Final Project Summary — PEER Lifelines Program

Project Title—**ID Number**	*Database for 1999 Chi-Chi (Taiwan) Earthquake*—**1E04**		
Start/End Dates	1/1/01 – 12/31/01	Budget/ Funding Source	$60,000 / Caltrans
Project Leader (boldface) and Other Team Members	**Kiremidjian (Stanford)**		

1. Project goals and objectives

The purpose of this proposal is to select and process at least 20 large aftershocks (M>4) at 20 or more well recorded stations form the September 20, 1999 Chi-Chi (Taiwan) earthquake. The recordings will result in a database that will augment the existing strong motion database currently available from the main shock of that event.

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.

The aftershock database represents the first such database for a major earthquake. Since the aftershocks were also of significant size, the database combined with the mainshock database can provide the opportunity for a variety of ground motion studies. These include various directivity affects, local soil effects, ground motion propagation effects among the many. Correlations between mainshock and aftershock ground motions can also be investigated – something that has never been studied, but can have serious implications for building performance in large earthquakes followed by significant aftershocks.

3. Brief description of the accomplishments of the project

The strong motion data for 33 aftershocks from the 1991 Chi-Chi, Taiwan earthquakes were processed and synthesized in a database. A total of 3,153 strong motion records including 5 aftershocks with magnitude greater than 6 and 9 aftershocks with magnitude greater than 5. Of these, 400 records were rejected due to dead component trace, belated triggering or 12-bit accelerographs, a total of 2,753 acceptable strong motion records were obtained. They are organized in a set of two CD-ROMs. The CD's also contain software that makes it easy to search the database and retrieve strong motions according to magnitudes, component direction and record number. Included in the database is also information on each aftershock for subsequent referral. The CD-ROMs are available upon request. A report describing the strong motion database was also published.

4. Describe any instances where you are aware that your results have been used in industry

This database is now available as part of the general ground motion database that can be used in site specific ground motion estimation. We are not aware of specific instances where these ground motions may have been used in practice.

5. Methodology employed

The following steps were used in the development of the database:

1. *Initial processing:* All records were converted into the same format called PC-SUDS and errors in the header information were corrected.

2. *Time correction and file association with an earthquake:* Most Taiwan Central Bureau (CWB) accelerographs did not have accurate GPS time synchronization, and their internal clocks night have been manually set incorrectly and/or drifted substantially over time. Lee et al. (2001a) procedure was used to correct the timing of records to at most 2 seconds for stations within 100 km.
3. *Quality assurance*: An interactive program called SMQC by Dodge and Lee (2000) was used to perform quality assurance of the associated strong-motion data files for a given earthquake. An analyst verifies that the predicted P and S arrival times are agreeable with the actual observed arrivals, DC-offsets are removed, spikes (if present) are removed, and any unusual appearance of the recorded accelerograms is noted.
4. *Final processing*: Strong-motion records are then plotted and visually inspected. Any records with defects (e.g. triggered late, or recording has defects, or timing is uncertain) are rejected. The remaining records are placed in a file under sub-directory called SUDfiles.
5. *ASCII files*: Readable ASCII text files corresponding to those under the sub-directory SUDfiles are created using the SUD2ASC program. These ASCII text files are placed under the sub-directory call ASCfiles.
6. *Auxiliary information*: A station map showing the location of the accelerographs with acceptable records is plotted along with the location of the aftershocks. In addition, two tables of station information are generated to aid the users with the selection of the data files: one table is listed according to increasing epicentral distance, and the other is alphabetical by station name.

6. Other related work conducted within and/or outside PEER

N/A

7. Recommendations for the future work: what do you think should be done next?

Conduct extensive correlation studies on the mainshock-aftershock data from these databases; investigate phase angle and directivity effects; develop complete Fourier transform information for ground motions simulation purposes …

8. Author(s), Title, and Date for the final report for this project

Lee, W. H. K., Lai, J. and Kiremidjian, A. S., "Development of Aftershock Strong-Motion Database for the 1999 Chi-Chi (Taiwan) Earthquake", Final Report with Processed Data flies for 33 Aftershocks on Two CD-ROMs, The John A. Blume Earthquake Engineering Center, Stanford University, Stanford, California, August 26, 2001.