National Science Foundation
Role in the
National Earthquake Hazards Reduction Program

Presentation
to the
National Earthquake Conference
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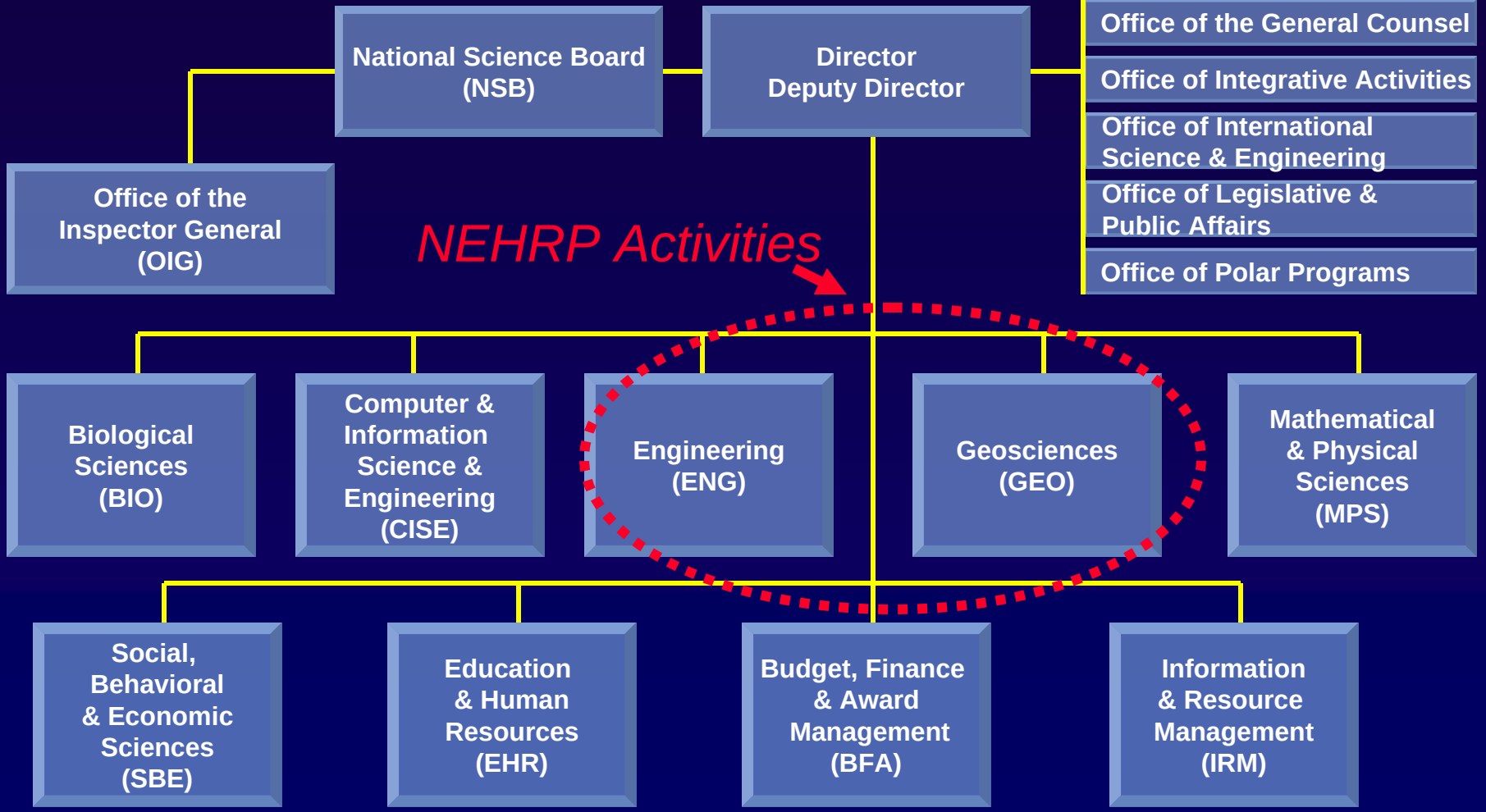
National Science Foundation



