PEER Request for Proposal:
Solicitation TSRP-PEER 21-02

Introduction

The Pacific Earthquake Engineering Research (PEER) is a multi-campus center that has continuing funding from the State of California related to the seismic performance of transportation and related systems. This funding supports the Transportation Systems Research Program (TSRP), the purpose of which is to lessen the impacts of earthquakes and other natural hazards on the transportation systems of California, including highways and bridges, port facilities, high-speed rail, airports, and other related systems.

Funding from the TSRP supports transportation-related research that uses and extends PEER's performance-based engineering (PBE) methodologies, and integrates fundamental knowledge, enabling technologies and systems. The program also aims to integrate seismological, geotechnical, structural, hydrodynamic and socio-economical aspects of earthquake engineering, and involve theoretical, computational, experimental and field investigations. The program encourages vigorous interactions between practitioners and researchers.

The PEER TSRP is coordinated by PEER Research Committee (PEER-RC). Proposals will be reviewed by external reviewers, who will be determined by this committee, among experts who have not submitted proposals to this solicitation and have no conflict of interest.

Requested Proposals

The PEER-RC is soliciting **proposals focusing on organizing workshops** in one or more of the areas listed in Appendix A. Workshops may be of the following formats: Duration of 1 or 2 days; online, in-person, or a hybrid of the two; invited speakers or speakers selected through abstract submission process; at a PEER core institution or at PEER Headquarters. In-person workshop may be held only if such gatherings are allowed by the local health departments and must follow all health protocols. Each workshop proposal is limited to a maximum budget of **$20,000**.

All workshop proposals must meet the following requirements:

1. Be led by investigators from the PEER core institutions[1]. *PEER Business and Industry Partners* (*BIPs*) interested in this solicitation are strongly encouraged to collaborate with the researchers at PEER's core institutions and submit a joint proposal.
2. Each investigator is limited to be the PI or the co-PI on **one** proposal only.
3. Proposals may focus on large strategic thrusts in new areas spanning over a long term, or on tactical thrusts related to unsolved problems in known areas with shorter term goals.
4. At least a quarter of the speakers of the workshop shall be industry members, stakeholders, government agencies or sponsors.
5. Attendance should be open to the larger PEER community by a registration process – a limit on number of attendees and/or deadline for registration are allowed. Proposals with closed attendance may be allowed at the discretion of PEER-RC, if the PI provides compelling reasons for doing so, with the understanding that the proceedings of such workshop be made available to the larger PEER community at a later date.
6. Proposed workshops must have the following components: review of the current status (work done by PEER or others in the area of interest), identification of research gaps,

[1]PEER core institutions are: UC Berkeley, Caltech, OSU, Stanford, UC Davis, UCI, UCLA, UCSD, UNR, USC, and UW.

suggestions to address these gaps, identification of funding opportunities, development of a concrete research plan, and final recommendations of the workshop. Workshops must allow sufficient time for discussions from the audience.

Investigators must commit to:

1. Working as part of the overall TSRP team, sharing information, data, models, outcomes and ideas needed for other projects,
2. Attending at least two meetings per each year of funding: the PEER Annual Meeting and the PEER Researchers' Workshop (usually held in summer),
3. Submitting a brief scope of the proposed workshop as an announcement at the beginning of the project for distribution to the PEER community, and
4. Writing a PEER report documenting the outcomes of the workshop.

Workshop proposals will be evaluated based on the primary criteria of technical merit and broader impact. Further, proposals with matching funding will be viewed favorably. In addition to the above considerations, projects will be selected to result in a diversity of specialization.

These workshop proposals are limited to a budget of **$20,000** per workshop and need to be held in the calendar year 2022. All proposed workshops will be subject to final approval by the PEER Director.

A list of the current and past TSRP projects is posted on the PEER website at: https://peer.berkeley.edu/research/transportation-systems/projects.

