Final Project Summary — PEER Lifelines Program

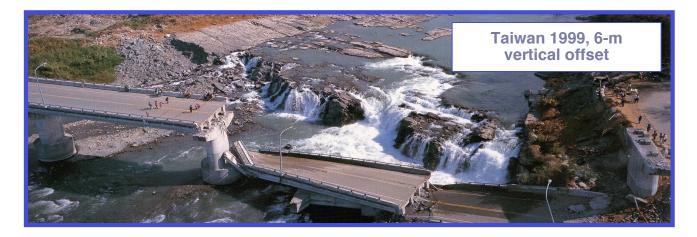| Project Title—ID Number	Surface Fault Rupture Design Models: Statewide Mapping Products—1J03		
Start/End Dates	2/1/02 – 6/30/04	Budget/ Funding Source	$50,000 / Caltrans
Project Leader (boldface) and Other Team Members	**Wills (CDMG)**		

1. Project goals and objectives

The overall goal of the 1J project series is the development of improved design-oriented conditional probability models needed for estimating fault rupture hazard within either a deterministic or probabilistic framework, and implementing them both in spreadsheet form and as trial fault rupture hazard maps. The model is structured to yield rupture hazard as a function of earthquake parameters, distance from mapped fault, and footprint area of a facility. The model was developed in close coordination with technical experts in the field, and periodically reviewed by additional experts representing the user community.

2. Benefits of the results of this project to develop technologies and protocols to mitigate the vulnerability of electric systems and other lifelines to damage directly and indirectly caused by earthquakes. Also, benefits to develop assessment techniques to evaluate damage to electric systems caused by earthquakes and to assess fiscal impacts due to the loss of electric service to the community.

Surface fault rupture can be highly damaging to extended infrastructure systems as evidenced by bridge and pipeline damage in the recent Turkey and Taiwan earthquakes. This project developed improved design-oriented models and maps for estimating surface fault rupture hazard. This tool will provide lifeline organizations with the information needed to better site and/or design important facilities near faults.

Turkey 1999, 3-m horizontal Offset

Taiwan 1999, 6-m vertical offset

3. Brief description of the accomplishments of the project
For this project we utilized a database of fault rupture and displacement developed under project 1J01 to develop a model for calculating the probability of fault displacement. We assembled advisory panels to direct the work and suggest both the form of the analysis and the use of the resulting program. We have used the model to calculate the probability of fault displacement for example locations and prepare maps showing fault displacement hazard.

4. Describe any instances where you are aware that your results have been used in industry
None at this time. As part of this project we have developed example analyses for "real world" problems, but use in industry probably won't occur until the final report is completed.

5. Methodology employed
We have developed empirical equations relating the amount of surface displacement to earthquake magnitude and distance from fault, considering how the fault trace was mapped prior to the earthquake and the complexity of the fault trace. This can be incorporated with the probabilities of earthquakes of different magnitudes from a probabilistic seismic hazard analysis and the probability that an earthquake will rupture the ground surface, from global statistics, to calculate the displacement hazard given distance from a fault and information about that fault.

6. Other related work conducted within and/or outside PEER
Project 1J01 and 1J02, by the U.S. Geological Survey in Golden, CO and Menlo Park, CA, were coordinated with this project and the three effectively functioned as one project.

7. Recommendations for the future work: what do you think should be done next?
The analysis developed in this project could be extended by developing similar equations for thrust fault earthquakes. We were not able to obtain data for the ChiChi, Taiwan earthquake in satisfactory form to use in this project, and data for other thrust fault earthquakes was not available.

8. Author(s), Title, and Date for the final report for this project
Not yet completed. 2 interim reports have been published:

Mark Petersen, Tianqing Cao, Tim Dawson, Arthur Frankel, Chris Wills, and David Schwartz: Mapping Fault Rupture Hazard for Strike-Slip Earthquakes, 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada

Mark Petersen, Tianqing Cao, Tim Dawson, Arthur Frankel, Chris Wills, and David Schwartz: Mapping Fault Rupture Hazard for Strike-Slip Earthquakes, American Society of Civil Engineers, GeoTrans 2004 Conference, Universal City, California