Site Classification Method in Microtremor Array Exploration Using a Supervised Machine Learning

*Takumi Hayashida[1]

1. International Institute of Seismology and Earthquake Engineering, Building Research Institute

Seismic wave is amplified in the subsurface soil layers and understanding of the amplification effect is important for the estimation of ground motion characteristics. The average S-wave velocity in the upper 30m (AVS30) has been widely used as a simplified indicator of site classification since the 1980s (e.g. NEHRP site classification). The microtremor array exploration, a method to estimate subsurface S-wave velocity structure using seismic noise recordings, has been used globally as a low-cost and practical tool for site classification. However, recent blind tests show the possibilities of different interpretation for the dataset among analysts (e.g. Yong et al., 2018; Ohori et al., 2018), which could be caused by different ways of preprocessing, parameter selection for data processing, initial model setting for phase-velocity inversion, or by differences of user’ s knowledge and experiences, as well as software for analysis. In this study we propose a way of dealing with the problem, using a machine learning method. Here we test the possibility of site classification with randomly constructed 720 subsurface soil structure models. Each model consists of three layers; the minimum S-wave velocity of the top layer is 100 m/s and the maximum value of the bottom layer is 1,700 m/s. Assuming array radii of 5, 10, 15, and 20 m we derive Bessel functions of the first kind of order zero (i.e. theoretical SPAC coefficients) and characterize each function by extracting frequencies at which the values become 0.5, 0.0, and the minimum value. We employ supervised machine learning methods to the extracted dataset and investigated the possibility of soil type classification. The results show that soil type could be classified well for soil classes B and E, but sometimes show the difficulties for soil classes C and D. On the other hand, when we assume that microtremor array surveys are conducted with two or more different size arrays, the performance has been substantially improved. Our results indicate that the machine learning methods effectively work for interpretation of microtremor exploration and variabilities attributable to analyzers and tools could be reduced.

Keywords: microtremor, SPAC method, supervised machine learning, site classification

