SSS33-04 Room:103 Time:May 19 10:00-10:15

A new development in shallow explorations using microtremors based on a practical use of a CCA method

Ikuo Cho[1*], Shigeki Senna[2], Tsutomu Nakazawa[1], Hiroyuki Fujiwara[2]

[1]National Institute of Advanced Industrial Science and Technology, [2]National Research Institute for Earth Science and Disaster Prevention

We have continued development of a CCA method (Centerless Circular Array) for nearly 10 years as a tool to determine phase velocities of Rayleigh waves by using vertical-component microtermor arrays. The initial development was characterized by the applicability of a CCA method to irregular arrays consisting of three seismometers (Cho et al. 2004). Later, we found the potential of a CCA method to deal with a very long-wavelength range relative to an array size (Cho et al., 2006). Recently, we showed that wavelengths more than 100 m are analyzable using miniature arrays having radius less than 1 m, by adopting a CCA method and a noise-compensated CCA method (Cho et al., 2013). This time, we have examined the practical use of a CCA method and its application.

We replaced the cross spectra that are involved in a fundamental equation of a CCA method with coherence functions (Hereafter, we call it a coherence CCA method). A comparison between the analysis results of coherence-SPAC and CCA methods indicated that the coherence CCA method can produce confidential and robust results. In particular, the noise-compensated CCA method for miniature arrays were significantly stabilized by the use of coherences, producing performances much higher than that of the SPAC method. We expect that the use of the coherence CCA method with miniature arrays ($r < 1$ m), together with small irregular arrays consisting of three seismometers ($r < 10$ m) depending on the necessity, enables shallow subsurface explorations (to the depth of about several tens of meters) more practical than ever before, from view points of the mobility of observations, broadness of the analyzable wavelength ranges, and the reliability and robustness of the analysis results.

Incidentally, the amplitudes of microtremors, as well as the phase data by an array analysis, have information on the subsurface structure. A peak frequency of H/V spectra is related to either the thickness or the elastic-wave velocity of a surface soft soil, while the height of the peak is related to the impedance ratio between the soft-soil and basement layers. However, we cannot constrain the depth scale corresponding to the peak of a H/V spectrum due to the tradeoff between the velocity and thickness.

This problem can be solved by conducting a miniature-array observation adjacent to a single-point observation. Obtaining a relation between frequency and wavelength from an array observation, we can apply it to the H/V spectra to obtain a relation between the wavelength and the HV ratio. By using some conversion equation from a wavelength to a depth, we can have a plot of depth vs. H/V ratio. We call a subsurface structure obtainable in this way a H/V structure.

We propose an integrative interpretation of H/V section, together with a pseudo shear-wave velocity section (Ling et al., 2003; Haraguchi, 2010), obtainable by adopting miniature arrays for phase velocities and single-point observations for H/V spectra. Miniature arrays for the CCA method have high mobility and high horizontal resolution owing to the array size. A combination of the CCA and H/V methods enables to obtain more information from microtermors in a easier way than before.

We are planning to increase application examples and to validate the usefulness of the method proposed above. A seismometer JU-215, which was co-developed by the NIED and Hakusan Co. (Senna et al., 2006), is best suited for our purpose from a view point of the portability, the simple handling, and the capacity of providing with high-quality data. Fig. 1 shows H/V and pseudo shear-wave velocity sections along a measurement line about 10 km. The data were obtained by a single researcher, who conducted a two-day observation, including a preliminary inspection, using JU215 seismometers. In the presentation, showing analysis results of the data obtained using JU215 (at Tsukuba, Kashiwa, Urayasu, Itako, ... etc), we will discuss the usefulness and problems of the proposed method.

Keywords: microtremor, velocity structure, surface waves, phase velocity, expolation method, array

SSS33-04 Room:103 Time:May 19 10:00-10:15

Figure 1
Upper : A measurement line at Kashiwa (about 10 km)
Lower : a pseudo shear-wave velocity section (Left) and a H/V section (Right)