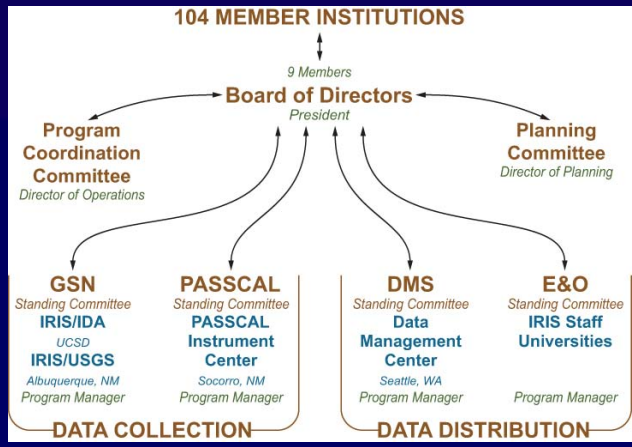
NEHRP Activities funded by NSF

- Directorate for Geosciences
  - Incorporated Research Institutions for Seismology
  - Southern California Earthquake Center
  - Fundamental Research on Earthquakes
  - EarthScope (Related non-NEHRP activity)
- Directorate for Engineering
  - Earthquake Engineering Research Centers, now graduated
  - Learning from Earthquakes Program
  - National Hazards Research Center
  - Unsolicited Fundamental Research on Earthquake Engineering and Social Science and Public Policy Aspects of Disasters
  - George E. Brown, Jr. Network for Earthquake Engineering Simulation

Incorporated Research Institutions for Seismology (IRIS)

(NEHRP Program Activities: Understanding Earthquakes and Their Effects and NEHRP Facilities)

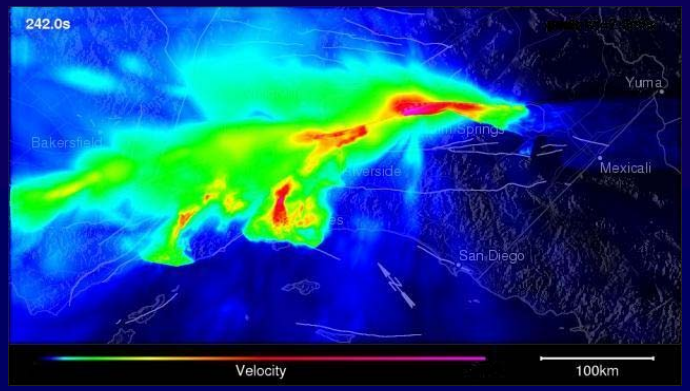
- NSF-funded university research consortium that explores the Earth's interior through collection and distribution of seismographic data
  - PASSCAL - seismic sensors, data acquisition, telemetry and power systems for earth science research
  - DMS - 8 nodes that coordinate data flow from GSN, PASSCAL & other sources
  - E&O – enables access to and use of seismological data and research for educational purposes
- Partners with USGS to operate GSN
- NSF provides approximately 30% of GSN support through an award to IRIS
- http://www.iris.edu



Southern California Earthquake Center

(NEHRP Program Activity: Understanding Earthquakes and Their Effects)

- "Collaboratory" co-funded by NSF and USGS
  - Tripartite mission:
    - Gather data on earthquakes in Southern California
    - Integrate information into a comprehensive, physics-based understanding of earthquake phenomena
    - Communicate to the community at large knowledge for reducing earthquake risk
  - 2005-2006: Community Fault, Velocity, and Block Models developed
  - Renewed for 5 years starting February 2007 (SCEC III)
- Community Modeling Environment
  - Cyberinfrastructure collaboration between SCEC member institutions and the San Diego Supercomputer Center, Information Science Institute, and CMU
  - Physics-based PSHA for better estimates of strong ground motion and earthquake forecasts
  - http://epicenter.usc.edu/cmeportal/index.html



