

# Preparing undergraduates for success through a multi-disciplinary, multi-campus research internship program focused on earthquake resiliency



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## **SUMMARY:**

Recent earthquakes in the US and around the world have shown that earthquake resilience is essential to building and sustaining urban communities. Earthquake resilience will thus play an increasingly important role in the professions associated with earthquake hazard mitigation. To educate the next-generation of professionals, the Pacific Earthquake Engineering Research Center (PEER) conducts a multidisciplinary summer research internship program for undergraduates focused on Engineering Earthquake Resilient Communities. PEER's program demonstrates the success of using a multi-disciplinary, multi-campus approach to train future faculty and student researchers in the field earthquake engineering and mitigation.

*Keywords: internship, REU, undergraduate, resilient, multi-disciplinary*

## **1. BACKGROUND & PURPOSE**

Community resilience is becoming an issue of increasing importance to the professions associated with earthquake loss mitigation, including structural, transportation, and geotechnical engineering, as well as public policy. To educate the next-generation of these professionals, the Pacific Earthquake Engineering Research Center (PEER) hosts a 10-week summer internship program that places three or four undergraduate students at each of three universities: University of California Berkeley, University of California Davis, and University of Washington. This program is funded by a 3-year grant from the National Science Foundation and hosted its first cohort of interns during the summer 2011 (PEER 2011).

### **1.1. Objectives**

The internship program aims to set the participating interns on a path to a broader education and understanding of earthquake hazard mitigation beyond the classroom. The vision when developing this program was to create a comprehensive research program that:

- Exposes undergraduate students to experimental and analytical research, and thereby inspires them to pursue research-based graduate studies
- Demonstrates the importance of collaborative, multi-disciplinary research to solve real problems
- Teaches the research process from defining a research project, to analyzing and disseminating results in a meaningful way
- Recruits and retains students in earthquake engineering, particularly under-represented minorities
- Enhances the mentoring and teaching skills of graduate students

## **1.2. Intellectual Focus: Earthquake Resiliency**

The NEHRP Strategic Plan for 2009 – 2013 declared that “earthquake resiliency” is a critical goal of our nation (NEHRP 2008). Earthquake resiliency can be defined as the capacity of a community to withstand earthquakes safely, maintain functionality, and recover quickly from any post-earthquake damage to the economic, physical and political framework of the community. A resilient city is able to contain the effects of earthquakes when they occur, carry out recovery activities in ways that minimize social disruption, and rebuild in ways that mitigate the effects of future earthquakes. This idea has led organizations like the San Francisco Planning and Urban Research Association (SPUR) to develop mitigation plans for communities and recommend new approaches to policy development and urban planning (SPUR 2009). To achieve long-term resiliency, new methods and solutions are also needed from researchers in the engineering community to ensure good performance of the infrastructure and the built environment.

Based on the burgeoning importance of this topic for future earthquake engineers and mitigation professionals, all intern research projects in 2011 were related to internship program theme of “Engineering Earthquake Resilient Communities.” Additionally, students were assigned projects in a variety of engineering and social science fields including structural and geotechnical engineering, urban planning, and public policy. The intentionally diverse nature of the projects and research disciplines was intended to give students technical expertise in one specific discipline while also giving them a broad understanding of the numerous issues related to resiliency. It was intended to broaden the experience of the students beyond their university course work, provide intellectual stimulation, and inspire them to tackle big problems that benefit society.

## **2. INTERN RESEARCH PROJECTS**

Eleven undergraduate interns were assigned research projects at three different participating universities during the summer of 2011. Each student was paired with a faculty and graduate student mentor who assigned him or her a research project to complete at the host institution during the 10-week internship. Through their research projects, the undergraduate student interns worked closely with their faculty and graduate student mentors to explore the background concepts related to their research project, completed literature reviews of related research, completed their in-depth research experiment or analysis, and gained exposure to the long-term research projects being completed by the graduate student and professor.

Each university that hosted students had a unique focus related to the program theme of earthquake resiliency. The specific focus areas at each university are described below in addition to the description of their student projects in 2011. The collaborative nature of the student projects and the integration of many disciplines helped to provide a broad research experience for all Research Experience for Undergraduate (REU) interns in the program.

At the end of the summer, each of the PEER REU interns compiled a full research paper describing their results. These final technical research papers were compiled into a compendium and published in the PEER Report Series (Faison and Mahin 2011).

