Seismic maximum acceleration estimates in Lima city based on macroseismal intensity data of the 1974 8.1-Mw earthquake

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Knowledge of maximum seismic acceleration spatial distribution in an urban area due to a destructive-earthquake shaking is important for territorial planning and use, urban development, risk management, implementation of disaster prevention measures, community emergency preparedness and other applications. This goal is achieved through a seismically microzoning of urban areas for realistic strong motion estimates, either through a comprehensive geophysical-geotechnical ground survey and appropriate numerical modeling, or having as many as possible seismic strong motion instruments recording a strong and destructive earthquake. In both cases, significant financing and time is required. However, if a destructive earthquake strikes an urban area, a preliminary ground response can be attained through a systematic macroseismal effects observations and a careful severity ground shaking rating, when no such strong motion network exists. This kind of experiment we report in this paper.

The last earthquake that severely shook the City of Lima happened on October 3, 1974. It was an 8.1-Mw magnitude subduction earthquake. The event was located at Lat. 12.24^{o} S, Lon. 77.58^{o} W and 27 km of depth. The city of Lima is $\sim$90 km from the epicenter. Soon after the occurrence of the event, the IGP, with the assistance of a scientific mission of the USGS, organized a systematic survey of the effects of this earthquake on popular-built environment. The field data was interpreted by IGP's personnel under Dr. E. Silgado's supervision. A total of $\sim$500 data points were analyzed. The shaking severity of this quake ranged between 4- and 9-MM degrees.

A mathematical relationship has been derived based on physical principles of the intensity of a wave propagation in an homogeneous and isotropic media considering a harmonic traveling wave of a given frequency. The final mathematical expression is a function of the wave acoustic impedance, the frequency- and amplitude-squared of the ground motion. We define a microseismic intensity scale as the logarithm of the quantity of seismic energy which flows through a unit area normal to the direction of wave propagation in the unit time. When the quantity of seismic energy is expressed as a function of the ground acceleration, the macroseismic intensity rating and the logarithm of the acceleration are linearly related. The intercept term, depends on the acoustical impedance of the media. When the constant factors of this functional are evaluated from the maximum values of acceleration of past earthquakes recorded at

IGP-USGS strong motion station and the macroseismal intensity of the site, the results are consistent with the values obtained from the mathematical functional. We use this fact to estimate the maximum acceleration from the intensity spatial distribution and the geotechnical data. There is a wealth of geotechnical data from civil works in the City of Lima. The cataloged data of density, shear wave velocity propagation, and/or SPT's are used to compute the acoustical impedance on the observed macroseismal intensity site, and compute the maximum ground acceleration associated with the reported macroseismal intensity value. Preliminary results correlate favorably with the geotechnical zonation of the City of Lima based on ground bearing capacity, and soil amplification of known anomalous areas.