

2020 PEER Annual Meeting

The Future of Performance-Based Natural Hazards

Engineering

Opening & Welcome Khalid M. Mosalam, PEER Director, UCB

January 16-17, 2020

2020 PEER Annual Meeting (PAM)

PAM Steering Committee



Gregory Deierlein



Grace Kang



Amarnath Kasalanati



Dawn Lehman



Khalid Mosalam



Keri Ryan



Thomas Shantz

PEER Staff Supporting PAM



Christina Bodnar-Anderson



Erika Donald



Selim Günay



Claire Johnson



Zulema Lara



Arpit Nema



Gabriel Vargas



2020 PEER Annual Meeting (PAM)

22 Volunteers for Thursday, Poster Session & Friday (Alphabetical) LBNL: 1; OSU: 1; Stanford: 2; UC Berkeley: 4; UC Davis: 2; UCLA: 11; UNR: 1 Jorge Archbold – UC Berkeley Parsa Arefian – UCLA Tsandi Chen – UCLA Chrystal Chern – UC Berkeley Honor Fisher – UCLA Tatiana Gospe – UCLA Hamid Hasani – UNR Ahmed Hassan – UC Davis Kenneth Hudson – UCLA Anne Hulsey – Stanford Omar Issa – UCLA Siddhant Jain – UCLA Ioanna Kavvada – UC Berkeley Amory Martin - Stanford Mamun Miah – I BNI Tim O'Donnell – UCLA Renmin Pretell – UC Davis David Rivera – OSU Rio Sano – UCLA Keri Scholte – UCLA Abhimanyu Singh – UCLA Chaofeng Wang – UC Berkeley





2020 PEER Annual Meeting

The Future of Performance-Based Natural Hazards

Engineering

Opening Remarks

Tsu-Jae King Liu, Dean of Engineering, UCB

January 16-17, 2020

PEER Overview

Khalid M. Mosalam PEER Director, Taisei Prof. of Civil Eng., UC-Berkeley

January 16, 2020

Status

- Today, PEER comprises 11 core institutions (150 faculty participants) & 9 educational affiliates.
- <u>Expertise</u>: geo-hazards; buildings; bridges; network; experimental & analytical techniques; and monitoring (**including AI**) technologies.
- Expertise, facilities & culture to develop <u>robust methods & research</u> <u>tools</u> make PEER poised to achieve **Resilient Design for Extreme Events**.







PEER Institutional Board (IB)

IB provides policy level guidance & oversight to PEER Director & Associate Director.

Outgoing chair: Anne Kiremidjian

Incoming chair: Dawn Lehman



Anne Kiremidiian Chair, Institutional Board Stanford University



Dominiki Asimaki California Institute of Technology



Joel P. Conte University of California, San Diego





Rakesh Goel Educational Affiliate Representative CalPoly

Dawn Lehman

University of Washington

John Wallace

University of California, Los Angeles



lan Buckle University of Nevada, Reno



Erik A. Johnson University of Southern California



Jack Moehle University of California, Berkeley



Farzin Zareian

University of California, Irvine

PFFR



Sashi Kunnath University of California, Davis



Michael Scott Oregon State University

Vision & Mission

PEER's <u>vision</u> is to be the leader in **Resilient Design for Extreme Events** affecting the built environment. PEER will lead the research and development of new modeling, analysis, assessment, and design frameworks, technologies and tools to enhance the **resilience of communities** exposed to natural hazards.

PEER's mission is to:

- 1. develop, validate & disseminate **performance-based engineering technologies** for buildings, critical civil structures & infrastructure networks subjected to earthquakes & other natural hazards, with the goal of achieving community resilience; and
- 2. equip the earthquake engineering and other extreme event communities with **tools, technologies & future workforce**, through collaboration between PEER institutions and industry partners.



PEER: University, Government, Professional & Industry Alliance



PEER combines resources of major research universities in western US where earthquake hazard is large. PEER Mission focuses on **Integrated Performance-based Engineering Methodology**.