### **2.1. University of Washington Projects**

Resilient communities rely on functional infrastructure after any disaster. Therefore, an important aspect of structural resilience is minimizing the post-earthquake damage to infrastructure. Four interns were placed at the University of Washington with projects related to the earthquake resiliency of transportation structures, systems and networks.

The 2011 intern projects are as follows:

1. Project 'High-volume SCM Concrete in Composite Construction' was completed by REU

intern Gulzat Atymtayeva under the supervision of the following mentors: Professor Charles Roeder, Professor Dawn Lehman, and Arni Gunnarsson (University of Washington). Through the use of compressive strength, drying shrinkage, and creep tests, this project investigated the time-dependent behavior of concrete with a high level of cement replacement in composite construction such as concrete-filled steel tubes.

2. Project 'CFT Bridge Pier Connections' was completed by REU intern Zhi Long Liu under the supervision of the following mentors: Professor Charles Roeder, Professor Dawn Lehman, and Kenneth O'Neil (University of Washington). This project investigated a new connection between circular concrete-filled steel tubes piers and reinforced concrete foundations, in an attempt to achieve a connection with a logical and cost-effective construction sequence.
3. Project 'Earthquake Resiliency: Managing Waste Water Sector Vulnerabilities through Green Infrastructure and Related Policies' was completed by REU intern Jason Naanos under the supervision of the following mentors: Professor Peter May and Ashley Jochim (University of Washington). This project addressed how environmental land use planning with "green" infrastructure and environmentally conscious government policies could create a stronger waste water infrastructure to achieve a more resilient Seattle in terms of earthquakes, economics, and environmental impacts.
4. Project 'Disaster Resilience of Maritime Ports' was completed by REU intern Sarah Welsh-Huggins under the supervision of the following mentors: Professor Peter May and Ashley Jochim (University of Washington). Evaluations of the disaster preparedness of the two largest container ports in Washington State were conducted to determine how major earthquakes impact port facilities, why community awareness of the seismic risk to infrastructure should be increased, and what actions are needed to strengthen the interdependencies that determine post-disaster resilience of ports.

## **2.2. University of California, Davis Projects**

Some communities rely on functional levee systems after a disaster. Earthquake-induced levee failures in California's Sacramento-San Joaquin Delta and the resulting rapid inundation of the inner islands have the potential to significantly reduce the freshwater supply for California, in addition to damaging the natural habitat, crops and civil infrastructure (Lund et al. 2007). Seismic fragility of the levee system is strongly dependent on the assessed potential for liquefaction of loose soils within non-engineered levees or their foundations. Current research is underway at UC Davis to investigate these issues and four interns supplemented this research with projects related to the earthquake resiliency of levees.

The 2011 intern projects are as follows:

1. Project 'Effect of Fines Content on the Limiting Compression Curve of Intermediate Soils' was completed by REU intern Christopher Kissick under the supervision of the following mentors: Professor Ross Boulanger, Professor Jason DeJong, and Ian Maki (UC Davis). Experiments were performed on various soil mixtures that will inform research that is attempting to identify the liquefaction potential of a soil through improved calculation of the Overburden Correction Factor ( $C_N$ ).
2. Project 'How well are fines and plasticity represented in liquefaction triggering curves?' was completed by REU intern Christopher Krage under the supervision of the following mentors: Professor Ross Boulanger and Jack Montgomery (UC Davis). Analysis of the Cone Penetration Test based liquefaction database proposed by Moss et al. (2006) was conducted to evaluate the representation of fines and plastic fines within the case history database and also to determine any relationship between cases with plastic fines.
3. Project 'Microbial Induced Calcite Precipitation in Partially Saturated Soils' was completed

by REU intern Andrew Makdisi under the supervision of the following mentors: Professor Jason DeJong and Brian Martinez (UC Davis). Testing was conducted to determine the effectiveness of treating weak, unsaturated sands via a surface-down percolation approach to create a substantial layer of liquefaction-resistant sand from Microbial Induced Calcite Precipitation.

4. Project 'The Effect of Microbially Induced Calcite Precipitation on the Liquefaction Resistance of Sand' was completed by REU intern Douglas Spitzer under the supervision of the following mentors: Professor Jason DeJong and Brina Montoya (UC Davis). Cyclic and monotonic one dimensional direct simple shear tests were conducted on specimens of loose Ottawa 50-70 sand to compare the improvement in behavior of specimens that had been treated with Microbially Induced Calcite Precipitation to those that remained untreated.

