

### 3. EDUCATION PROGRAM

#### 3.1 Strategic Education Plan, Methodologies, Milestones, and Deliverables

The Education Program is designed to introduce, stimulate, cultivate and educate undergraduate and graduate students with the knowledge that will enable them to contribute to the earthquake-engineering profession from a variety of disciplines and perspectives. The program attracts students to earthquake engineering early in their academic career and aims to retain them through graduate study. While the principal audience of the Education Program is undergraduate and graduate students, K-12 students also benefit directly from the Education Program's activity. PEER's Education Committee, composed of representatives from all 9 Core and 5 Educational Affiliate universities, is charged with planning and implementing the program.

Several specific programs have been instituted to provide undergraduate and graduate students with opportunities in the Education Program. Our overall objective is to build a culture within PEER, starting at K-12 and extending through graduate school, where students are excited about earthquake engineering learning and realize the need to contribute to the learning of others. Figure 3.1 illustrates the overall strategic plan with focus areas and milestones. Programs and deliverables cover the range from K-12, undergraduate students, and graduate students. Detailed descriptions of programs/projects are provided in subsequent sections of this chapter.

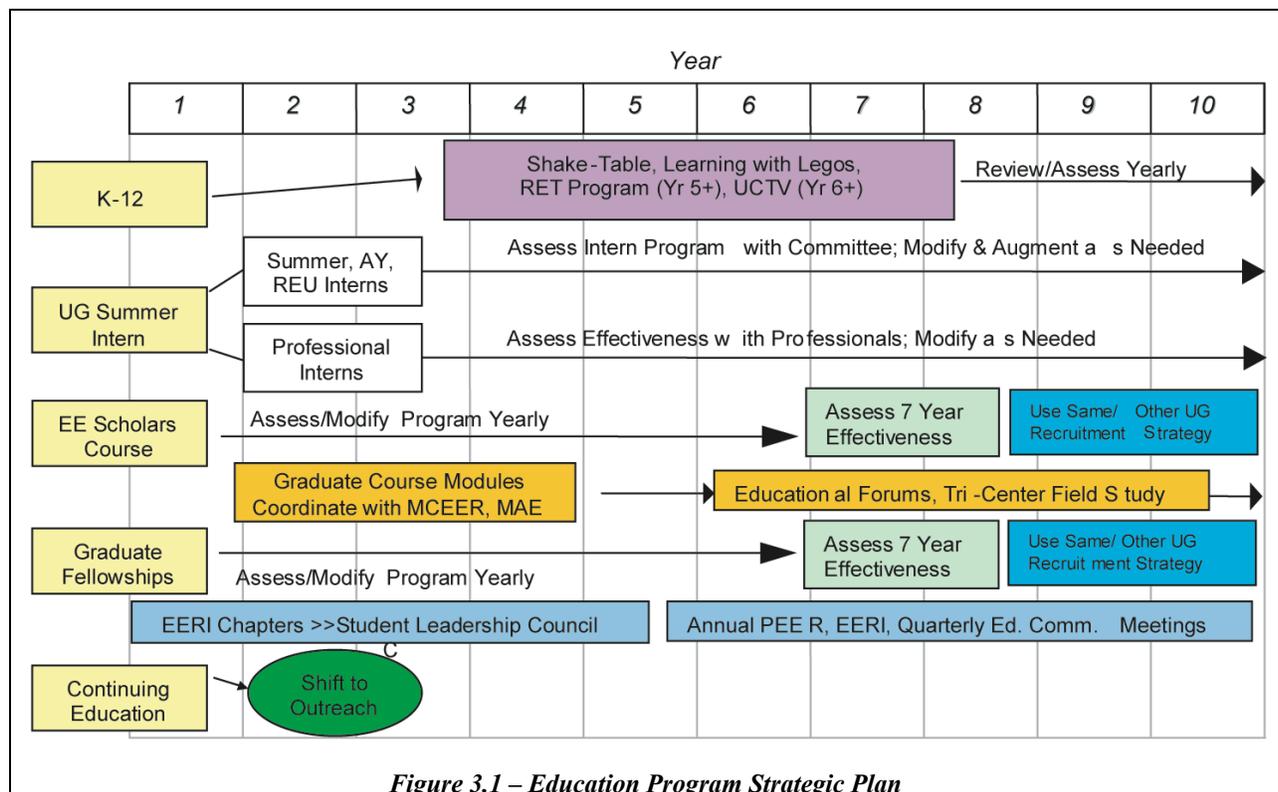


Figure 3.1 – Education Program Strategic Plan

## 3.2 Current Education Projects and Curriculum Innovations

### 3.2.1 Current Education Projects

During Year 7, the Education Program will sponsor nine on-going projects. These are described briefly below.

#### 3.2.1.1 Research Experience for Teachers (RET)

Middle school students from the inner city are often unaware of career opportunities in science and engineering. In an effort to improve math and science education at the middle-school level, PEER has begun working with teachers and their students through a **Research Experience for Teachers (RET)** supplemental grant. Our goal is to increase the knowledge and skill level of teachers from inner city schools, while at the same time having some direct impact on their students. In Year 5, nine teachers from eight inner-city schools spent several weekends on a PEER campus learning about earthquake engineering from faculty and graduate students, as well as receiving detailed instruction on operation of the university's laboratory equipment. These teachers also participated in one session of PEER's Earthquake Engineering Scholars Course. The teachers then worked with their own students to develop science fair projects with experiments carried out by the students and teachers at the PEER university campus. Two of these projects made it to countywide science fair finals, taking second place. We believe that this program is making an impact on K-12 education in two ways: (1) by developing earthquake engineering knowledge and laboratory skills of the K-12 teachers that they can utilize in the classroom, and (2) by exposing K-12 students to the university environment so that they can begin to realize it is an achievable goal for them.

