

# **Pacific Earthquake Engineering Research Center (PEER)**

Jack P. Moehle<sup>1</sup>

## **ABSTRACT**

The Pacific Earthquake Engineering Research Center (PEER) is an Earthquake Engineering Research Center administered under the US National Science Foundation Engineering Research Center Program. The mission of PEER is to develop and disseminate technology for design and construction of buildings and infrastructure to meet the diverse seismic performance needs of owners and society. To accomplish its mission, PEER has organized a program built around research, education, and technology transfer. The research program merges engineering seismology, engineering, and socio-economic sciences in coordinated studies to develop fundamental data, tools, and methodologies that are tested and refined using testbeds in collaboration with practicing professionals. The education program promotes engineering awareness in the general public and attracts and trains undergraduate and graduate students to conduct research and implement research findings. The technology transfer program involves practicing earthquake professionals, government agencies, and specific industry sectors in PEER programs to promote implementation of appropriate new technologies.

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<sup>1</sup> Jack P. Moehle, Pacific Earthquake Engineering Research Center, University of California, Berkeley, 1301 S. 46<sup>th</sup> St., Richmond, CA 94804, USA.

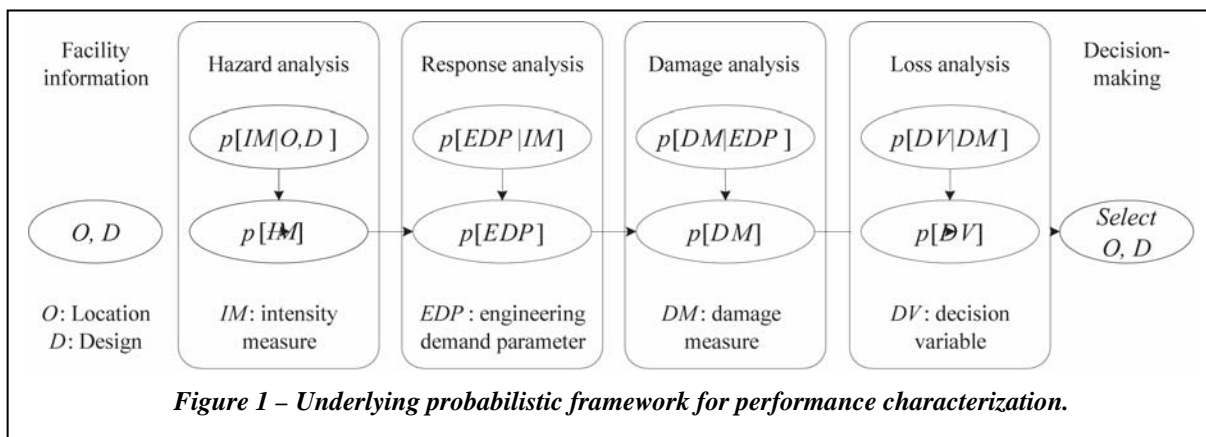
## THE PEER CENTER

The Pacific Earthquake Engineering Research Center (PEER) is an Earthquake Engineering Research Center administered under the National Science Foundation Engineering Research Center Program. The mission of PEER is to develop and disseminate technology for design and construction of buildings and infrastructure to meet the diverse seismic performance needs of owners and society. Current approaches to seismic design are indirect in their use of information on earthquakes, system response to earthquakes, and owner and societal needs. These current approaches produce buildings and infrastructure whose performance is highly variable and may not meet the needs of owners and society. The PEER program aims to develop a performance-based earthquake engineering approach that can be used to produce systems of predictable and appropriate seismic performance.