### **2.3. University of California, Berkeley & SPUR Projects**

A resilient community relies on functional urban buildings and housing after earthquakes. Learning from the effects of past earthquakes and planning for swift, effective recovery from future earthquakes can help to ensure our built environment is resilient. Three students conducted research projects related to the earthquake resiliency of buildings.

The February 22, 2011 Christchurch New Zealand Earthquake caused staggering amounts of damage to the community of Christchurch, and resulted in the closure of the downtown business district due to building collapses and extensive earthquake damage, along with major liquefaction-induced damage to surrounding community housing and infrastructure (EERI 2011). With funding from NSF RAPID Award CMMI-1138358, one intern worked with investigators from UC San Diego to gather perishable data in two buildings damaged in the Christchurch Earthquake. This 2011 intern project was:

1. Project 'Assessing and Mapping Earthquake Damage in Christchurch, New Zealand' was completed by REU intern David Deutsch under the supervision of the following mentors: Professor Jose Restrepo and Matt Schoettler (University of California, San Diego). Damage mapping of a 9-story precast concrete hotel and a 5-story precast concrete parking garage from the February 22, 2011 Christchurch, New Zealand earthquake was conducted during a field-based data gathering expedition in July 2011, and follow-up documentation and assessment was conducted at UC Berkeley.

To achieve a multi-disciplinary perspective on the issue of earthquake resilient urban housing, two of 2011 interns at UC Berkeley were hosted by San Francisco Planning and Urban Research Association (SPUR) to complete urban planning research under the mentorship of Sarah Karlinsky. Research conducted by the interns was used to inform a recent report on post-earthquake housing and recovery issues (SPUR 2012). The development of this report was a multidisciplinary effort that utilized a broad team of experts, including urban designers, structural engineers, market rate and affordable housing developers, city officials and financiers. The 2011 housing and recovery intern projects were:

2. Project 'The Resilient City: Achieving Shelter-in-Place in San Francisco' was completed by REU intern Amanjot (Amy) Dhaliwal under the supervision of the following mentors: Sarah Karlinsky (SPUR), Professor Mary Comerio (UC Berkeley), Laura Dwelley-Samant (consultant). GIS mapping was completed for San Francisco to identify the seismic vulnerability of buildings, the Shelter-in-Place capacity, and demographic characteristics for each San Francisco neighborhood.
3. Project 'The Resilient City: San Francisco Shelter-in-Place Analysis' was completed by REU intern John Pham under the supervision of the following mentors: Sarah Karlinsky (SPUR), Professor Mary Comerio (UC Berkeley), Laura Dwelley-Samant (consultant). This project validated the need for a 95% shelter-in-place standard for San Francisco by conducting data analysis of San Francisco's residential building stock vulnerability with its demographic

profiles at the neighborhood level.

In addition to the intern research projects, a variety of supplemental program elements were designed to give opportunities for student collaboration and interaction while also improving the intern's understanding of multi-disciplinary nature of earthquake resiliency research.

### **3. PROGRAM ELEMENTS**

This internship program consisted of several program elements that contributed to its success. With the challenge of hosting students at various locations, these elements bolstered interaction between the students at each site.

#### **3.1. Orientation Program**

The theme for this NSF funded REU site, hosted by the PEER Center, is "Engineering Earthquake Resilient Communities," so the orientation began with a workshop discussing the concept of resiliency and how it applies to earthquakes. Professor Mahin, the REU Principle Investigator, gave a presentation that broadly discussed how resiliency relates to sustainability and how both are largely impacted by earthquake performance. According to one of the interns, "I had very little understanding of what the term meant but after the initial orientation session I had a much clearer picture. The presentation by Dr. Mahin was very helpful in providing a detailed introduction to the topic."

Following Professor Mahin, several mentors presented how their research and their summer intern's research project relate to the concept of resiliency. An additional presentation was given by a visiting researcher Alexandra Ja Yeun Lee of the University of Auckland, New Zealand, about the her studies of the earthquake recovery efforts underway in Christchurch, New Zealand. By the end of all presentations and subsequent discussion, the workshop was able to emphasize and reinforce Professor Mahin's assertion that earthquake resiliency requires interaction of many different disciplines. One of the interns echoed this in his/her evaluation form comments: "The workshop introduced different ways to think of Earthquake Resiliency and the capacity/necessity for integration between disciplines."