This past summer, the program expanded to more PEER universities. Six teachers participated in the RET program. In addition to working with a PEER faculty mentor for four weeks during the summer, the participants attended a one-day Communication Skills Workshop, a collaborative effort between the Southern California Earthquake Center (SCEC) and the PEER Research Experience for

Undergraduates (REU) Summer Internship Program, as well as a workshop on how to translate their research experience into hands-on classroom practice and experiences for their students. An example of the impact we can have is RET participant Tami Church. She is a science teacher at Lapwai High School, on the Lapwai Reservation in Idaho. Through doing research, she "feels better prepared to help (her) students follow their dreams and pursue their goals." She also participated in the Native American Engineering Camp at Washington State University, and has set a personal goal of seeing at least four of her former students graduate with engineering degrees.

#### 3.2.1.2 PEER Summer Internship Program

The **PEER Summer Internship Program** is intended to interest, attract, train and retain



*Figure 3.2 - Middle school students and teachers gain experiences in science and earthquake engineering through PEER's Research Experience for Teachers program*

promising undergraduates who have expressed an interest in earthquake engineering research. Students work, over a period of ten weeks, under the direction of a PEER faculty mentor on a PEER-funded research project during the summer months and submit a report detailing their research experience during the fall term. We endeavor to restrict interns to working on projects that are current or recent-past PEER projects, although in exceptional cases we will accept students to work on PEER-related projects. During the past six years, PEER sponsored participating students to attend the EERI Annual Meetings in St. Louis, Monterey, Long Beach, Portland, and Los Angeles.



*Figure 3.3 - PEER Summer Interns at the EERI 2003 Annual Meeting in Portland*

Prior to the Friday evening reception, students presented posters about their summer research experience in an informal setting, while interacting with renowned specialists in earthquake engineering. PEER's internship opportunities provide students with experience in hands-on, individualized laboratory and field research, and increase opportunities in academia and professional practice. The students who participated in the PEER Summer Internship Program during summer 2003 submitted their final research reports on November 1, 2003. The interns' papers are being compiled into a compendium document for distribution to PEER's community of faculty and students. The Education Program is currently recruiting fifteen students to participate in the PEER Summer Internship Program during summer 2004.

