A Study on Characteristics of Long-Period Ground Motion in the Kathmandu Valley during the 2015 Gorkha Nepal earthquake aftershocks

*Michiko Shigefuji[1], Nobuo Takai[2], Subeg Bijukchhen[2], Masayoshi Ichiyanagi[2], Tsutomu Sasatani[2]

1. Kyushu University, 2. Hokkaido University

The Indian Plate underthrusts the Eurasian Plate resulting in occurrence of a number of large earthquakes in the Nepal Himalaya. The Kathmandu Valley is formed by drying of a paleo-lake and consists of thick soft sediment below the center of city. We have installed a strong motion east-west line array observation (four sites; one rock site and three sedimentary sites) in the valley, on 2011, to understand the site effects of the valley. On 25 April 2015, a large M_W 7.8 earthquake occurred along the Himalayan front. The epicenter was near the Gorkha region, 80 km north-west of the Kathmandu Valley, and the rupture propagated eastward from the epicentral region passing through the valley and reached about 80 km north-east of the valley. The aftershock of M_W 6.6 occurred on 25 April 2015 ˜80 km northwest of Kathmandu at epicenter near to that of the main shock. The other three large aftershocks were originated ˜80 km east of Kathmandu; the aftershock of M_W 6.7 occurred on 26 April 2015 and the aftershocks of M_W 7.3 and M_W 6.3 occurred on 12 May 2015. The ensuing aftershock activities are concentrated in the eastern part of the rupture area. After the mainshock, we installed additional four stations on sedimentary sites on 05 May 2015. We discuss the characteristics of long-period ground motion in the Kathmandu Valley based on these strong motion records from large aftershocks (M_W > 6).

The acceleration waveforms at the sedimentary sites are longer and larger than those at the rock site. We checked acceleration Fourier spectra of 40.96 sec of S-wave with rotated acceleration records for each sites and compared between the rock site and other sedimentary sites. In high frequency range (around 0.2 Hz ˜), we can observe the strong amplification factor in each site condition. On the other hand, the amplification are extremely small in low frequency (˜ around 0.2 Hz) on horizontal components, whereas amplitude are almost same on vertical component. In low frequency range, the spectra have peak in 0.1 ˜ 0.2 Hz even in the rock site. Furthermore, the spectral shape on the low frequency range is proportional not to the square but to the cube of frequency. The transition frequency is around 0.2 Hz, but this frequency has small variations by earthquake. Regarding M_W 7.3, M_W 6.3 aftershocks, vertical components semblance analysis show that 0.1 Hz waves are propagated from epicenter with 3 km/sec phase velocity. The particle motion of vertical-radial component shows the retrograde motion which is fundamental Rayleigh wave.

Considering the shape of spectra in low frequency range, we tried to calculate 1-D theoretical waveforms by the discrete wave number method (Takeo, 1985) with 1-D velocity structure (Crust1.0; Laske *et al.*, 2013) and GCMT source mechanism. By this simulation, the surface waves are contained in the analyzed time window; Rayleigh and Love waves which have 0.1 Hz power reached just after direct S-wave initial motion. Therefore, we understood that the shape of the low frequency range are affected by these surface waves.

Spectral ratios of the sedimentary sites to rock site have different dominant frequency (0.2 ˜ 0.8 Hz) and amplitude at each sites. These differences of the spectral shape in closed area speculate the complexity

of the basin structure. The predominant frequencies of the spectra could be roughly explained by theoretical response based on 1-D structures made with geological data and gravity anomaly data (Bijukchhen *et al.*, 2016).

During examination of long period motion on large aftershocks, the characteristics are strongly affected by surface wave. We will study the excitation and propagation of surface wave of the Kathmandu basin extensively, try to examine the amplification characteristics quantitatively, and construct the velocity structure of each site in detail.

Keywords: The 2015 Gorkha Nepal earthquake aftershocks, Kathmandu Valley, Long-Period Ground Motion

