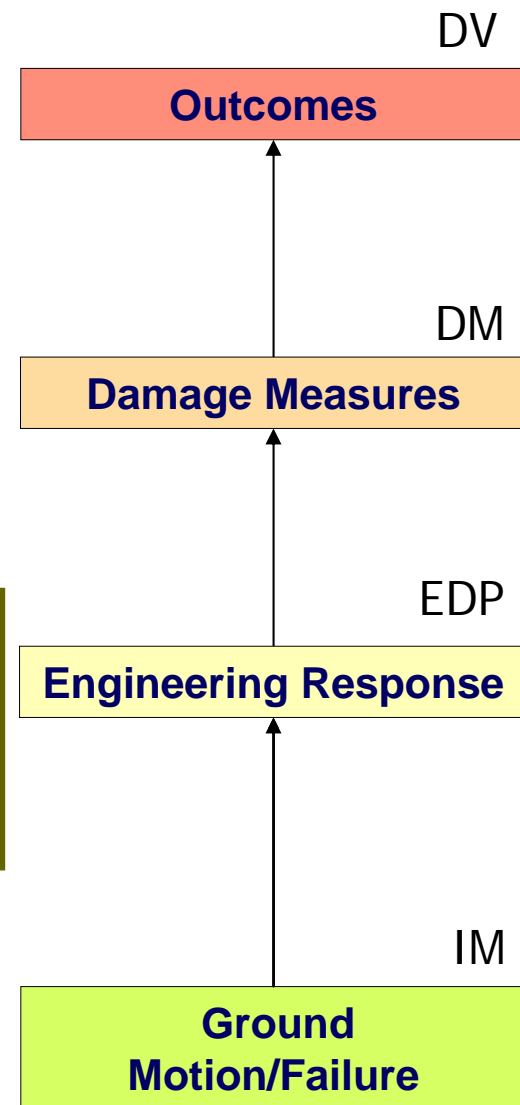
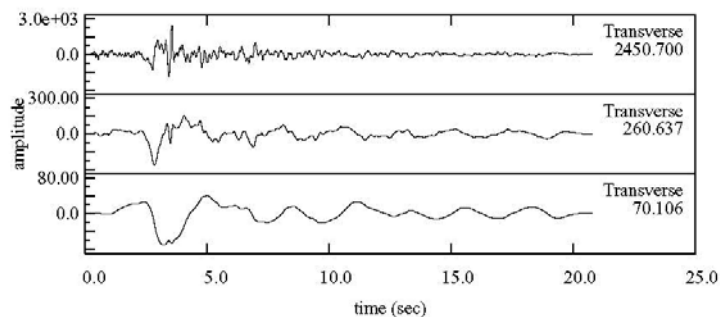
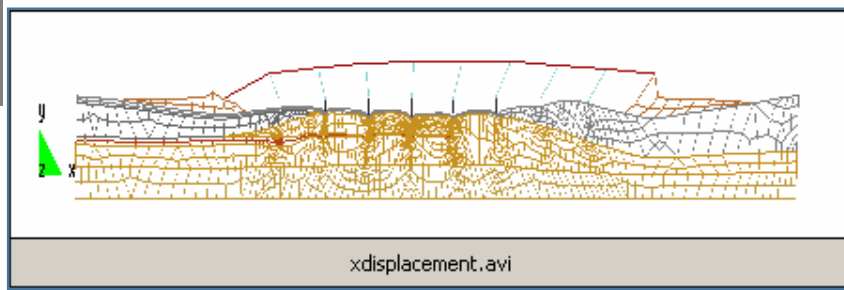


# PEER's Mission

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- ❑ 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 international research collaboration, focusing on Pacific Rim

# PEER takes an integrative, quantitative approach to PBEE



# *Scope of Activities*

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- Vulnerable existing buildings
  - Evaluation and retrofit
- New Buildings
  - Design criteria for tall buildings
  - Sustainable and natural hazard resilient buildings
- High Performance Simulation
- Lifeline systems
  - Earthquake hazard assessment
  - Electrical power distribution systems
  - Nuclear power plants
  - LNG storage facilities
- Transportation Systems
  - Highway bridges
  - High-speed rail systems