In addition to the resiliency workshop, the interns participated in a variety of activities during the orientation including:

- Library Research Tools: Librarian Chuck James hosted this workshop in the National Information Service for Earthquake Engineering Library (NISEE 2012). The students were instructed on how to complete a thorough literature review and how to effectively find documents necessary to write a research results paper. This training was intended to help students with summer research projects that required literature reviews but also will help any students who continue on to larger, open-ended research work in graduate school.
- Laboratory Tours: Tours of the earthquake engineering laboratories on the UC Berkeley campus were conducted. These included the Earthquake Simulator Lab with UC Berkeley's large scale shaking table (PEER 2012), the nees@berkeley lab (NEES@berkeley 2012), and the Davis Hall structures lab (UC Berkeley 2012).
- Team Building Design Challenge: A team-based K'Nex building challenge spurred interaction and teamwork. The intern designed structures were tested on a earthquake shaking table.
- Graduate School Information Session: This session included a meeting with a Graduate School Admissions Counselor for UC Berkeley Civil and Environmental Engineering that discussed how to apply to graduate school and what elements make a strong application. This meeting was followed by a panel discussion about graduate school and graduate-level research with five graduate students from different disciplines including structures, geotech and public policy.
- Research Ethics Training: During this two and one half hour session the interns and REU coordinator held a lively, interactive discussion of ethical issues and topics related to engineering practice and engineering research through the use of selected readings and case studies. The topics covered most thoroughly included Research Misconduct, Conflict of Interest,

Authorship, and Data Integrity, though other issues were covered as they came up in discussion. Various resources including written materials and videos were used to frame this discussion. (National Academy of Engineering 2011, CITI 2011, Office of Research Administration and Compliance 2009, ASCE 2006, National Academies 2009)

- **Poster Presentation Session:** This session was held to discuss important aspects of visually communicating research results through a research poster. The students were given design tips for use at the end of the summer when they needed to prepare their own research poster, and an interactive review of past intern posters was conducted to help them understand what aspects of poster design allow the material to be conveyed clearly.

From the intern evaluations, the most popular activities were the graduate student panel and graduate school admissions discussion. This comment from one of the interns summarizes the remarks of several interns: “The Friday discussion of grad schools was very helpful. It was daunting at first to hear about all that we will need to do to successfully get into grad school. After listening to the panel, however; I was reassured that this is the path that I want to follow, and that it is attainable.”

### **3.2. Weekly Web-Meetings with Interns and Mentors**

One-hour web-based weekly meetings were held on Wednesdays during the 10-week summer internship program. All eleven REU interns attended each meeting along with the REU coordinator and as many faculty, graduate student, and post-doc mentors as were available (approx. 2 – 6 per week). Each week general announcements were made about logistical issues, but more importantly, three or four interns orally presented their research project with the aid of PowerPoint slides.

During the first three weekly meetings the interns each had the opportunity to present an overview of their research project. In the next three weeks, the interns presented updates on the status of their research project and discussed some of their research challenges to date. During the final weekly meetings at the end of the summer the interns presented a final, complete research presentation that included their project overview, results, and how their project related to future community earthquake resiliency. By hearing the other students present their research the interns learned from the projects of their peers and better understood how each project and discipline can influence earthquake resiliency.

One of the strongest benefits of requiring the interns to present three times during the summer was that the interns practiced creating content to disseminate, orally presenting their research to an audience unfamiliar with their project details, and answering questions about their research in an informal, comfortable team setting. This helped prepare them to answer questions and clearly describe their project during the poster session where they presented their research at the PEER Annual meeting.

### **3.3. PEER Annual Meeting**

Ten of the summer interns were able to attend the 2011 PEER Annual Meeting (PEER 2011) and participate in the student poster session. Each student designed a 30 in x 40 in color poster that described their research project goals, methods and results. During this poster session, the interns joined graduate students working on PEER projects, to share their research projects and results with the entire PEER research community. There were at least 150 attendees at the 2-hour poster session including faculty, students, and practicing professional engineers, so the students had a great opportunity to share their project details and research findings while networking with professionals.

In addition to the poster session, the interns attended the entire conference to learn more about the numerous multi-disciplinary PEER research projects and experience a professional conference. For many of the interns, this was their first attendance at a professional conference.

During the Annual Meeting, the interns were interviewed about their experiences in the PEER Internship Program. A video compilation of their impressions of the program can be found at the PEER YouTube Channel (PEER 2011).

