E04

Site Effect Analysis of Shallow Subsurface Structures at Mashiki Town, Kumamoto, Based on Microtremor Horizontal-to-Vertical Spectral Ratios

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1. Introduction

The 2016 Kumamoto earthquake sequence included a main-shock with M_{JMA} of 7.1 on April 16, 2016. According to field survey result of Kawase et al. in 2016, there’s a Damage Concentrated Area (DCA) in Mashiki Town along Azumi river. Simultaneously, Kawase pointed out that effect of EW direction was stronger than the NS direction. In the main-shock, it appeared spatial differences in ground motion which may have caused the damage distribution in Mashiki. In this research we conducted microtremor observation in this area to verify stratum of DCA area (Figure 1).

Figure 1, observation sites of microtremor in DCA of Mashiki Town

Recently, a new research method of the diffuse field concept (DFC) to Earthquake Horizontal-to-Vertical spectra ratios (EHVRs) has been proposed by Kawase et al. (2011). But, as it is difficult to get enough earthquake waves at one area, Kawase et al. (2018) proposed the Earthquake-to-Microtremor spectra ratios (EMR) transfer method, which can be used to transfer Microtremor Hovizontal-to-Vertical Spectra ratios (MHVRs) to EHVRs. They called the calculated EHVR of EMR method as pseudo Earthquake HVR (pEHVR). In this research, we want to check whether this new method will be suitable in Kumamoto.

2. Empirical EMR and analysis results

The comparisons between EHVRs and MHVRs show that they are more or less similar untile the fundamental peak frequency but that they are significantly different in the frequency range higher than that. Kawase et al. has found a significant but a common trend between EHVRs and MHVRS in their observation sites. They obtained the EMR with the following equation

EMR=earthquake HVR/microtramor HVR (1)

They classified empirical EMR into 5 categories (Figure 2) based on the fundamental peak frequency (0.1-20Hz). With equation (1), we can get EHVR of every observation site once we get their MHVR. Here we showed the EMR and one analysis result (Figure 3) with this method.

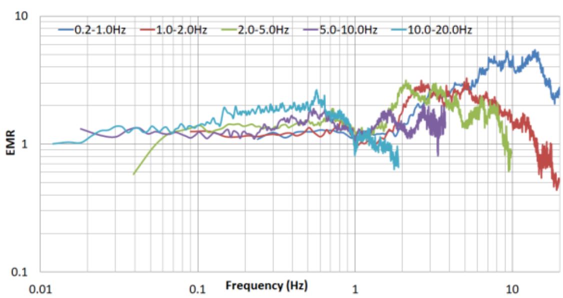

Figure 2, dark blue line is from 0.2Hz to 1.0 Hz; red line is from 1.0Hz to 2.0Hz; green line is from 2.0Hz to 5.0 Hz; purple line is

from 5.0 Hz to 10.0 Hz; light blue line is from 10.0 Hz to 20.0 Hz.

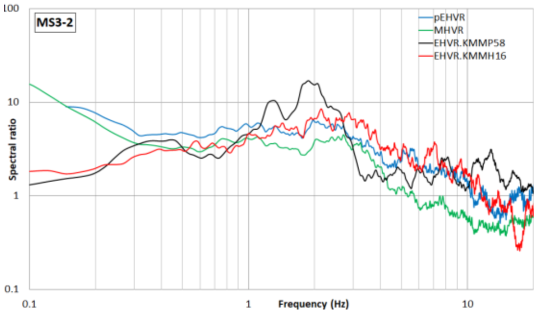

Figure 3, red line is EHVR of KMMH16, black line is EHVR of Mashiki Town Hull, blue line is pseudo EHVR, green line is MHVR.

3. Shear wave velocity structure estimation

We identified Vs structures with inversion method which was proposed by Nagashma et al. (2014). In this part, we have three steps.

First, we get the boring hole data of KMMH16 (Kik-net site) and J-SHIS model around mashiki area. After that, we did fist-stage calculation of every site and selected 50 best estimated models. Then we calculated their averaged model.

Second, we revised our initial model referenced to first-stage's averaged results. Then we estimated Vs structure of every site without any constraint of both Vs and thickness. Like what we did in the first stage, we get the averaged model of 50 best models.

Third, we kept all the parameters of second-stage's averaged model in the initial model except for thickness and depth. We input thickness and depth in initial model in accord with the best model of every site in second stage. Finally we would get 50 initial models. In this stage, we will remain Vs unchanged and set variation range of thickness as ±80%. Comparing with residual of 10 times' calculation, we would identify subsurface structure of every site after calculating 10 trials of every site.

Here I showed the estimation results of KMMH16 stie (Figure 4).

4. Conclusion

First, pseudo EHVRs are more close to observed EHVR than MHVR. It means the EMR research method was quite suitable to translate MHVR to pEHVR.

Second, Nagashima's research method is quite well to identify the Vs structure of Mashiki Town. Our estimation results can explain underground structures of the observation area.

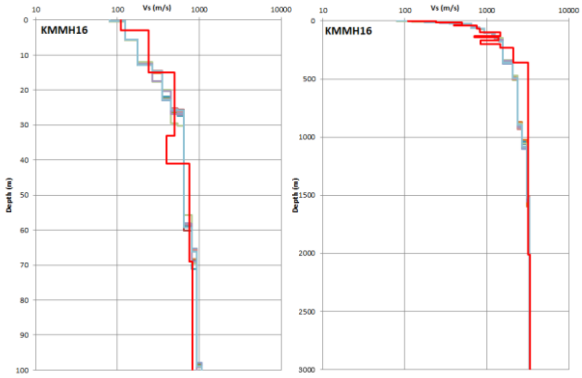

Figure 4, red line is borehole data and J-SHIS model of KMMH16, other lines are simulation results of 10 trials, depth of left figure is 0-100m, depth of right figure is 0-3000m.

Acknowledgments

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Reference

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