Proposal Submission Instructions

Format

Submit proposals online at https://peer.berkeley.edu/research/transportation-systems/request-proposals. Proposals should be submitted using the form found in the above site. Uploaded attachment may be a Word document or PDF (.doc or .docx or .pdf) and shall include the following:

- a three-page project description,
- a two-page biographical sketch of the PI(s), and
- a one-page draft budget.

Filename of the attachment should follow the format:

"<category>_<Last name>_WSRFP2021_<optional title less than 50 characters>"

For example,

"M5_Lastname_WSRFP2021_Hybrid simulation.pdf"

or

"A1_Lastname_WSRFP2021.docx"

Budget

All proposed work should be completed within a period less than or equal to **one year**. Budgets should be limited to:

1. maximum of quarter of a month of summer support (or its equivalent) for the PI,
2. one graduate student researcher or postdoctoral fellow,
3. event venue & meal expenses, in case of in-person workshop,

4. speaker travel support, in case of in-person workshop,
5. travel to two PEER coordination meetings by the PI, and
6. other reasonable expenses, as approved by the PEER-HQ.

It is expected that proposing institutions will waive indirect costs, as is the practice for the University of California institutions. Final budgets with campus Sponsored Project Office (SPO) approval can be prepared after the initial selection of successful proposals, and any negotiated agreement on the scope and budget.

To meet the needs of the TSRP program, PEER-HQ may approach proposers to negotiate possible revisions to the scope and budget to better fit the program goals.

Important Dates
The **key dates** for responding to Solicitation PEER 21-02 are:
15 October 2021: submitting questions to peer_center@berkeley.edu
01 November 2021: proposal submission deadline
17 December 2021: completion of the review process of all proposals
17 January 2022: project start date
30 December 2022: completion of the workshop and submission of the report

Appendix A: Research Topics for this Solicitation

Proposals are solicited for workshops on the topics listed in this appendix. Workshops will not be awarded in all areas, and it is possible that multiple projects will be selected in some of the areas.

Overarching Thrust Areas

Workshops on these broader fields are intended to come up with long-term strategic research plans in the thrust area.

O.1. Infrastructure initiatives: With the national focus on the new infrastructure bill, there is an opportunity to come up with a broad, strategic & long-term plan for resiliency. The final product of this workshop is a draft proposal with targeted sponsors.

O.2. Geohazards: PEER researchers have contributed to a significant body of work in the field of geohazards over the past two decades. A workshop in this thrust area will focus on review of past work, identification of gaps, determining research needs and opportunities in this thrust area.

O.3. Structural Engineering: A review of PEER's work in the field of new and existing structural systems, identification of gaps, determining research needs and opportunities in this thrust area.

O.4. Modeling & Computation: PEER researchers have developed or improved elements, constitutive models, and solution strategies in OpenSees. In addition, significant contributions are made in modeling SSI and FSI over the past years. A workshop in this thrust will review existing work, identify future needs and opportunities.

O.5. Transportation Systems & Networks: TSRP goal of improving the resiliency of transportation systems has resulted in significant work in regional-scale assessment of networks. A workshop in this area will develop a research plan and determine new funding sources.

O.6. Structural Health Monitoring: This emerging thrust area has seen development in new sensors, use of Artificial Intelligence (AI). A workshop in this area will synthesize these components into a coherent research plan and identify future opportunities.

O.7. Reconnaissance: This field is seeing a significant transformation as the traditional reconnaissance methods are combined with newly developed virtual methods including damage detection from images, and natural language processing, further information can be found in the StEER Network (https://www.steer.network/). A workshop in this area will synthesize these components, develop a research plan and identify future opportunities.

Workshops in the following subtopics are tactical in nature, will focus on tackling the unsolved problems in these specific areas and are expected to be short to medium-term. These topics are listed as examples and other topics can be proposed or combined with these in any logical manner for the scope of the proposed workshop.

Geotechnical Engineering

G.1. Triggering criteria: Data gathering and evaluation from recent earthquakes to address liquefaction triggering criteria.

G.2. Permanent deformations: Development of scientific basis for estimates of permanent deformation that improve on current empirical & semi-empirical estimates; Validation of numerical models.

