Seismic Microzonation for Las Vegas: Shallow Soils Effects

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Barbara Luke[1], Ph.D., P.E., Civil and Environmental Engineering, University of Nevada Las Vegas
Wanda Taylor, Ph.D., Geoscience Department, University of Nevada Las Vegas
John Louie, Ph.D., Nevada Seismological Laboratory

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Project overview/scope:
The Las Vegas basin exhibits anomalous responses to ground shaking. Amplitude and duration of shaking are lower on the valley margins and higher in the mid-basin. The anomalous response appears to be correlated to the structural geometry of the basin. Another important factor is the constitution of the shallow sediments. In general, sediments grade from coarse on the basin margins to fine in its center. We propose to enhance understanding of the potential for anomalous shaking in the Las Vegas valley by characterizing the shear stiffness of key sites. We will use this information to (1) develop geographical and geological correlations to enhance microzonation of seismic response and (2) perform one-dimensional equivalent-linear ground response analyses to determine the extent to which shallow sediments contribute to anomalous response. This project will have broader impact due to complementary funding by Lawrence Livermore National Laboratory.

Work Plan summary:
We will generate shear wave velocity profiles at several sites in Las Vegas valley using SASW and ReMi methods. Test locations will be selected to best support delineation and characterization of earthquake microzones. Wanda Taylor (UNLV Geoscience) will assist in correlating results with sediment types to enhance microzonation. John Louie (UNR Seismological Laboratory) will assist in interpreting datasets collected by the ReMi method. We will perform one-dimensional equivalent-linear seismic response analyses using the measured soil profiles and measured earthquake ground motions modified using appropriate scaling and attenuation relationships to project acceleration response spectra and illustrate amplitude of local variation attributable to the shallow sediments.

Justification/Benefit:
The project will improve our understanding of causes as well as magnitude of variability of earthquake ground motions across the Las Vegas valley. This is important because of the tremendous seismic risk in our heavily populated valley, and because the seismic hazard is poorly understood. This project is particularly timely as we re-evaluate our building codes. In some conditions and locales, we might find that requirements must be increased to ensure public safety.

Outcomes:
The research was conducted primarily by Graduate Research Assistant Ying Liu, with advice and assistance of the Principal Investigators. Results show that the seismic response in the Las Vegas valley can be partitioned according to predominant sediment type in the upper 30 m. In his dissertation research, Mr. Liu showed that much of the lowest-lying parts of the basin are predominately clay, and these areas show the highest amplification potential. This work is included

[1] (702) 895-1568; bluke@ce.unlv.edu

in his dissertation, scheduled for defense this month. Publications that resulted in part from the funded research are listed below. The funded research has sparked follow-on work by other graduate students, under complementary funding. Ms. Helena Murvosh is expanding the velocity database for the valley and building a more detailed 3-D model of shallow velocities, and Ms. Qiuhong Su is creating a first-generation urban seismic hazard map for the Las Vegas area.

Publications and presentations resulting directly or indirectly from the funded research

Y. Liu, B. Luke, S. Pullammanappallil, J. Louie, and J. Bay, 2005, "Combining active- and passive-source measurements to profile shear wave velocities for seismic microzonation," Earthquake Engineering and Soil Dynamics, ASCE Geotechnical Special Publication (GSP) 133, R. W. Boulanger, M. Dewwolkar, N. Gucunski, C. Juang, M. Kalinski, S. Kramer, M. Manzari and J. Pauschke, Eds., 14 pp.

B. Luke, W. Taylor, Y,. Liu, 2005. "Dynamic and lithologic cues for site amplification in the Las Vegas Valley," *Program with Abstracts*, Association of Engineering Geologists, p. 75.

H. Murvosh, B. Luke, W. J. Taylor, Y. Liu, X. Jin, 2006, "Characterizing shallow shear wave velocities in fabulous Las Vegas: Processes and site selections," *Proceedings*, Symposium on the Application of Geophysics to Engineering and Environmental Problems, Environmental and Engineering Geophysical Society, Denver. CD-ROM P-180, 9 pp.

B. Luke, W. Taylor, Y. Liu, J. Wagoner, Q. Su, 2006, "Correlating a sparse seismic data set with lithology for site amplification investigations," Invited paper, Second International Conference on Environmental and Engineering Geophysics, Wuhan, China, June. In press.