PEER: University, Government, Professional & Industry Alliance



Ex-Officio members:

Committees: Kickoff Meeting Jan. 15th, 2020

Norman Abrahamson

Leader of

the PEER

Lifelines

Research

Program

Research Committee (RC): Sets research agenda based on PEER's vision & work with stakeholders & industry partners to identify community needs and integrate them into the research plan.





Pedro Arduino Tara Hutchinson



Amit Kanvinde



Ertugrul Taciroglu

Industry Advisory Board (IAB): Identifies present & future needs of the profession & engineering community.







Brian Kehoe



Steve Marusich



Jennie Watson-Lamprey

Resource Identification Committee (**RIC**): Pursues existing opportunities & actively seeks out new sources of funding to help realize PEER's vision.





Hosam Ali

Jeffrey Bachhuber Marc Eberhard Ahmed ElGamal David McCallen Farhang Ostadan











Tom Shantz

Patrick Lynett

Eduardo Miranda

Recent & Future Reports

- Long Term Monitoring of Bridge Settlements Using a Vision-Based Embedded System, UCB
- Influence of Vertical Ground Motion on Bridges Isolated with Spherical Sliding Bearings, UNR
- More than **6** reports for the CEA project findings.



To date, **306** PEER technical reports published, http://peer.berkeley.edu/publications/peer_reports.html





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Φ-Net (Open-Sourced)



I

Introduction

Both AI and machine learning (ML) technologies have developing rapidly in recent decades,

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Peoples

Technical Committee Khalid M. Mosalam, Professor of Civil and Environmental Engineering,

Citation

If you are reporting results or using the dataset, please cite: 1. Gao Y. and Mosalam K.M. (2018).

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https://apps.peer.berkeley.edu/spo

http://apps2.peer.berkeley.edu/sim

PEER

Φ-Net "Online Uploading/Labeling Tool & SIM* (DL Classifier)"

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Natural Language Processing (NLP) & Text Analytics (TA) for Earthquake Reconnaissance

Automatic data (news & tweets) collection hosted at PEER server



Natural Language Processing (NLP) & Text Analytics (TA) for Earthquake Reconnaissance

Automatic summarization using NLP for reconnaissance report generation

		$\overline{\mathbf{V}}$					
	StEER	EVENT BRIEFING					
	STRUCTURAL EXTREME EVENTS RECONNAISSANCE	Event:	15 December, 2019 Philippines, Mw 6.8 Earthquake				
		Region:	Southeast Asia				
Authors:	Selim Günay, Jorge Archbold, Fan Hu, Alicia Tsai, Khalid M. Mosalam. University of California, Berkeley						
Editors:	Tracy Kijewski-Correa, University of Notre Dame Ian Robertson, University of Hawaii at Manoa						
DesignSafe Project #	PRJ-2664	Release Date:	21 December, 2019				

Key Lessons

- The Mw 6.8 earthquake that occurred on December 15 was the fourth large earthquake to hit the region within the past two months, which is a rare occurrence for seismic hazards.
- These events and several previous earthquakes in 2019 (e.g., Ridgecrest, California) highlight the need to consider aftershocks in the seismic design of buildings (currently neglected in seismic provisions of building codes).
- Despite the fact that buildings were weakened by the previous large earthquakes, there were few collapsed buildings, which can be considered good structural performance. One reason is the relatively low levels of ground shaking (about 0.2g).
- Infill walls experienced damage due to in-plane/out-of-plane interaction; consideration of this important effect has been added to standards only recently, e.g., 2017 version of ASCE 41.
- Infill wall failures can have fatal consequences, including the death of a six-year-old girl in this earthquake. Furthermore, debris can significantly increase the evacuation time in densely populated areas. This earthquake highlighted the need to take precautions against the debris generated by the out-of-plane failures of infill walls.

