Empirical Study of Sediment-Filled Basin Response: The Case of Taipei City

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We analyze the site response of the Taipei basin using the records obtained by the Taiwan Strong Ground Motion Instrumentation Program (TSMIP) network. Records of 66 earthquakes of M=2.6-6.5 with a hypocentral depth varying from 1 km to 118 km and hypocentral distances of up to 150 km are studied for 35 stations located within this triangle-shaped alluvium structure. The site response is obtained in terms of spectral ratios calculated by dividing of the site spectrum by the reference spectrum estimated for a hypothetical "very hard rock" site. The recently developed empirical source scaling and attenuation models for the Taiwan region are used for the reference spectra calculation. This approach allows us to evaluate the variability of spectral ratios due to uncertainties introduced by source and propagation path effects and variability in the site response itself. The characteristics of site response in the Taipei basin depend on the properties of soil deposits and, in general, may be described by 1-D models. However, there are some peculiarities of spectral ratios that show the influence of subsurface topography.

INTRODUCTION

It is well understood that near-surface geological conditions strongly influence earthquake ground motion at a particular site, and the building codes used in earthquake-prone countries take into account the effect of local site conditions by using simplified site categories. Recent destructive earthquakes, including the 1985 Michoacan earthquake in Mexico, the 1988 Spitak earthquake in Armenia, the 1989 Loma Prieta and the 1994 Northridge earthquakes in California, and the 1997 Hyogo-Ken Nanbu (Kobe) earthquake in Japan, reveal the necessity to re-evaluate the building code provisions for site effect because the earthquakes were more severe than the provisions allowed for. It is believed that the local site effect is one of the major factors controlling the damage during these events (e.g., Seed et al. 1987, Borcherdt et al. 1989, Hanks and Brady 1991, Stewart et al. 1994, Irikura et al. 1996). Among many factors determining the site response to earthquake ground motion (see, for example, Aki 1988, for review) the influence of laterally irregular geological structures — sediment-filled valley or basin — may play a key role in site amplification and damage distribution (e.g., Yegian et al. 1995, Irikura et al. 1996, and Akamatsu et al. 1998). Many urban areas are situated on deep sediment-filled basins, and therefore the study of the features of basin response is very important to mitigate damage during an earthquake.

Several studies have been devoted to develop models for two- and three-dimensional structures (e.g., Lee 1984, Bard and Bouchon 1985, Bard and Gariel 1986, Sanchez-Sesma et al. 1988, Graves and Clayton 1992, Papageorgiou and Kim 1993, and Rodriguez-Zuniga et al. 1995; see also Bard 1995, for review) and to compare theory and observation (see Kudo 1994, for recent review; Campillo et al. 1988, Papageorgiou and Kim 1991, Hisada et al. 1993, Chavez-Garcia et al. 1995, Irukura et

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