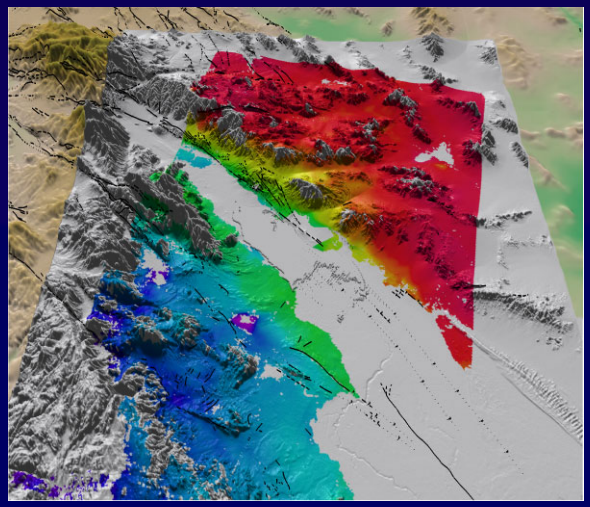
TeraShake simulations of M7.7 earthquake on southern SAF
(Image: Kim Olsen (SDSU), Geoffrey Ely (UCSD))

Fundamental Research on Earthquakes

(NEHRP Program Activity: Understanding Earthquakes and Their Effects)

- GEO/EAR programs fund fundamental earthquake-related science through general program solicitations
  - Geophysics, Tectonics, Continental Dynamics, Instrumentation and Facilities
- Individual research projects
  - Southern San Andreas Fault deformation from satellite data, Fialko (awarded 2004)
  - Fault zone modeling to understand earthquake dynamics, Rice (awarded 2005)
- Fundamental research is conducted and facilitated by centers such as SCEC, IRIS, UNAVCO, CIG, GEON and others.

Landsat satellite image of the Salton Sea, Coachella Valley and the San Andreas Fault in California (Fialko, UCSD)



Satellite radar images are used to infer slippage on the Southern San Andreas Fault system (Fialko, UCSD)

Related Non-NEHRP Activities

earthscope

- **A multipurpose array of instruments and observatories to advance understanding of the structure, evolution and dynamics of the North American continent**
  - **San Andreas Fault Observatory at Depth (SAFOD)**
  - **Plate Boundary Observatory - geodetic component**
  - **USARRAY- short-term, intermediate-term and permanent seismograph installation**
- **Installation conducted in partnership with USGS**

- 3.1 km San Andreas Fault borehole
- 852 permanent GPS stations
- 103 borehole strainmeters
- 5 laser strainmeters
- 39 Permanent seismic stations