# *Scope of Activities*

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- Vulnerable existing buildings
  - Evaluation and retrofit
  - Scope
    - Develop a consensus on the “**hazardous**” buildings
    - Demonstrate cost-effective retrofit
    - Identify mitigation policy alternatives
    - Promote active mitigation programs





# Scope of Activities

- New Buildings
  - Design criteria for tall buildings
  - Sustainable and natural hazard resilient buildings



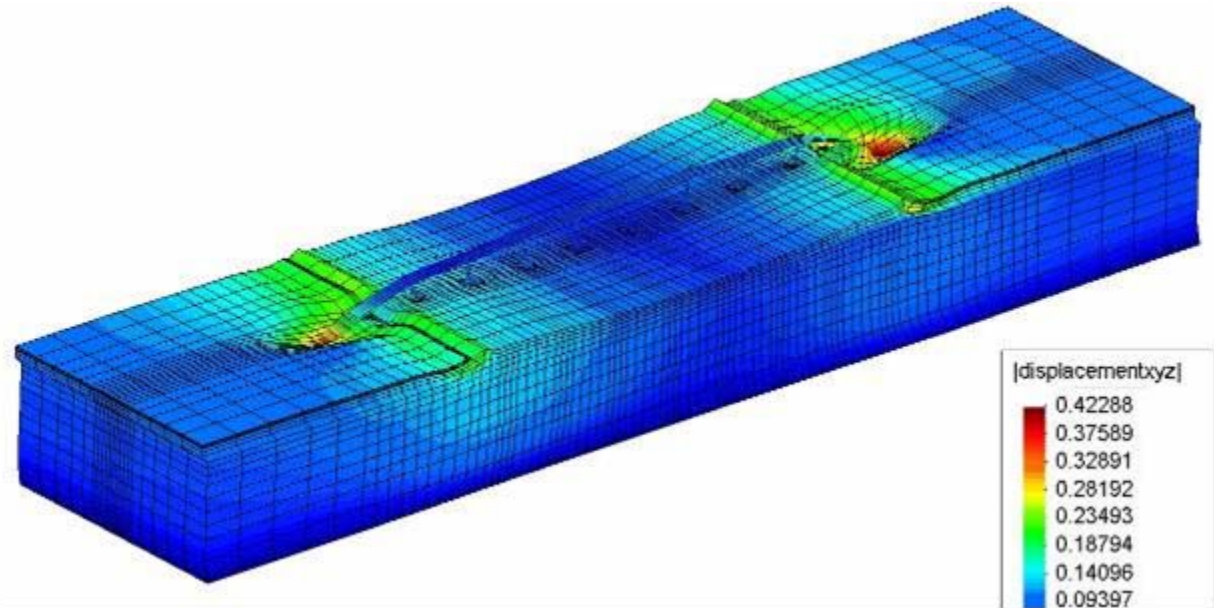
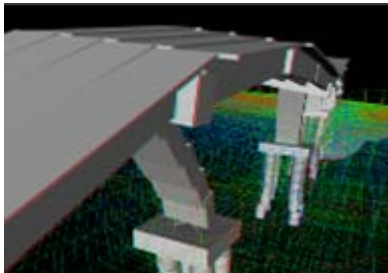
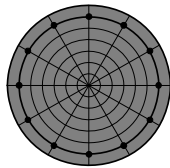
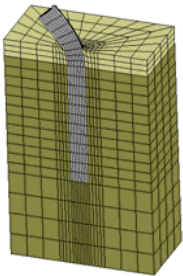
- ❖ Advanced dynamic analysis procedures
- ❖ Soil-structure interaction
- ❖ Innovative structural systems

- ❖ Seismic isolation
  - ❖ Re-centering systems
  - ❖ Testing and modeling of components and systems



# Scope of Activities

- High performance simulation



OpenSees

<http://opensees.berkeley.edu>





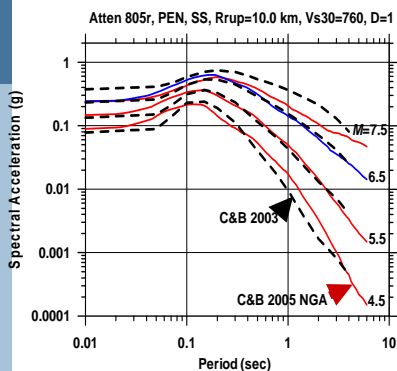
# Scope of Activities

## □ Lifeline systems

- Earthquake hazard assessment
- Electrical power distribution systems
- Power generation plants
- Fuel storage facilities

PEER Lifelines Program is funded by:

- EPRI, PG&E and other utilities
- California Department of Transportation
- California Energy Commission
- Nuclear Regulatory Commission



QuickTime™ and a decompressor are needed to see this picture.