### *3.2.1.3 Research Experience for Undergraduates Summer Internship Program*

In a program that parallels the PEER Summer Internship Program, the ***Research Experience for Undergraduates (REU) Summer Internship Program*** sponsors PEER students working at an institution other than their home campus, or students from campuses outside the PEER consortium, to work on PEER-funded research projects mentored by a PEER faculty member. In addition to the research experience, the REU Program (in an activity conducted jointly with SCEC) offers a one-day Communication Skills Workshop for the interns to assist them with oral and written reporting skills. The Workshop affords them the opportunity to discuss their ongoing research experience with other engineering and earth science students. The impact of the workshop is evident in the superior quality of the REU students' oral presentations and written reports submitted during the fall term following their internship.

The REU program also provides an opportunity to meet REU students from the other EERCs and thereby learn how earthquake engineering is perceived in other parts of the U.S. In August 2003, REU students from MAE, MCEER, and PEER met in Bend, Oregon, for a lively discussion of ethics in engineering, as well as an opportunity to hone their presentation skills in PowerPoint presentations relating their summer research experience to the group.

The PEER Education Program is currently recruiting seven students, focusing on those from groups historically underrepresented in the field, for the summer 2004 REU Program. The 2004 REU Symposium will be held August 7-10 in Charleston, South Carolina.

### *3.2.1.4 Earthquake Engineering Scholars Course*

PEER's Undergraduate ***Earthquake Engineering Scholars Course*** (EESC) is a program

implemented to showcase the graduate programs at PEER core institutions and introduce high-ranked undergraduate students to four topics in the field of earthquake engineering including seismology, geotechnical engineering, structural dynamics, and public policy. The Fall 2003 version of the EESC was a multi-campus program that provided instruction to 30 students from eleven PEER universities during four weekend retreats at PEER core-university campuses [University of Southern California (Geotechnical Earthquake Engineering), Stanford University (Seismology), University of Washington (Structural Dynamics), and UC Davis (Public Policy)]. These individual topics were the primary focus of each of the four weekends; however, the students commented on the faculty's success in developing a connection between the four topics which united the course overall and provided the students an opportunity to explore many facets of the earthquake engineering profession. Starting with the 2002 program, the Education Committee invited at least one PEER Business and Industry Partner member to present during each of the retreats. For example, at UC Berkeley, several young BIP engineers gave the PEER Scholars tours of seismic retrofit projects on the Berkeley campus, described engineering drawings and engineering practices, and shared experiences going from school to professional practice. The schools also utilized the opportunity to conduct tours and "show off" their laboratories and facilities. An objective of the course is to recruit new talent to the field of earthquake engineering. Most students who participated in the EESC in 2000 and 2001 have gone on to pursue graduate study at a PEER institution.

#### *3.2.1.5 Tri-center Earthquake Field Study Program for Students*

The ***Tri-center Earthquake Field Study Program for Students*** is an effort focusing on earthquake reconnaissance experience for PEER students that started in May 2002. Each summer this project brings students from MAE, MCEER, and PEER together to conduct post-earthquake investigations during a weeklong summer camp at a non-US site. The "new blood and experience" that are gained not only broaden the students' experiences but also train students future earthquake reconnaissance in programs such as the EERI Learning from Earthquakes Program. The participating students are drawn from a variety of institutions and disciplines. Each student is required to issue a formal reconnaissance report following the field investigation. The Education Directors have extended an invitation to EERI to fund four (non-EERC) students, plus a young faculty member, as part of its endowment program. In May 2002, three PEER students took part in the Taiwan Earthquake Field Study. In October 2003, three PEER students joined their counterparts from MAE and MCEER for a field study in Italy. Students from the Southern California Earthquake Center (SCEC) also participated. PEER will be responsible for coordinating a trip to Japan in July 2004, where we will visit the Miki Shake Table, Kobe Earthquake Museum, and the research city Tsukuba (including PARI, BRI, and PWRI). A select group of middle-and high-school teachers from the RET program will also join us.