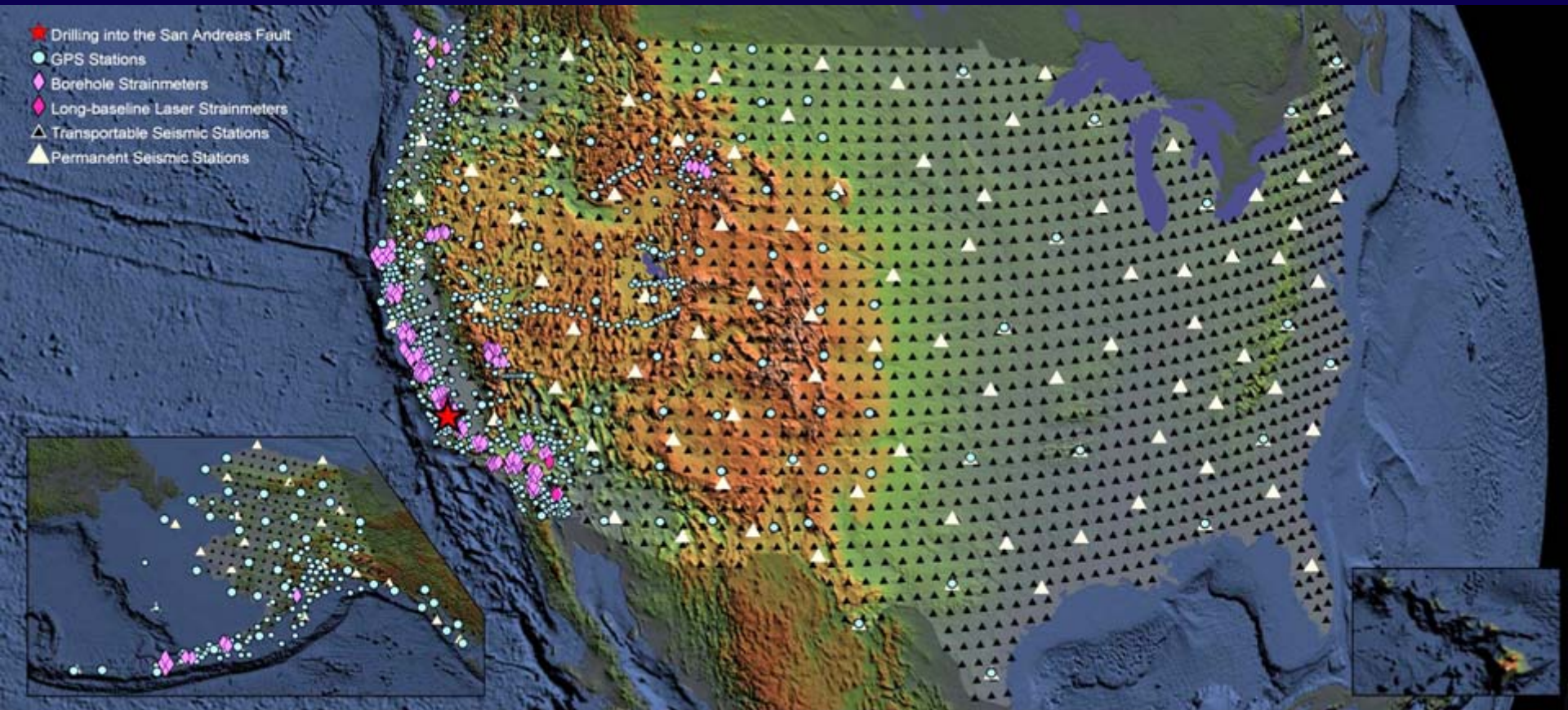
- 400 transportable seismic stations occupying 2000 sites
- 27 magneto-telluric systems
- 100 campaign GPS stations
- 2400 campaign seismic stations

Related Non-NEHRP Activities

earthscope

EarthScope has already:

- Captured eruptive sequences at Mt. St. Helens and Augustine
- Captured ETS events in Cascadia (seismic, GPS, and strainmeter)
- Drilled across San Andreas Fault
- Begun determining Earth structure from “noise”



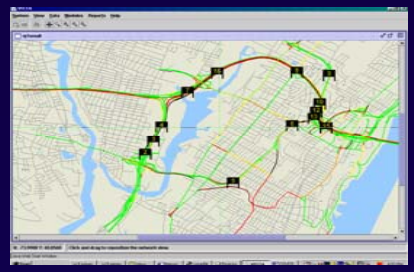
NSF Earthquake Engineering Research Centers (FY 1998 – FY 2007)

(NEHRP Program Activity: Understanding Earthquakes and Their Effects)

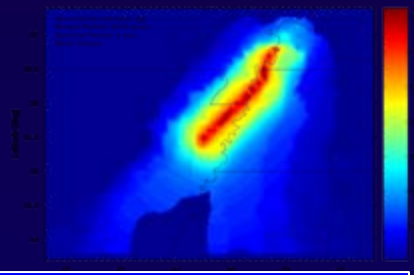
- Mid-America Earthquake (MAE) Center
  - Lead: University of Illinois, Urbana-Champaign
  - Focus: Earthquakes and their effects in Mid-America
  - http://mae.ce.uiuc.edu
- MCEER – Earthquake Engineering to Extreme Events
  - Lead: SUNY Buffalo
  - Focus: Critical infrastructure, hospitals, response & recovery
  - http://mceer.buffalo.edu
- Pacific Earthquake Engineering Research (PEER) Center
  - Lead: University of California, Berkeley
  - Focus: Performance-based earthquake engineering
  - http://peer.berkeley.edu