G.3. Constitutive modeling: Development and validation of constitutive models for soils subjected to cyclic loads to be used in 2D and 3D geotechnical modeling to capture highly nonlinear response.

G.4. Site characterization: Geology considerations for site characterization, including integrated site characterization; Development and usage of new intensity measures to characterize liquefaction.

Structural Engineering

S.1. Functionality & Life-cycle Costs: Development of fundamental knowledge, as well as enabling technologies, for transportation systems to help decision-makers to evaluate life-cycle design options; Impact on functionality due to damage to transportation systems and components; Better estimation of costs of loss of functionality; Better estimation of costs of repair, demolition and replacement of damaged facilities.

S.2. New Systems & Materials: Evaluation of cost, resilience, durability and constructability of new systems (bridges, buildings or other structures); development of these systems within the PBE framework; Estimation of mechanical properties and sustainability characteristics of promising new materials to enable the design of such systems.

S.3. Ports, Airports & High-speed Rail: Studying ports, high-speed rail networks and airports with PBE to evaluate their resilience; Early Warning Systems (EWS) to maintain functionality of these systems.

PBE Methodology

M.1. Ground Motion Characterization: Improved characterization of ground motions and hazard intensity for PBEE and consideration of ground motion effects (such as pulses or multi-directional characteristics) that influence response of structures for increased understanding of near-fault ground motions and their effects on transportation systems.

M.2. Physics-based GM Modeling: Physical simulation of earthquakes as input to the structural analysis stage of PBEE making use of physics-based and stochastic ground motion modeling.

M.3. Uncertainty Quantification: Forward uncertainty quantification including record-to-record variability, parameter uncertainty, modeling uncertainty, and material uncertainty with investigation of these uncertainties on important bridges, port facilities, airports, etc.; Backward uncertainty quantification including benchmarking current design practice, development of simplified design procedures, use of optimization and multi-fidelity analyses, and design of a network, not only a single facility.

M.4. Experimental Methods: Hybrid simulation and shaking table tests of conventional and innovative bridge systems that can provide input to the structural and damage analysis stages of the PBE methodology.

M.5. Instrumentation, Data Collection, AI & ML: Cost effective instrumentation, and sensor development and field testing of bridges and other structures including development of testbeds for validating PBE approaches, collecting data, and developing effective models and algorithms for artificial intelligence and machine learning methods. This can also make use of technologies such as non-contact measurement methods, laser scanning, laser-based sensors, mobile sensing systems, drones, etc.

M.6. Protective Systems: Use of protective systems in transportation networks that validate PBE approaches and also developing cost effective retrofit methods for existing bridges and their

evaluation using PBE methods applied to single facility or a network of multiple components and sub-systems.

PBE Tools

T.1. Visualization & Data Mining Tools: Visualization, data mining and artificial intelligence tools needed to facilitate checking and generation of input data and evaluation of output data, including uncertainty quantification.

T.2. Highly Nonlinear Elements and Materials: Improvement or verification of highly nonlinear elements and materials, necessary for modeling structures from elastic response to the point of collapse.

T.3. Complex Models & Large Networks: Further research focused on highly complex models that include tens of thousands of variables and large networks.

Areas of Application

A.1. PBE for Tsunamis, Fire and Other Extreme Events: Research is needed to develop the design and evaluation criteria, the methodologies and the tools needed to incorporate tsunamis and fires into the performance evaluation of port facilities and design of bridges.

A.2. Development of PBE Basis for New Systems: Application of PBE to new systems, such as water distribution lines, high-speed rail networks, electrical network, etc. These systems have new design criteria (e.g., in case of HSR these may be passenger comfort, extreme seismic and wind reliability expectations) and complex structures (dynamics, track vibration, long geometries). Research is needed to develop the fundamental knowledge necessary to develop the PBE basis for such systems.

A.3. PBE for Multi-Hazards: Going beyond a single hazard due to earthquakes and learning from past development of PBEE in the face of earthquakes, proposals are solicited in extending the PBEE methodologies to other natural hazards as a PBE for multi-hazards applied to transportation systems.