#### *3.2.1.6 Student Leadership Council*

PEER aims to create an environment in which students learn leadership and management skills through independent student organizations. In PEER's first years, we encouraged formation of EERI Student Chapters, with chapters now located at Caltech, Oregon State, San Jose State, Stanford, UC Berkeley, UC Davis, UC Irvine, UC San Diego, and the University of Washington. Starting in Year 2, PEER formed its ***Student Leadership Council*** (SLC) and ***PEER Student Association*** (PSA). Both undergraduate and graduate student representatives on the SLC, from the core and affiliated campuses, provide an active and valuable voice for all PEER students. Over the past four years, PEER's SLC has been an influential contributor to the PEER Education

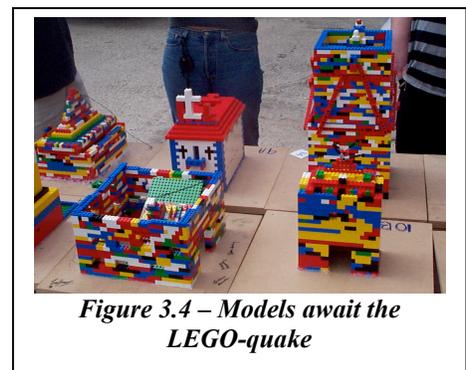
Committee and PEER Administration concerning the needs of undergraduate and graduate students. The SLC president attends each of the Education Committee's quarterly meetings to provide feedback and input concerning the programs offered by the PEER Education Program. The SLC conducts its own quarterly meetings, which are scheduled to coincide with other PEER Research and Education events to maximize opportunities for networking and discussion. PEER's fourth Student Day, held concurrently with the PEER Annual Meeting in March 2003, was an excellent forum for students to share their intellectual and personal experiences as participants in the PEER. The event includes meetings of the SLC and other students, formal poster sessions, and presentations by PEER students and Business and Industry Partners.

In order to increase the visibility of PEER among undergraduates during the past year, the SLC has been planning a new form of outreach to undergraduates studying civil/structural engineering through a competition in Seismic Design. Teams from PEER associated universities (as well as others) will design, build, and test their models on the Educational Shake Tables at this year's NSF Site Visit Meeting. If successful, this will become a tri-center event.

In 2002, the SLC had decreased in size to where only half of the core schools were represented, and three of the primary officers were on the verge of graduating. This had the potential to adversely affect their ongoing programs, while also making it difficult to get information out to the PEER Student Association. Since then, one of our goals has been to grow in size and depth, so that each core school is represented by at least one, if not more students. We now have an average of two SLC representatives per school, some just beginning their graduate work. With more people to share the volunteer work, the information flow to students has improved significantly.

### 3.2.1.7 *Tri-Center Ph.D. Candidate Exchange*

The ***Tri-Center Doctoral Candidate Exchange*** was a new program in Year 6 that sent two PEER graduate students nearing completion of their doctorate to give lectures at MAE and MCEER, while PEER welcomed two students for lectures from each of these centers as well. In Year 7, Kevin Mackie (UC Berkeley) will give a presentation of his work on fragility and performance-based seismic design of bridges at Georgia Tech on April 16 and Bryant Nielson (Georgia Tech) will give his talk on April 23 at UC Berkeley. Georgia Tech will be able to broadcast Kevin Mackie's presentation on the Internet. The program provides valuable speaking opportunities for advanced students and exposes research among the three centers in ways that would not otherwise occur.