MAE Center Selected Research Accomplishments

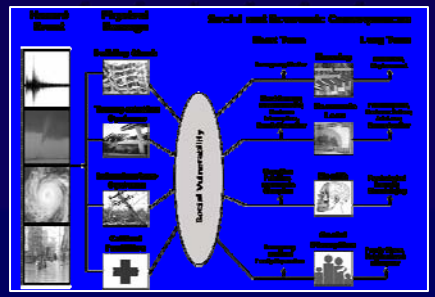
- Traffic Flow Models for Impact Assessment



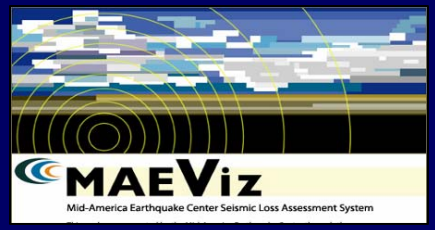
- NMSZ source models and attenuation
- Experimental (deep hole explosions) attenuation



- DEEPSOIL: State-of-the-Art Site Response Analysis
- Uniform Reliability Fragility Relationships (85% of US bridges and 90% of US buildings)
- Hazard-Independent Social-Economic Impact Models

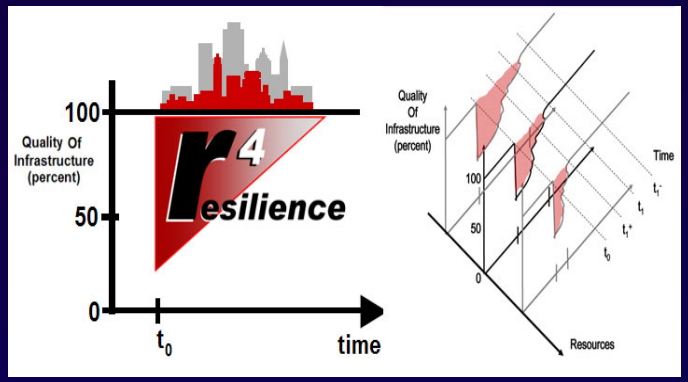


- MAEviz: Web-based open-source modular risk assessment



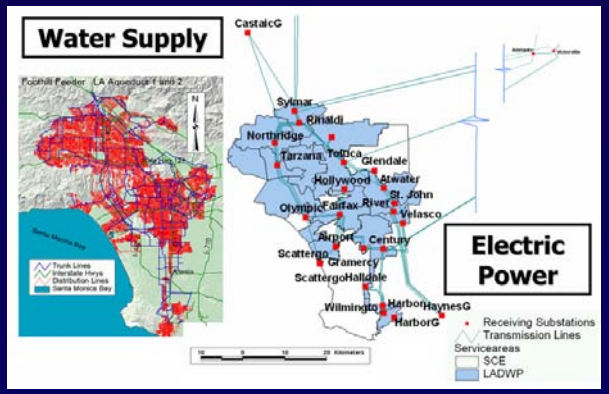
(Graphics courtesy of A. Elnashai, University of Illinois, Urbana-Champaign)

MCEER Selected Research Accomplishments



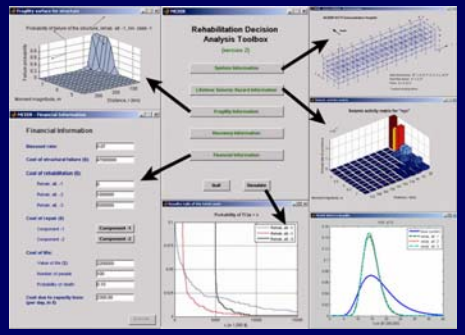
Community seismic resilience (4R's):

- Robustness
- Redundancy
- Rapidity
- Resourcefulness



Lifeline facilities

LADWP Decision Support System – interactions between electric power and water distribution systems and heavily damaged network modeling

