Final Project Summary — PEER Lifelines Program

Project Title—ID Number	*Examining Site Response issues for NGA—***2M01**		
Start/End Dates	8/1/03 – 6/30/04	**Budget/ Funding Source**	$59,570 / Caltrans
Project Leader (boldface) and Other Team Members	**Wang (Geomatrix)**		

1. Project goals and objectives
The issues to be examined in the study: 1) Comparison of RASCAL against SHAKE (both equivalent-linear soil models); 2) Comparison of SHAKE against non-linear codes (SUMDES and D-MOD2); 3) selection of typical dynamic properties and profiles for the analyses; 4) selection of typical ground motion sets;

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.
This project will support the Next Generation Attenuation (NGA) project (lifeline) in resolving the modeling issues that will be used to develop the site amplification functions needed by NGA attenuation relationship developers in their regression analyses of empirical ground motion data.

3. Brief description of the accomplishments of the project
1. Typical sites, geophysical measurements, dynamic soil properties were reviewed and selected; 2. Two sets of earthquake records (30 records for each of two magnitudes) were selected, spectral matched and used in the study; 3. RASCAL and SHAKE results were compared for two magnitudes and three soil profiles in terms of amplification functions and surface response spectra; 4. Two non-linear codes (SUMDES and D-MOD2) were revised (SUMDES) and evaluated (D-MOD2); 5. Non-linear results were computed using the two codes for selected records and compared with SHAKE results for two earthquake magnitudes and two soil profiles.

4. Describe any instances where you are aware that your results have been used in industry
Results from this project have not been used in industry so far. We have not published this project results.

5. Methodology employed
RASCAL uses random vibration theory, SHAKE uses frequency domain solutions, non-linear codes use time domain integration. Equivalent linear model is used in RASCAL and SHAKE. Bounding Surface Plasticity model is used in SUMDES. Modified hyperbolic model is used in D-MOD2. Results are compared at average levels from multi-input motions (30 records for each of two earthquake magnitudes).

6. Other related work conducted within and/or outside PEER
In Geomatrix, non-linear (as well as equivalent linear) response and deformation (including liquefaction) analyses are used in our project work. A number of projects have been performed using the nonlinear constitutive model (Wang et al., 1990) that is implemented in the SUMDES code, and a two dimensional program FLAC.

7. Recommendations for the future work: what do you think should be done next?
More detailed and critical evaluation should be done to identify the cases where the non-linear approach is more appropriate than the conventional equivalent linear approach. In addition, rational and practical non-linear codes should be identified and recommended to the industry.

8. <u>Author(s), Title, and Date</u> for the final report for this project
Final report has not been completed.

Top figure labels:

Mw 6.5, Med. Deep Profile - 300 ft
Input PGA=0.2g
Average Ground Surface Response
SHAKE
RASCAL
SUMDES
D-MOD

Y-axis: Spectral Pseudo-Acceleration (g)
X-axis: Period (sec)

Bottom figure labels:

Mw 7.5, Med. Deep Profile - 300 ft
Input PGA=0.5g
Average Ground Surface Response
SHAKE
RASCAL
SUMDES
D-MOD

Y-axis: Spectral Pseudo-Acceleration (g)