### 3.2.1.8 *Learning with LEGO Program*

The ***Learning with LEGO Program*** was inspired by a campus initiative at UC Irvine that brought over 800 K-12 students from socio-economically disadvantaged areas to the campus for an open house and shake-table demonstration in Spring 2000. One might think that seismic simulation is a topic only for advanced graduate students, but it has caught the attention of these younger students as well. The event pitted local elementary, middle and high schools against one another for the honor of having the best seismic designs. The LEGO structures were tested on one of PEER's major earthquake simulators housed in the UCI Structural Engineering Test

Hall. The event has been repeated each year, currently under the leadership of Tara Hutchinson, PEER Education Committee member from UC Irvine. The success of this event has been the catalyst for this type of K-12 outreach at other PEER Universities (UCSD, UCB), as well as the Undergraduate Shake Table Competition. A short documentary on this and other K-12 outreach activities is available at <http://peer.ucsd.edu>.

#### *3.2.1.9 PEER Professional Fellowship Program*

The ***PEER Professional Fellowship Program*** is aimed at increasing contacts between our students and practicing professionals. Though started on an informal basis, our first formal PEER Professional Fellow was Maury Power of Geomatrix Consultants in 2002. Another of our Professional Fellows for Year 6 was William Holmes of Rutherford & Chekene, who gave a lecture on “Staying Active in the Profession after Graduation.” In addition to the lecture, Mr. Holmes will have lunch with members of the EERI Student Chapter and meet with graduate students to discuss their research. As a leading practitioner who is very involved in PEER, EERC, and code committee development, Mr. Holmes will be a superb role model for our PEER students. In March 2004, Norm Abrahamson visited UC Davis for a one day meeting with students and made a presentation on Probabilistic Seismic Hazard Analysis. More Professional Fellowship awards are expected to be granted in 2004.

### ***3.2.2 Curriculum Innovations and Tools***

PEER has encouraged and coordinated several curriculum development activities, including the following.

#### *3.2.2.1 Teaching Modules for Graduate Students*

Initiated as a Tri-Center activity, this project has created a series of graduate-level, self-contained, web-based, teaching modules. The modules include materials on various subjects and may be shared by a variety of academic institutions that do not have resident expertise in specialized subjects pertaining to earthquake engineering. The modules consist of written text, specifications for experiments, visual materials and supplementary web information. Modules have been commissioned for the following areas: *Fluid Structure Interaction, Wave Propagation, Earthquake Engineering Design, Seismic Ground Motion and Hazard, Seismic Upgrading: A PBE Case Study, Seismic Behavior of Timber Structures, Earthquake Resistant Design, Liquefaction, Socioeconomic Aspects of Earthquakes, Putting a Face on Earthquakes: The Human Side of Earthquake Disasters, and Seismic Design of Diaphragms, Chords and Collectors*. In the early phases of this program, each center was to produce at least one module per year on different aspects of earthquake engineering and hazard-related studies. An inter-center task force of faculty and professional earthquake engineers selects the module topics in consultation with the other two centers. SLC input has been solicited during the beta-testing of each module. Currently many of the modules are being evaluated and distributed for use. Three modules are currently posted on the PEER Education Website for use by the public: [Wave Propagation](#), [Earthquake Resistant Design](#), and [Interactive Web-Based Learning Modules for Seismic Behavior of Timber Structures](#). The three EERC Education Directors have plans to place all earthquake modules on a common website.

#### *3.2.2.2 Instructional Earthquake Simulators*

In an effort to increase students’ knowledge of earthquake engineering through hands-on

experiments, the three EERCs have organized a program for deployment of small earthquake simulators specifically designed for use in a classroom setting. Twenty-three institutions drawn from the three EERCs cooperated in the design of a bench-scale shake table. The initial acquisition was partially supported by an NSF grant and other private funding and has grown to a consortium of over 40 institutions known as *University Consortium for Instructional Shake Tables* (UCIST). The equipment is used to integrate earthquake engineering into the undergraduate curriculum. Classroom demonstrations and “hands-on” experiments are conducted at all levels in order to have a significant impact on the curriculum. In addition, the shake tables are displayed and demonstrated at public awareness events, including: state fairs, primary and secondary schools, and local community disaster preparedness programs. In Year 6 (and beyond), the SLCs from the three centers will develop plans for two nationwide competitions in earthquake resistant design, one for undergraduates and one for elementary school children. Also in Year 6, these mini-shake tables were used by middle-school students and teachers through PEER’s RET program for demonstrations and for carrying out experiments for science fair projects. These tables will also be used for the Undergraduate Shake Table Competition being organized by our SLC.