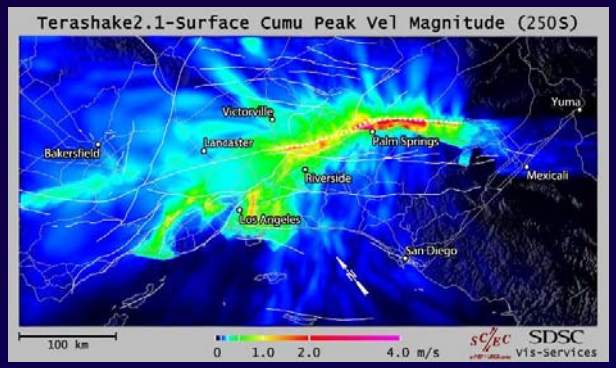


(Graphics courtesy of M. Bruneau, SUNY Buffalo)

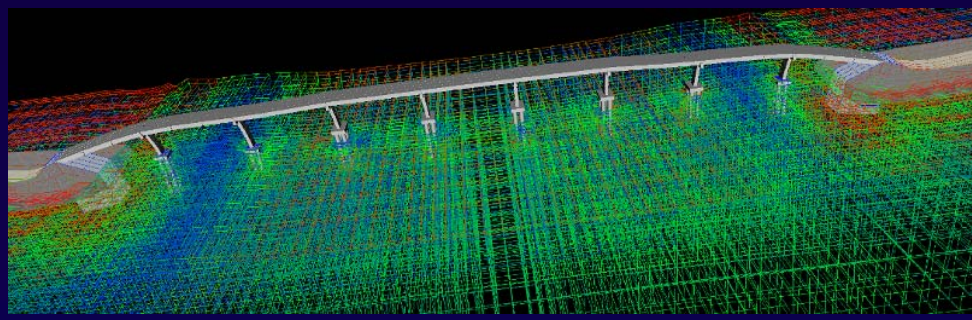
Acute care facilities

- Base isolation
- Passive Dampers
- Decision-Support Tools
- Nonstructural systems

PEER Selected Research Accomplishments



Collaborative research with SCEC and earth sciences for ground motion characterization



Advanced simulation and visualization for PBEE

Products include

- Loss estimation methodologies for structures
- Open System for Earthquake Engineering Simulation (OpenSees)
- Structural performance database for reinforced concrete columns
- BiSpec - Linear and nonlinear spectra of earthquake records
- Next Generation Attenuation
- PEER strong motion database

(Graphics courtesy of J. Moehle, University of California, Berkeley)

Learning from Earthquakes Program
Earthquake Engineering Research Institute
(Recent NSF Awards CMMI-0131895 & 0650182)
(NEHRP Program Activity: Understanding Earthquakes and Their Effects)

- Purpose: Post-earthquake field investigations
- Since 1973, over 180 investigations
- USGS Circular 1242 – NEHRP Post-Earthquake Investigations
- Recent Reconnaissance Reports
  - Sumatra, India – 26 December 2004
  - Niigata, Japan – 23 October 2004
  - Bam, Southeastern Iran – 26 December 2003
  - San Simeon, CA, USA – 22 December 2003
  - M 6.8 Northern Algeria - 21 May 2003
- More information: http://www.eeri.org/lfe.html

Natural Hazards Center
University of Colorado, Boulder

(NSF Award CMMI-0408499)

(NEHRP Program Activity: Understanding Earthquakes and Their Effects)

- Purpose: To advance and communicate knowledge on hazard mitigation and disaster preparedness, response, and recovery
- Co-funding: NSF, USGS, FEMA, and other federal agencies
- Publications include
  - *Natural Hazards Observer (bimonthly)*
  - *Disaster Research (biweekly e-newsletter)*
  - *Natural Hazards Review Journal (joint w/ASCE)*
- Quick response program and reports (post-disaster studies)
- Annual Workshop: July 8-11, 2007
- More information: http://www.colorado.edu/hazards/

Fundamental Research
ENG/CMMI Unsolicited Proposals
Examples of Recent Awards
(NEHRP Program Activity: Understanding Earthquakes and Their Effects)