StEER: Full presentation on Friday (P5)



STEER PUERTO RICO M6.4 EARTHQUAKE 7 JANUARY 2020 Released: January 10, 2020 NHERI DesignSafe Project ID: PRJ-2670

PRELIMINARY VIRTUAL RECONNAISSANCE REPORT (PVRR)



Agripina Seda School in Guánica, Puerto Rico.

Virtual Assessment Structural Team (VAST) Lead: Eduardo Miranda, Stanford University

Virtual Assessment Structural Team (VAST) Authors: (in alphabetical order)

Andrés Acosta, Stanford University Luis Aponte, U Puerto Rico Mayagüez Jorge Archbold, UC Berkeley Ao Du, Rice University María Cortés, U Puerto Rico Mayagüez Selim Gunay, UC Berkeley Wael Hassan, University of Alaska, Anchorage Pablo Heresi, Stanford University Ana C. Lamela, Pennoni, Florida Armando Messina, Stanford University Sebastian Miranda, PUC Chile Juan Miguel Navarro, Stanford University Jaime Padgett, Rice University Alan Poulos, Stanford University Giulia Scagliotti, Stanford University Alaicia Tsal, UC Berkeley

Virtual Assessment Structural Team (VAST) Editors: (in alphabetical order)

Tracy Kijewski-Correa, University of Notre Dame Khalid M. Mosalam, UC Berkeley David O. Prevatt, University of Florida Ian Robertson, University of Hawaii David Roueche, Auburn University



PVRR: Puerto Rico Earthquakes January 2020 PRJ-2670 | Released: January 10, 2020 Building Resilience through Reconnaissance

1



See a relevant poster

Natural Language Processing (NLP) & Text Analytics (TA) for Earthquake Reconnaissance



- $Tr = \sum_{i=1}^{N} tr_i w_i$
- *Tr*: recovery time *N*: number of considered factors *tr_i*: recovery time (t_1-t_0) for factor *i*, e.g. school *w_i*: weight for factor *i*

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BART Thresholds of Automated





BART Thresholds of Automated

Database of damage experienced by railway structures (Nakamura & Saita, 2007)

& 2018-2019 Bay Area earthquakes superimposed



PEER

Quantifying the Performance of Retrofit of Cripple Walls & Sill Anchorage in Single Family Wood-Frame Buildings





Un-retrofitted

Retrofitted

Napa EQ, 2014: Two almost identical houses with significant differences in damage.

Credit: Janiele Maffei, CEA

Quantifying the Performance of Retrofit of Cripple Walls & Sill Anchorage in Single Family Wood-Frame Buildings



- <u>Team</u>: Y. Bozorgnia (PI), H. Burton, K. Cobeen, G. Deierlein, T. Hutchinson, G. Kang, B. Lizundia, S. Rabinovici, E. Reis, D. Welch & F. Zareian (academic researchers & practitioners) [<u>Budget</u>: \$3.5M]
- <u>Objective</u>: develop fragility modification factors for use by loss modelers for retrofitted & un-retrofitted homes.
- Numerical modeling to simulate response of homes.
- Experimental testing to validate numerical modeling.
- Project to be completed April, 2020 (> 6 PEER reports).

UCSD component tests

Full session on Friday (C3) & relevant poster



Quantifying retrofit benefits

UCB full-scale tests



West Coast State-DOT Pooled-Fund Project



- Tsunami Design Guidelines for Coastal Bridges
- <u>Team</u>: P. Lynett (USC), H.-K. Thio (AECOM), M. Scott (OSU), T. Murphy (M&M), T. Shantz (CalTRANS), D. Istrati (UN-Reno), I. Buckle (UN-Reno)
- Start: 2016; Mapping: 2018; Loading Methodology: 2019; Draft Guide Spec: Under Review

- Determine appropriate hazard design level (975-yr hazard).
- Develop hazard maps for coastal CA, OR, WA, AK & HI (10–60 m resolution).
- Approach for site-specific hazard estimation: Determine appropriate flow depth & speed combinations for load calcs.
- Methodology to determine loads on sub- & super-structure (effects of open vs box girder, skew, deck slope, super-elevation, debris & sediment).
- Procedure to distribute loads to bearings or connections between super- & sub-structure.
- Prediction equations for scour on foundations & sub-structures.