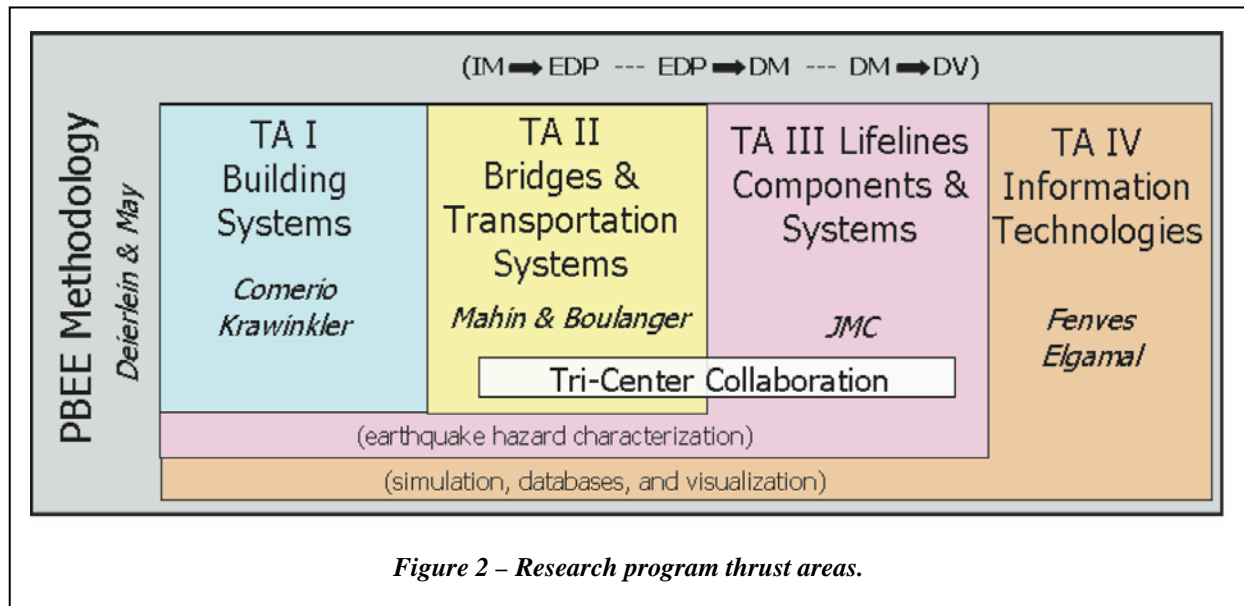
PEER is instituted among nine core universities (University of California at Berkeley (lead), Davis, Irvine, Los Angeles, and San Diego; California Institute of Technology; Stanford University; University of Southern California; and University of Washington). PEER activities are carried out at the core universities, education affiliates, and through an extended partnership of university, governmental, and private organizations and individuals. The program is funded primarily by the US National Science Foundation, the State of California, and industry partners.

## PEER RESEARCH

PEER research aims to develop the data, tools, and organizational framework to define seismic performance in terms that are useful to stakeholders. Given the uncertainties involved in the various aspects of the problem, the research is organized around an underlying probabilistic framework (Figure 1). The framework consists in four main analysis steps (hazard analysis, structural/nonstructural analysis, damage analysis, and loss analysis). The outcome of each step is mathematically characterized by one of four generalized variables: *Intensity Measure (IM)*, *Engineering Demand Parameter (EDP)*, *Damage Measure (DM)*, and *Decision Variable (DV)*. Research is under way on each of these elements.



To promote multi-disciplinary, multi-investigator research at a systems level, the research program currently is organized in four system-level thrust areas, as shown in Figure 2. Three thrust areas emphasize subsets of the built environment, including Building Systems, Bridges & Transportation Systems, and Lifelines Components & Systems. A fourth thrust area emphasizes seismic simulation and information technology applications in support of the other thrust areas.



The research program aims to accomplish the following outcomes:

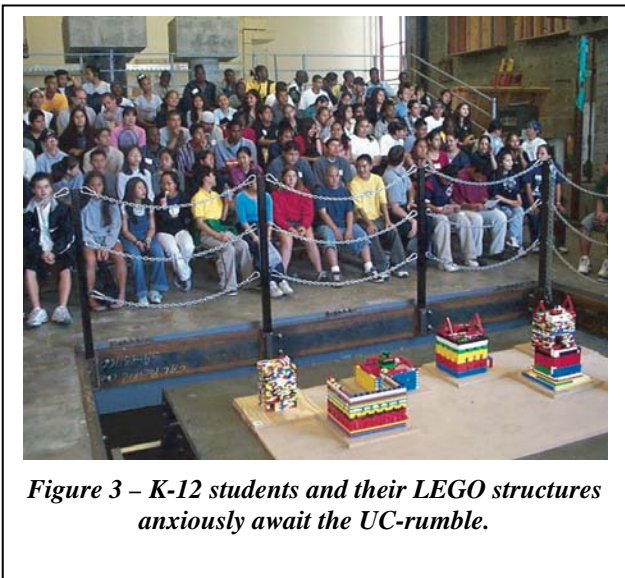
- *Earthquake Hazard Characterization:* Data, improved models, and guidelines to more accurately describe earthquake hazards due to ground shaking and ground deformation (including liquefaction and fault rupture). Included is the definition of appropriate seismic hazard Intensity Measures (IM) and input ground motions.
- *Geotechnical and Structural Simulation Tools:* Computational models, data, and criteria for accurate simulation of building and bridge facilities, including (where necessary) the foundations and surrounding site.
- *Building Performance Assessment:* Comprehensive methodology with supporting data, models, and computational tools to conduct detailed probabilistic assessment of earthquake losses to buildings. Losses are characterized in terms of direct financial losses, downtime (loss of functionality), and casualty predictions. Primary emphasis is on buildings with either ductile or non-ductile (conforming or non-conforming) reinforced concrete frame systems.
- *Bridge Performance Assessment:* Comprehensive methodology with supporting data, models, and computational tools to conduct detailed probabilistic assessment of earthquake losses to reinforced concrete bridges. Loss emphasis is on bridge damage leading to bridge closure or reduced functionality and estimates of restoration time and costs.
- *Distributed System Assessment:* Methodology with supporting data, models and computational tools to conduct probabilistic assessment of earthquake losses to geographically distributed lifeline systems. Emphasis is on (a) reduced traffic capacity

(leading to delays and other disruption) to highway and major arterial transportation networks in California due to bridge damage, and (b) disruption of electric utility networks, due to earthquake damage to substation equipment and buildings.

- *Earthquake Risk Decision Making:* Collection of methodologies, case studies, and financial models to assist stakeholders in utilizing PBEE to make more informed decisions concerning earthquake risk management.
- *Design Decision Making:* Methodologies and modeling simplifications to apply PBEE assessment techniques to make design decisions for new buildings and bridges. Emphasis is on guidelines for evaluating tradeoffs in performance objectives by altering of engineering demand parameters, which relate to key decision variables.
- *PBEE Implementation and Adoption:* Background information, guidelines, and strategies to facilitate implementation of PBEE techniques in practice and building codes and standards.

## PEER EDUCATION

The Education Program is designed to introduce, stimulate, and educate students including K-12, undergraduate, and graduate students. At the K-12 level, the objective is to introduce science and engineering as potential career paths and to get students to visit a university campus. To accomplish this, PEER participates in shake-table contests at UC Irvine and UC San Diego, in which students receive kits, participate in brief sessions on earthquake engineering, then build models and test them on shaking tables for prizes (Figure 3). PEER also organizes research experiences for K-12 teachers to provide them ideas on how earthquake science and engineering contribute to society, as well as to introduce



*Figure 3 – K-12 students and their LEGO structures anxiously await the UC-rumble.*

science project ideas for students to use in the classroom. At the undergraduate level, PEER operates a scholars course in which undergraduate students participate in four weekend courses on subjects of hazards, geotechnical engineering, structural engineering, and societal aspects related to earthquakes. PEER also involves undergraduates in summer intern programs where students work on an individual project with a professor and graduate student. At the graduate level, students participate in research and seminars. A new program initiated by PEER's Student Leadership Council organizes a shake-table competition for undergraduate students of participating universities.

## **TECHNOLOGY TRANSFER**

PEER aims to impact the practice of earthquake engineering by developing usable research results and disseminating them for use. This can be done most effectively by involving select industry partners in defining, guiding, and participating in the research activities. PEER involves an Implementation Advisory Board to advise the center on overall research directions and implementation avenues. PEER Business and Industry Partners attend PEER meetings and participate in various testbed projects to test the practicability of proposed methods. PEER also manages an industry-sponsored lifelines program that forms the basis for Thrust Area III (Figure 2). In this program, dedicated industry and government partners sponsor research, manage the research execution, and ensure the results are disseminated for immediate use. Important accomplishments of this program include next-generation models for ground motion attenuation and ground failure; design ground motions for seismic analysis; substation building models and decision tools; and fragility relations for electric distribution equipment.

PEER activities and results are published through the PEER report series, a newsletter, and a web site.

## **FOR MORE INFORMATION**

For more information, contact Parshaw Vaziri (email: [vaziri@peer.berkeley.edu](mailto:vaziri@peer.berkeley.edu)) or visit the PEER web site at <http://peer.berkeley.edu>.