- Structural Systems and Hazard Mitigation of Structures
  - Sensitivity analysis of concrete gravity dams subjected to non-uniform seismic excitations
  - Performance-based seismic design of concentrically braced steel frame members
- GeoEnvironmental Engineering and GeoHazards Mitigation
  - Liquefaction resistance of aged soils
  - PBEE using paleoseismic techniques
  - Landslide generated tsunamis
- Infrastructure Management and Hazard Response
  - Investment planning for regional natural disaster mitigation
  - Measuring cross-community disaster preparedness and resiliency: theoretical and practical application development

Infrastructure Management and Hazard Response Projects

- Social Science and Multidisciplinary Research
- Currently over 50 active awards
- FEMA'S USAR Task force Deployments: Implications for the management of emergency response
- Prevalence and Preparedness for Conjoint Natural and Technological Disasters
- Family Business Response to Federal Disaster Assistance

Infrastructure Management and Hazard Response Projects (cont.)

- Agency Within Disaster Preparedness and Response: The Role of Poverty and Disability
- Improvisation and Sensemaking in Sudden Crisis
- The October 2006 Federal disaster in Buffalo, NY: An Investigation of First and Second Responder Operations
- The Dynamics of Collaboration in Emergency Planning for America's Schools
- Responding to the Unexpected: Understanding Travelers' Behavioral Choices in the Wake of the Mississippi River Bridge Collapse
- Protective Action Decision Making in Wildfires

Human and Social Dynamics

- A NSF foundation wide five year solicitation supporting multidisciplinary research in social science, physical science, natural science and engineering.
- Decision-making under Risk and Uncertainty focus area has supported about 50 social science proposals on hazards and disasters.
- Total support for research on hazards and disasters is in excess of $30,000,000.

George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

Shared Use Infrastructure

NSF NEESR Project CMMI-0529903 "NEESWood" (Lead: Colorado State University)

Dual 6DOF Shake Tables at SUNY Buffalo NEES Site

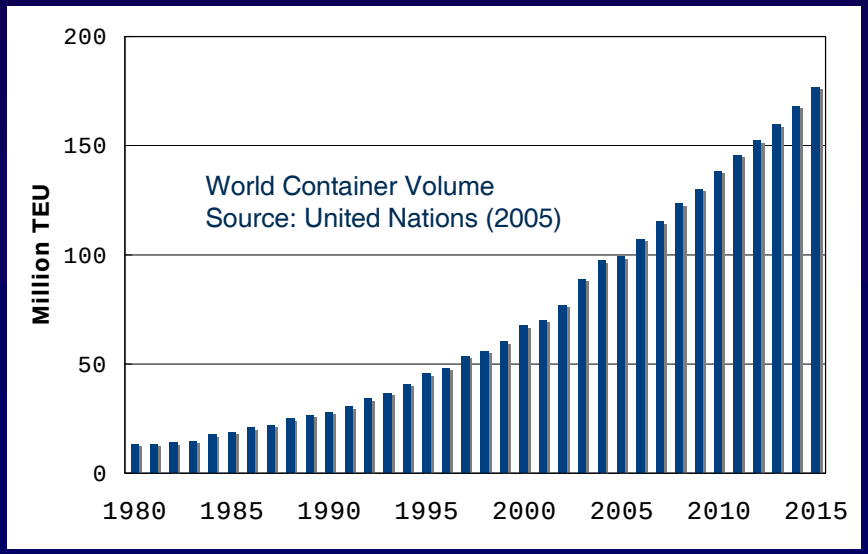
Full-scale test of a residential structure November 2006