### 3.2.2.3 Curriculum Changes from PEER Activities

PEER is seeking ways to incorporate its research activities into our earthquake engineering curricula. Some classes directly utilize the Graduate Course Modules developed in previous years, while many others are incorporating PEER research results into the lectures and assignments in a less formal way. Two examples of classes that have been significantly and positively impacted by PEER research are described below.

- **Earthquake Resistant Design of Structures (CE 227)** is a major component of the graduate curriculum at UC Berkeley attended by 40-60 graduate students and visiting scholars. The curriculum for this course has changed significantly in the past five years because of activities within PEER. An online course module was developed by PEER covering many aspects of the course, including the PEER PBEE methodology. In addition to containing course-related notes, the module contains a number of Java applets that allow students to rapidly assess the characteristics of ground motions they would expect at a site, and the effects of differing amounts and types of nonlinearity of structural response. In addition to facilitating the underlying complex computations, these applets allow students to do a lot more “what if” type comparisons so that they begin to develop a better intuitive understanding of the effects of ground motions on structures. In this regard, a computer program BISPEC, partially funded by PEER, has been extensively utilized in class. This program simulates the inelastic response of simple structural systems to up to two horizontal components of ground motion. With its rich graphical interface, students conduct a large number of nonlinear dynamic analyses to assess the effects of various factors such as strength, stiffness, viscous damping, shape of hysteretic loops, geometric nonlinearities, and so on, and develop design response spectra considering the methodologies being developed by PEER. The PEER ground motion database is used extensively in completing classroom assignments. Lastly, numerous examples of structural response of more complex systems are presented in the course based on results obtained using the PEER-developed OpenSees computational framework. In completing the final design project for the course, a number of students use OpenSees to carry out their analyses.
- **Case Studies in Seismic Design (Architecture 259X)** is a new course (Spring 2003) in the

Department of Architecture at UC Berkeley. It takes advantage of the campus retrofit program and the PEER Center's studies of PBEE. The class has a mix of students from Architecture and Civil Engineering. The class introduces the students to performance design principles and requires that each student undertake a case study of the retrofit design of one of the UC campus buildings. The students are investigating the history of the campus program in terms of campus policy and design precedents. In addition, for each case study, they review the design goals, performance objectives, and methods of retrofitting a major building. Collectively, the student work will be the basis for a guide to the seismic retrofit program on the Berkeley campus, in anticipation of the 100-year anniversary of the 1906 earthquake.

### 3.3 Progress on Future Plans

In the Year 6 Annual Report, we listed several specific plans for the future of the PEER Education Program. Here the plans are reviewed and progress noted. Some of the most significant advances that the PEER Education Program has delivered from the center's inception stem from two fundamental themes:

- a) Development of an instructional and research environment within PEER that provides a natural growth for a student's interest in all aspects of earthquake engineering through a variety of undergraduate and graduate student opportunities.
- b) Cooperative efforts with the MAE and MCEER Education programs.

PEER has promoted a student-friendly environment. The development of a *PEER student culture* has been evident and has encouraged Summer Interns to become Earthquake Engineering Scholars who, in turn, have become active participants in the Student Leadership Council as well as graduate researchers and faculty members. The PEER Center Director has been a staunch supporter of these student programs, and has provided a direct and sincere communication link to the students through the Student Leadership Council and Student Association. Support of PEER's student-friendly environment will continue to be one of our primary goals.

