FY 07/08 Research Initial Scope of Work

I. Project Title: **S102**

Propagating Vertical Ground Motion up to the Ground Surface

II. Background:

Every large bridge project needs ground motion in three orthogonal directions to excite the structure. Currently, the vertical component of this ground motion is wrong and frequently too high because geotechnical engineers do not know how to propagate vertical ground motion to the surface. The software program 'SHAKE' and other software are routinely used to propagate lateral ground motion, but vertical ground motion is poorly understood and hard to model.

III. Project Problem Statement:

Based on current lateral ground models, estimates of vertical ground motion at the ground surface are too high. Geotechnical engineers currently are using the bedrock values for vertical ground motion at the ground surface or are assuming that vertical motion propagates through the soil column in the same manner as the lateral motions, resulting in unreasonable vertical ground motions demands on our bridges. Research is required to determine how vertical ground motion is propagated upward through the soil.

IV. Objective:

The objective of this research is to determine how vertical ground motion propagates upward through the soil.

V. Description of Work and Expected Deliverables:

The steps includes:

1. Study records from down-hole arrays to see how vertical ground motion increases or decreases for different periods as it moves upward.
2. Create models of the soil surrounding the down-hole arrays.
3. Excite these models with the ground motion recorded at the bottom of the arrays.
4. Obtain the best fit between the recorded data and the results from the analysis by modifying the parameters of the soil models.
5. Use the results from this parameter study to provide tools and procedures to routinely obtain vertical ground motion at the ground surface.

VI. Estimate of Duration:

20 months

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VII. Related Research:

1. Elgamel, A., (2004). "Vertical Earthquake Ground Motion Records: An Overview," Journal of Earthquake Engineering. Vol. 8, no. 5, pp. 663-697.
2. Taniguchi, T. (2004). "Coincident Vertical Response Analysis of Structure at Maximum Horizontal Response," 13th World Conference on Earthquake Engineering Conference Proceedings.
3. Lopez, O. (2004). "Structural Design for Multi-Component Seismic Motion," 13th World Conference on Earthquake
4. Borzognia, Y. (2004). "The Vertical-to-Horizontal Response Spectral Ratio and Tentative Procedures for Developing Simplified V/H and Vertical Design Spectra," Journal of Earthquake Engineering. Vol. 8, no. 2, pp. 175-207.
5. Campbell, K. (2003). "Updated Near-Source Ground-Motion (Attenuation) Relations for the Horizontal and Vertical Components of Peak Ground Acceleration and Acceleration Response Spectra," Bulletin of the Seismological Society of America. Vol. 93, no. 1, pp. 314-331.
6. Elnashia, A. (2001). "A Procedure For Combining Vertical And Horizontal Seismic Action Effects," Journal of Earthquake Engineering. Vol. 5, no. 4, pp. 521-539.
7. Yang, J. (2000). "Interpretation of Seismic Vertical Amplification Observed at an Array Site," Bulletin of the Seismological Society of America. Vol. 90, no. 2, pp. 275-285.
8. Bourzognia, Y. (2000). "Observed Spectral Characteristics of Vertical Ground Motion Recorded during Worldwide Earthquakes from 1957 to 1995," 12th World Conference on Earthquake Engineering [Proceedings] [computer file]; 2000.

VIII. Deployment Potential:

This research should provide recommended revisions to the Caltrans Seismic Design Criteria and/or the AASHTO LRFD Seismic Guide Specifications.

IX. Date: July 18, 2007