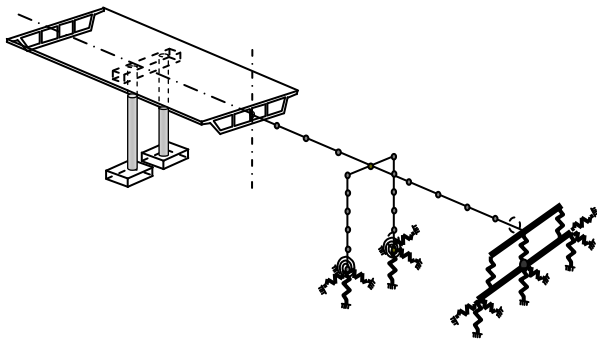
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Goal: To improve safety and reliability of Lifelines Systems

More than 120 projects have been initiated

# Scope of Activities

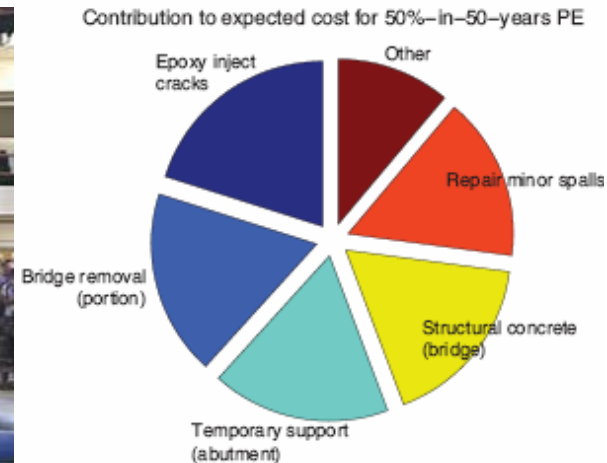
- Transportation Systems
  - Highway bridges



Modeling response



Validating predictions



Assessing impacts

# *Scope of Activities*

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- Transportation Systems
  - Highway bridges
  - High-speed rail systems



- ❖ Early warning systems
- ❖ Bayesian network systems for design and post-event emergency management
- ❖ Fault crossing studies
- ❖ Seismic isolation
- ❖ Vehicle dynamics during earthquakes

# *Transportation Systems Research Program: Objectives*

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- ❑ Devise and validate transportation systems that are more:

## **Economical, reliable, sustainable and disaster resilient**

- Lessen post-earthquake disruption through better planning, engineering and technology advances
- Reduce environmental impact (sustainable materials, improved construction methods, etc.)
- Achieve faster, more economical and safer construction (Accelerated Bridge Construction)
- Increase traffic flow (new systems)

# Current Projects

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Ground motions & hazard assessment		
Guidelines for selection of ground motion time histories for PBEE	J.Baker	Stanford
Stochastic modeling and simulation of near- and far-field ground motions for use in PBEE	Der Kiureghian	UC Berkeley
Calibration of hybrid simulation methodology for high and mid frequency IMs	Stewart	UCLA & SCEC



# Current Projects

PBEE Development and Applications		
Application of PBEE tools to actual bridge	Bray & Stojadinovic Caltrans	UC Berkeley & Caltrans
Performance-based seismic assessment of skewed bridges	Taciroglu and Zareian	UCLA & UC Irvine
Detailed PBEE studies of bridges with foundations allowed to uplift	Panagiotou	UC Berkeley
Bayesian framework for PBEE assessment and risk management of transportation systems	Der Kiureghian	UC Berkeley
Pilot PBEE studies on next generation bridge systems	Stojadinovic	UC Berkeley
Contributions to OpenSees Framework for PBEE Analyses of Bridges	Conte	UC San Diego
Integrated Graphical User Environment for Dynamic Analysis and PBEE of Bridges	Elgamal, Mackie, Hachem	UC San Diego, UCF, Consultant

