Estimation of site amplification factors in Metropolitan Manila, the Philippines from analysis of strong ground motion records

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Earthquake observation in seismic array has been conducted in Metropolitan Manila, the Philippines for estimation of seismic hazard in the area by our group and PHIVOLCS (Kurita et al., 2000). The 10 stations were deployed with different geological conditions in coastal lowland, central plateau, and Marikina valley. One of the stations is located in mountain area in the east of the area. We used this site as reference site, because basaltic rock can be seen near the surface at this site.

In this study, spectral inversion technique is applied to S-wave spectra observed in the earthquake array to estimate source, path and site effects. We, then, estimated empirical relationships between the estimated site amplification factors and average S-wave velocity of shallow soils. Finally spatial distributions of site amplification factors are mapped using the empirical relations and previous soils model database.

The strong motion data used were obtained in the earthquake stations during 36 events having Mj from 2.7 to 6.8. Totally 189 S-wave spectra were calculated for initial S-wave part with duration of 10 s. Site effects were estimated from spectral inversion technique by Iwata and Irikura (1986). In the analysis, 1D transfer function for the surface soils over the basement at the rock site is used as a constraint condition. It is noted that the S-wave velocity of the basement is 3 km/s at the rock site (Yamanaka et al., 2002).

The Q-value for the propagation path is estimated to be modeled with Q=55fˆ1.1. This value is similar to those obtained from strong motion data in Japan. The source spectra for most of events are approximated with w-squared model in frequency band lower than several Hz. The site effects at the stations in each geological classification show different features. The site amplification at the sites in coastal area and Marikina valley have dominant peaks at frequency of 1 to 3 Hz indicating strong effects of shallow low-velocity soils. On the other hand, the site effects in the central plateau are flat in a wide frequency band. The amplifications at each frequency are compared with average S-wave velocity (Vs30) of soils in top 30 meters. We found that amplifications at frequencies of 1 and 5 Hz well correlated with Vs30 and Vs10. Using the empirical relation between frequency-dependent amplification and average S-wave velocity from existing soil data (JICA, 2004), amplification maps at several frequencies were estimated in the whole Metropolitan Manila area