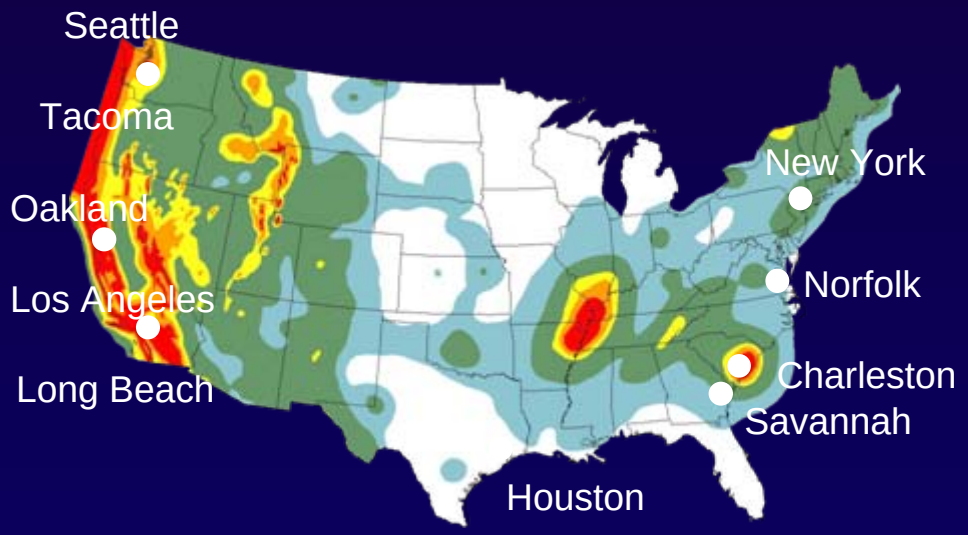
Photo courtesy of the NEESwood project web site: http://www.engr.colostate.edu/NEESWood/

NEESR GC: Seismic Risk Mitigation of Ports
Lead: Georgia Tech

(NSF Awards CMMI-0530478 & NEES Operations CMMI-0402490)

Seaports are a critical national asset in this era of global trade, which is projected to grow at annual rates exceeding 6%





Earthquakes pose a threat to many large U.S. ports with potentially devastating consequences

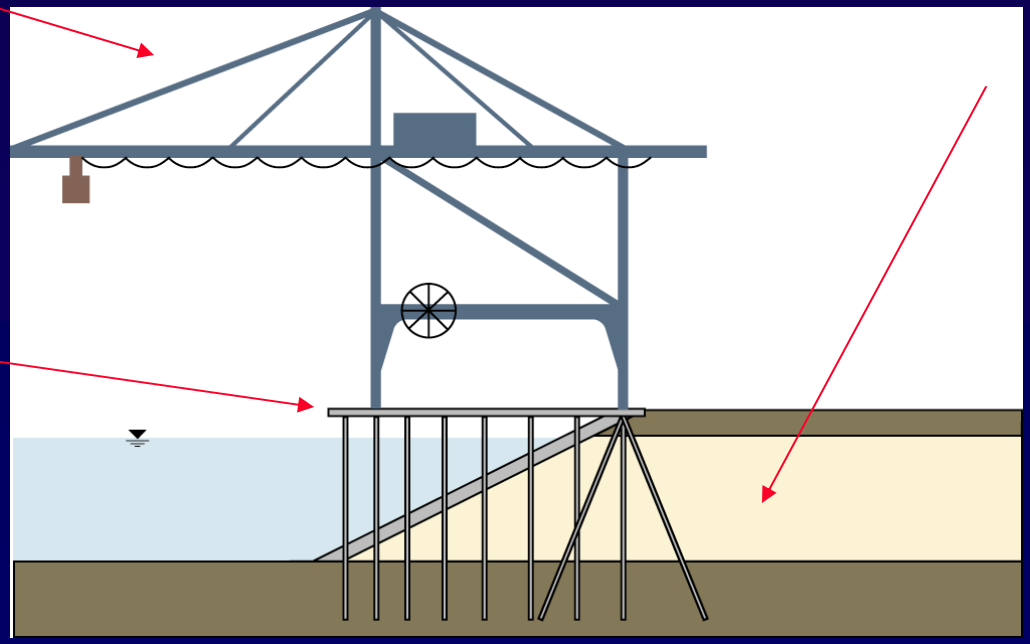
(Graphics provided by G. Rix, Georgia Tech)

NEESR GC: Seismic Risk Mitigation of Ports

Goal: Design, retrofit, and remediation strategies using experimental and numerical simulations to mitigate damage to vulnerable port infrastructure

Container crane response (NEES@Buffalo)

Wharf response (NEES@UIUC)



Liquefiable fill soils: (NEES@UTexas)

(NEES@UCDavis)

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national earthquake hazards reduction program

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