# Current Projects

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PBEE issues related to soils & foundations		
Simplified Design Procedure for Piles Affected by Lateral Spreading based on 3D Nonlinear FEA using OpenSees	Arduino and Mackenzie	Univ. of Washington
Mitigation of lateral spreading effects on bridges	Boulanger	UC Davis
Simulation of global bridge response to 3D shaking and lateral spreading	Brandenberg and Zhang	UCLA
Last hurdles for implementation of rocking foundations for bridges	Kutter et al	UC Davis
Damage-Resistant Pile to Wharf Connections	Roeder and Lehman	Univ. of Washington

# Current Projects

PBEE issues for structures		
Self-compacted Hybrid Fiber Reinforced Concrete for Bridge Columns	Ostertag & Panagiotou	UC Berkeley
Ductile High-Performance Fiber-reinforced Concrete for Durable, Resilient Bridge Columns	Billington	Stanford
New seismic isolation concepts for improving the seismic performance of bridges	Mahin	UC Berkeley
Advanced Precast Concrete Dual-Shell Steel Columns	Restrepo	UC San Diego
Rapid Construction of Self-Centering Precast Bridge Bents, plus extension of PEER column performance database	Eberhard and Stanton	Univ. of Washington
State-of-the-art report and workshop on seismic design of high-speed rail systems	Bardet	USC

# To learn more about PEER and its activities

- ❖ PEER operated for 10 years as a university based center of excellence with funding from the US National Science Foundation
- ❖ Continues with funding from Federal, State and Local government agencies as well as from industry

PEER recognized as California's primary earthquake engineering research arm by state's Seismic Safety Commission

More information:

[www.peer.berkeley.edu](http://www.peer.berkeley.edu)

The screenshot shows the PEER website homepage. At the top is the PEER logo and the text 'PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER'. Below this is a navigation bar with links: HOME, ABOUT PEER, NEWS, EVENTS, RESEARCH, PRODUCTS, LABORATORIES, PUBLICATIONS, NISEE, BIP MEMBERS, EDUCATION, FAQs, LINKS. A search bar is located on the right side of the navigation bar. The main content area features a large image of a bridge simulation with the text 'Simulation and information technologies for earthquake engineering' and 'developed by PEER'. Below this is a 'Latest News' section with several news items, including a call for papers for a conference, registration for a briefing, and nominations for a prize. An 'Upcoming Events' section lists three events: a workshop on May 22, 2009, a briefing on June 4, 2009, and a seminar on June 8, 2009. On the right side of the page, there are several promotional boxes: 'Breaking News' for a Caltrans and PEER Seismic Research Seminar, '3rd International Conference on Advances in Experimental Structural Engineering' with a 'CALL FOR PAPERS' deadline, '2009 PEER ANNUAL MEETING' with 'REGISTRATION OPEN', and 'Tall Buildings Initiative' with a description of the initiative and a photo of tall buildings.

# SAVE THE DATE:

## October 17, 2009

**20<sup>th</sup> anniversary** of the **Loma Prieta Earthquake**  
Commemorative event in **San Francisco**

*in conjunction with the*

**PEER Annual Meeting &  
3rd Int'l Conf on Advances in Experimental Structural Engineering  
October 15 – 16, 2009**

The anniversary event is cosponsored by:





# Today's Agenda

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8:30-9:00 AM	Introductions
9:00-10:00 AM	Determination of Seismic Hazard using Next Generation Attenuation (NGA) Models
10:00-10:30 AM	Break
10:30 AM - 12:30 PM	Seismic Performance of Rocking Foundations
12:30 - 1:30 PM	Lunch
1:30 - 3:30 PM	Seismic Analysis and Design of Abutments
3:30-4:00 PM	Conclusions/Final Panel Discussion



# *Session 1*

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## **Determination of Seismic Hazard using Next Generation Attenuation (NGA) Models**

Co-Chairs: Tom Shantz (Caltrans) and Yousef Bozorgnia (PEER)

Speakers:

Brian Chiou (Caltrans): Overview of NGA Program

Tom Shantz (Caltrans): Implementing NGA at Caltrans

Panelists: Tom Shantz, Yousef Bozorgnia, Brian Chiou, Norm Abrahamson