#### **4. MENTOR DEVELOPMENT & TRAINING**

An important goal of the PEER internship program is to enhance the mentoring and teaching skills of graduate students. Through their involvement as mentors, graduate student participants had the opportunity to develop their professional skills by leading new undergraduate learners through the process of conducting thoughtful and thorough research. Faculty members at universities around the world also need these mentoring skills as they mentor their own graduate students. By developing these leadership skills of the graduate students, it is hoped that they become more qualified applicants for academic faculty positions upon completion of their degree.

A mentor training workshop was conducted by the REU Coordinator for all participating graduate student mentors during the summer of 2011 based on "Entering Mentoring: A Seminar to Train a New Generation of Scientists" developed by the Wisconsin Program for Scientific Teaching (Handelsman 2005). The goals of this workshop were to help mentors clearly communicate their goals and expectations to the students, develop mentoring goals, identify and resolve problems, and evaluate their progress as mentors. By honing the mentoring skills of these graduate students and providing both tools and time for thoughtful evaluation of effective mentoring practices, this mentor training workshop was intended to help prepare them for future careers as academic faculty members or senior professional engineers.

This training was completed in four approximately 1 hour sessions and covered a variety of topics including tips for establishing a good relationship with your intern, goal and expectation setting, discussion of how to identify and resolve mentoring challenges, and brainstorming on how to ensure an excellent finish for the intern at the conclusion of the research experience.

##### **4.1. Impact on the 2011 Mentors**

Eight mentors participated in this seminar; seven were graduate students and one was a post-doc. From the results of an end of summer mentor evaluation, seven of the eight participating mentors answered "Yes" when asked "Would you recommend the mentoring seminar to a colleague?" Five of the mentors felt that the seminar prepared them to clearly communicate their goals and expectations to the interns, and provided a forum that allowed them to evaluate their progress as a mentor.

Based on these results, the mentor seminar was useful to many of the mentors. For some of the more experienced mentors, however they found the mentoring seminars a time consuming exercise, in addition to the weekly intern presentations and other mentoring duties. Thus, during the summer of 2012 this mentor training workshop will be slightly revised to achieve even better outcomes.

##### **4.2. Revisions to the Mentor Training approach for summer 2012**

To better fit the needs of all levels of summer mentors during the 2012 program, experienced mentors will be asked to lead some of the discussion and training sessions. This will take advantage of their expertise, and encourage sharing of their current mentoring approaches and successes instead of focusing on generic case study examples. This will further develop the teaching and mentoring skills of the experienced mentors as they help new mentors evolve and progress in their mentoring capacity.

Additionally the mentor training workshop will be supplemented by one-on-one phone calls by the REU Coordinator to follow up on individual mentor progress and get unique feedback. These calls will especially target first-time mentors in most need of additional help, ideas or resources.

It is hoped that this revised approach plan will allow all levels of graduate mentors to gain experience from the program, either in a teaching role or in a learning role. The development of these skills will allow them to be effective coaches to their interns, so that valuable research can be achieved during the summer.

## 5. OUTCOMES & CONCLUSIONS

The Undergraduate Research Student Self-Assessment (URSSA) is an online survey instrument developed with funding by NSF, which is used to determine what students learned from their summer research experience both in a summative and formative manner (URSSA 2009). The PEER REU interns completed the URSSA assessment at the end of the summer and the results of this evaluation survey are used throughout this section to summarize and highlight several outcomes and impacts.

### 5.1. Success in Meeting Program Objectives

The five project objectives were stated at the start of this paper, and the program's ability to meet these goals is assessed below.

#### 5.1.1. *Exposes undergraduate students to experimental and analytical research*

The achievement of this goal can be determined by some of the responses to the URSSA evaluation form that the interns completed at the end of the internship. As a result of the PEER Internship Program, 55% of the interns declared a "good gain" and 36% of the interns declared a "great gain" in "Understanding what everyday research work is like." When asked "How much did you engage in real-world science research?" 36% of interns reported "a great deal" and 27% reported "a fair amount."

#### 5.1.2 *Inspires them to pursue research-based graduate studies*

At the conclusion of their summer research experience, 82% of the interns "Agreed" or "Strongly Agreed" that "My research experience has prepared me for advanced coursework or thesis work" and "My research experience has prepared me for graduate school." Additionally, several of the comments from the URSSA evaluation forms by individual interns shows that this project goal was achieved:

- "My research experience motivated me to pursue graduate school and other post undergraduate positions. It has shown me the diligence required to pursue these positions and the work that is entailed."
- "Prior to this research experience I intended to work for a few years and then return to graduate school. My current plan is to apply to graduate schools this fall, with the hope of going directly into a master's program in Civil Engineering (focus on Earthquake Engineering) next year."

