# A method for setting engineering bedrock using records of miniature array microtremor observation in Kanto Area

*Atsushi Wakai[1], Shigeki Senna[1], Kaoru Jin[1], Ikuo Cho[2], Hisanori Matsuyama[3], Hiroyuki Fujiwara[1]

1. National Research Institute for Earth Science and Disaster Resilience, 2. National Institute of Advanced Industrial Science and Technology, 3. OYO

1. Introduction
In order to estimate damage caused by strong ground motions from a mega-thrust earthquake, it is important to improve broadband ground-motion prediction accuracy in wide area. To realize it, it is one of the important challenges to sophisticate subsurface structure models.
On the purpose of precisely reproducing characteristics of seismic ground motions, we have ever collected as many data as possible obtained by boring surveys and microtremor array surveys, and then have modeled subsurface structure from seismic bedrock to ground surface. At present, we are modeling subsurface structure in Kanto and Tokai area in the project conducted by SIP (Cross-ministerial Strategic Innovation Promotion Program), “reinforcement of resilient disaster prevention and mitigation function” of Council for Science, Technology and innovation.
In this study, we attempt to sophisticate shallow subsurface structure models for Kanto area, including Tokyo, where miniature array microtremor surveys have been conducted from the second half of 2014 to 2016. The method is that initial geological models, which were developed based on boring data and surficial geological informaiton in the past, are improved using S-wave velocity structure estimated from records of miniature array microtremor observations. Especially, with connection between shallow and deep ground in mind, we will focus on boundary surface of velocity layer around engineering bedrock from Vs300 m/s to Vs500 m/s regarded as transitional range between shallow and deep ground.

2. Miniature array microtremor observation
About microtremor observations, array observations were conducted in lowland and plateau of Kanto area. It consists of 4-point miniature array with a radius of 60cm and 3-point irregular array from 3m to 10m on a side. These observations are made on the road and near seismic ground-motion stations such as K-NET and KiK-net. The total number of observation sites has reached about ten thousand, as of February in 2017. In addition, we made an observation for 15 minutes per site at intervals of 1km or 2km using JU210/215 or JU410 which is an all-in-one microtremor observation unit. Sampling frequency was 100Hz or 200Hz.

3. Analysis method and the results on shallow subsurface structure
In this study, we evaluated one-dimensional S-wave velocity structure using shallow subsurface structure survey method based on microtremor observation. The method has been proposed and advanced in recent researches [3-5]. We made an analysis in the following procedure using a microtremor analysis tool such as “BIDO” and “Microtremor Array Tools.”
[1]Auto-analysis and reading of disperse curves and H/V spectral ratios
[2]Extraction of amplification factors such as AVS30
[3]Direct depth transformation of disperse curves [Simple Profiling Method; SPM]
[4]Inversion process such as Simple Inversion Method [SIM]
[5]Joint inversion using H/V spectral ratio and initial velocity structure obtained in 3,4 noted above [Linear Inversion]
[6]Extraction of the depth of top surface in Vs350 m/s and Vs500 m/s layer

 

One-dimensional S-wave velocity structure and two-dimensional cross-section obtained by analysis mentioned above were, if necessary, modified after comparison with existing initial geological models and investigation. As a result, on the river basin, the models were consistent with S-wave velocity structure models based on boring data [initial geological models]. Besides, three-dimensional structure was revealed on velocity layers around engineering bedrock [Vs300 m/s to Vs500 m/s], which cannot be estimated only through boring data.

4. Summary
In this study, we estimated 1-D S-wave velocity structure and 2-D cross-section based on miniature array microtremor observation records in lowland and plateau of Kanto area. And then, more precisely, we set boundary surface of velocity layers after comparison with existing initial geological models and investigation. This challenge can be a key method about modeling of subsurface structure for seismic ground-motion prediction.

Keywords: engineering bedrock, S-wave velocity structure model, miniature array, microtremor