The intra-university and inter-university networking opportunities provided for students by PEER are leveraged with the cooperative programs established with MAE and MCEER, creating academic and social relationships across center boundaries. The cooperative efforts of the three EERCs have provided an environment enabling the students to jump-start their professional contacts – among themselves, EERC faculty, and industry representatives – sooner than those students who have not participated in the EERCs.

In Year 7 and beyond, the PEER Education program intends to continue those programs that have served the students well, including *PEER Summer Intern Programs, Earthquake Engineering Scholars Course, REU Program (including Symposium for Young Researchers), Student Leadership Council, the PEER Professional Fellowship, Tri-Center Doctoral Student Exchange, and the Tri-Center Earthquake Field Study.*

While we have implemented several new programs in the recent past, and are busy supporting those, we still are interested in pursuing additional new programs in the near future such as:

- ***Undergraduate Shake Table Competition:*** We are constantly looking for new ways to use our UCIST Shake Tables. Last year we proposed starting an Undergraduate Shake Table Competition, and this year, it is a reality. Ultimately, this will involve teams from several universities building earthquake-resistant structures within specified constraints. The

competition would begin within each EERC, and culminate in a Tri-Center Competition. Our first trial run is culminating in the “shake-off” at the NSF Site Visit in May 2004. We are already making plans to expand the program to the other EERC’s next year.

- ***Earthquake Education Series on UCTV:*** PEER is continuing work with UCTV on developing an Earthquake Education Series that would combine on-demand video and narrowcasting from the PEER Education Website, together with broadcasting on UCTV via satellite to reach a broader audience. The pilot for this series is completed and has been broadcast several times in the greater San Diego area, and is available online at <http://peer.ucsd.edu>. The series would consist of up to six short documentaries on PEER Interns and Graduate Students working on Earthquake Engineering research, as well as short video clips of PEER faculty explaining key issues and concepts in Earthquake Engineering. It is anticipated that funding for this effort would take the form of an NSF Informal Science Education Supplement. While originally planned as a PEER activity, the three EERC Education Directors have discussed making this another Tri-Center Collaboration.
- ***Curriculum Changes from PEER Activities:*** PEER aims to facilitate the incorporation of research results into our earthquake engineering curriculum. Some current curriculum developments have already been described. The Education Committee will be evaluating ways of accelerating this process, though we find that faculty on their own are making Performance Based Earthquake Engineering an integral part of many upper-division and graduate classes.
- ***Increased diversity in student programs:*** PEER has aimed to increase the diversity of students involved in earthquake engineering, but had not succeeded to the degree that it would like in the past. We now appear to be making progress. This year for the first time, we have added “Overcoming Adversity” in addition to Academic Preparation, as criteria for our PEER Summer and REU Internships. We have also increased our efforts at increasing the awareness of PEER Programs to traditionally underrepresented groups and undergraduate students in general. Examples include directly E-mailing ASCE Student Chapters at universities serving under-represented populations, and sponsoring an information table at a statewide Undergraduate Research Symposium sponsored by the Louis Stokes California Alliance for Minority Participation held at UC Irvine in February 2004. These efforts seem to be making a difference. We have twice the number of internship application as previous years, as well as a diverse applicant pool. We plan to continue these efforts with the Year 8 Earthquake Engineering Scholars Course, including overcoming adversity as a selection criteria, as well as making more space available to students outside the PEER Core Universities.
- ***Increased Undergraduate Involvement in Research:*** Increasing undergraduate student involvement is an ongoing goal for PEER. We were successful in Year 6 by adding several \$5,000 academic year internships for any researcher. The increased awareness of PEER by undergraduates is evidenced by the sharp increase in applications for our internship programs. We are also increasing undergraduate participation by including them in the site visits by the PEER Professional Fellows.

*For a list of faculty involved in the Education Program, please refer to Chapter 5, Table 5.2.*