PEER

West Coast State-DOT Pooled-Fund Project

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See a relevant poster

PBEE Assessment Tool for Gas Storage and Transmission Systems



PEER

Next Generation Liquefaction (NGL) Project



See a relevant poster



Current activities

- Sponsor recruiting
- Populate case history DB
- Expand DB to accommodate lab studies
- Susceptibility supporting study
- Collaborative lateral spread study

http://nextgenerationliquefaction.org



OpenSEES 2019 Analytics & Future Changes





2019

- Version 3.1.0
- Moving source code to GitHub has been a success (more contributions)

Search docs

4. Commands

5. Examples

5. Issues

2020

- Version 3.2.0 coming March
- Documentation moving to GitHub (everyone can contribute)



2019 Tools: Single Building Response

Cloud-enabled research tools utilizing HPC with emphasis on UQ



Quantified Uncertainty & Optimization for FEM Applications – Forward Methods, Inverse Methods, Sensitivity & Reliability



Earthquake Engineering with UQ – Stochastic Motion, PEER NGA & Site Response



Wind Engineering with UQ – Stochastic Wind Event, Wind Tunnel & OpenFOAM



Performance-Based Engineering (Buildings & Lifelines) – HAZUS & FEMA P58



Full presentation this afternoon (P4) & relevant poster



2020 Tool: Sincenter Computational Modeling and Simulation Regional Loss Estimation

- Simcenter - Earthquake Scenario Simulatio

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Analysis completed successfully







PEER

Property

Site

> Location

Mode: Results

Value

950



2019 TSRP Request for Proposals

PEER TSRP – Request for Proposals: Solicitation PEER-TSRP 19-01, September 2019 - Now Closed

The deadline to submit technical proposals is <u>11:59pm (PST), November 3, 2019</u> (posted October 30, 2019, supercedes date in Solicitation)

The deadline to submit questions to <u>peer_center@berkeley.edu</u> [™] is 5pm (PDT), October 15, 2019.

<u>Topics grouped into</u>: Geotechnical Engineering; PBEE of Bridge & Other Transportation Systems; Areas of Application; PBEE Methodology; PBEE Tools.

→ 44 proposals received.

Reviews are almost complete with 3 independent reviewers per proposal.

Decisions will be announced <u>January 21, 2020</u>.

See several posters for past & currently funded projects



2020 Request for Proposals



PEER – Bridge Research Topics:

- Maintenance/Sustainability (including bridge monitoring: BRACE2*)
- New Materials
- Bridge Modeling & Analysis
- Accelerated Bridge Construction
- Performance-Based Earthquake Engineering (PBEE)/Bridge & System Reliability
- Foundations & Walls
- Intelligent Design Tools/Bridge Design Aids

Projects selected by Caltrans through an annual selection process synergized with the PEER TSRP program

Investigators selected by a PEER administered RFP process

*<u>B</u>ridge <u>Rapid</u> <u>A</u>ssessment <u>C</u>enter for <u>E</u>xtreme <u>E</u>vents



BRACE2: Data-Driven Structural Health Monitoring (SHM)



Develop a data & simulation center for **real time rapid assessment** & **near real-time comprehensive assessment** of Caltrans designed & operated bridges immediately after seismic events by taking advantage of sensors on the bridges. ³²

PEER

Kobe-PEER Workshop on 25th Anniversary of Great Hanshin-Awaji Earthquake (To Be Held Fall 2020)

PEER Collaboration with Japanese Research Institutions

An agreement of academic collaboration has been signed between PEER and the following five Japanese research institutions:

- National Research Institute for Earth Science and Disaster Resilience ("NIED")
- RIKEN Center for Computational Science ("R-CCS")
- Center for Mathematical Science and Advanced Technology ("MAT/JAMSTEC")
- Kobe University, Graduate School of Engineering ("KU Engineering")
- Kobe University, Research Center for Urban Safety and Security ("RCUSS")

All six organizations share mutual interests in education and research, including simulation research for prevention and mitigation for natural disaster impact on infrastructure, and liquefaction. They have agreed to implement the following activities:

- joint research activities
- exchange of faculty, researchers, students, and staff
- exchange of research results and publications

Academic Program (Venue: Kobe University)

<u>Day1</u>: Towards Practical Implementation of Technology (3 or 4 speakers from PEER & panel discussion: Introduction to PEER; Implementation of PEER Methodologies & Simulation tools) <u>Day2</u>: Public-Private-Academic Partnership on Community Resilience (3 or 4 speakers from Kobe University & panel discussion: Safety Assessment & Investment; Public Awareness)

Training Program (Venue: Osaka)

A week-long for private companies & public (~10 programs: posters, lectures & exhibits)

Organizer: Kobe University + PEER

Sponsors: ~15 companies

Sponsoring organizations: Ministry of Land, Hyogo Prefecture, Osaka Prefecture & Kobe City





November 5, 2019



2019 PEER Blind Prediction Contest



Winners to be announced at 5 pm today



PEER

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Summary

- PEER has a well-defined vision & mission and is growing topically, institutionally, professionally, and financially from federal, state, and industry resources.
- 2. PEER is well-organized with important recurring events that engage the broad community.
- 3. PEER committee structure is in place and we look forward to more future activities and progress with their work.
- 4. Thank you, enjoy 2020PAM, and remain engaged with PEER.



2019 PEER Blind Prediction (BP) Contest

Michalis Vassiliou, ETH Selim Günay, PEER Bozidar Stojadinovic, ETH Khalid M. Mosalam, PEER/UCB <u>PEER Staff Support</u>: Erika Donald

January 16, 2020

2019 PEER BP Contest: Overview



- Four-column rocking podium structure excited by
 200 artificial ground motions on a shaking table.
- Objective: Prediction of maximum bi-directional seismic response.
- □ The structure was designed by an <u>ETH Zurich team</u> led by Profs. <u>Michalis Vassiliou & Bozidar Stojadinovic</u>.
- The tests were conducted using the 6-dof shaking table located at the Earthquake and Large Structures (EQUALS) Laboratory of the <u>University of Bristol</u>.
- Tests were supervised by Profs. <u>George</u>
 <u>Mylonakis & Anastasios Sextos</u> under the
 SERA transnational access project "3DROCK:
 Statistical Verification and Validation of 3D ×
 Seismic Rocking Motion Models"
 <u>http://www.sera-eu.org/en/home/</u>.



2019 PEER BP Contest: Evaluation



13 teams with contestants from 10 different countries



<u>Cumulative Probability</u>: CDF(x) = (# of Mave < x)/100

□ For each team:

ErrEC, ERRCC = abs (max vertical distance between team prediction CDF & experimental data CDF)
ERR = ERREC + ERRCC (EC: El Centro, CC: Chi Chi)
Teams are ranked in order of increasing ERR

PEEF

2019 PEER BP Contest: 1st Place



2019 PEER BP Contest: 2nd Place



Structural Extreme Events Reconnaissance (StEER) Network

<u>StEER FAST-1</u>: Puerto Rico Earthquake Sequence

<u>Mw 5.8</u> on Jan. 6th, 2020 at 6:32 am local time <u>Mw 6.4</u> on Jan. 7th, 2020 at 4:24 am local time <u>Mw 5.8</u> on Jan. 7th, 2020 at 7:18 am local time

Sample observed damages

3 days after the events, a Field Assessment Structural Team (FAST) was deployed by **StEER** & **Blume Center** led by Prof. Eduardo Miranda with graduate students (Stanford & UCB).