#### 5.1.3 *Demonstrates the importance of collaborative, multi-disciplinary research to solve real problems*

The URSSA evaluation form directly asked a question about this goal: "Did the PEER summer internship program activities demonstrate the importance of collaborative, multi-disciplinary research to solve real problems?" 64% of the interns answered "a great deal" and 27% answered "a fair amount."

#### 5.1.4. *Teaches the research process from defining a research project, to analyzing and disseminating results in a meaningful way*

A series of questions on the URSSA form help to show that this goal was achieved. Over 90% of the interns stated either "good" or "great" gains in the following areas:

- "Figuring out the next step in a research project."
- "Identifying limitations of research methods and designs."
- "Understanding the theory and concepts guiding my research project."

#### 5.1.5. *Recruits and retains students in earthquake engineering, particularly under-represented minorities*

This goal cannot be accurately reported on at this time, however many of the interns wrote or spoke to the REU Coordinator about submitting graduate school applications. More details will be provided in future years when better longitudinal data on the interns becomes available.

#### *5.1.6. Enhance the mentoring and teaching skills of graduate students*

When asked, “Did this experience enhance your mentoring skills,” in the electronic mentor survey completed by 9 of the mentors, 55% of the mentors answered “Yes, to a large degree” and 44% answered “Yes, to a small degree.” Thus all responding mentors saw gains in these skills. Remarks by the mentors in their own words from the evaluation form also show that many of the mentors gained a great deal from the experience:

- “Every undergrad researcher is different, and I feel like I got to practice different management skills that I haven’t needed to before. This is a good experience as I will have my own grad students to mentor as a faculty member in the near future.”
- “I gained valuable experience on mentoring and learning what areas I need improvement when mentoring in the future.”

### **5.2. Highlights of Skills Gained**

The URSSA evaluation was able to track student gains in many areas. Over 90% of the interns stated either “good” or “great” gains in understanding journal articles, time management, and conducting procedures in the lab or field. Over 80% of the interns stated either “good” or “great” gains in making oral presentations, preparing a scientific poster, and increased confidence in their ability to contribute to science. Over 70% of the interns stated either “good” or “great” gains in writing scientific reports or papers, analyzing data for patterns, explaining their project to people outside their field, working independently, and discussing scientific concepts with others.

One intern’s comment from the evaluation survey highlights the value of various gains: “Skills such as making presentations to fellow interns, writing a technical paper were definitely the biggest gains for me. In addition, understanding that research may not go as planned and still being able to manage it is another aspect of my research.”

### **5.3. Impact of Mentoring and Interactions between the Interns and Mentors**

In the URSSA evaluation several questions looked at the intern/mentor relationship. According to the survey results, 45% of the interns rated their “working relationship with my research mentor” as “Excellent” and another 45% rated it as “Good.” 82% of the interns rated the “amount of time I spent with my research mentor” as either “Excellent” or “Good.” One comment from the intern evaluation shows how much this intern valued his or her mentors: “My mentors provided me with a lot of freedom during my research experience. I felt by doing that, my mentors were giving me an opportunity to grow as a researcher and try and figure difficulties out on my own. They were always available for help when I needed. This type of relationship with my mentors has given me the opportunity to grow - research-wise, creatively, and managing my time in a wise manner. Excellent experience.”

When the mentors were asked if they would mentor an intern again in their evaluation form, 100% of the mentors said “Yes.” This shows that the mentors as well as the interns valued the experience.

### **5.4. Success of “Earthquake Resiliency” Theme**

One other important aspect of the REU program that was tracked in the URSSA evaluation form was the learning gains related to the internship theme of “Earthquake Resiliency.” 73% of the interns felt that the PEER summer internship improved their understanding of the concept of Earthquake Resiliency, and was successful at demonstrating how research can advance earthquake resiliency by developing tools and technologies that minimize earthquake damage and help communities to recover quickly from large earthquakes. Additionally most felt that the summer internship enhanced their knowledge and understanding of earthquake-related disciplines such as public policy, geotechnical engineering and structural engineering.

This shows that the thematic approach to the internship program with a variety of disciplinary research

projects related to a common theme was a successful model and provided useful learning gains for the interns.

## ACKNOWLEDGEMENT

PEER and the authors extend thanks to the participating undergraduate interns, as well as the faculty, graduate student and earthquake professional mentors for their dedication to this program. Funding for the 2011 PEER Internship Program is provided National Science Foundation under Grant No. EEC-1063138. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).

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