Enhancement of shallow velocity structure models based on array microtremor explorations for Tokai region, Central Japan

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1. Introduction
For sophistication of strong ground motion prediction, it is important to model subsurface velocity structure so that earthquake ground motions can be evaluated in broadband period from 0.1 s to 10 s. Therefore, it is indispensable to combine shallow and deep velocity structure models which have ever been constructed separately and to constructed subsurface velocity structure models so that earthquake observation records can be reproduced.

We have ever modeled subsurface velocity structure for Kanto, Tokai and Kumamoto region in the national investigation conducted by SIP (Cross-ministerial Strategic Innovation Promotion Program), “reinforcement of resilient disaster prevention and mitigation function” of Council for Science, Technology and innovation.

This study attempted to sophisticate shallow geological and soil structure models in initial subsurface velocity structure ones from seismic bedrock to ground surface which had been constructed for Tokai region (Shizuoka, Gifu, Aichi and Mie pref.) last year. It was based on results of a great number of array microtremor explorations. This report will introduce outline of array microtremor exploration, sophistication process of shallow velocity structure models and characteristics of ground motion.

2. miniature and irregular array microtremor exploration
About microtremor measurements, array observations were conducted in lowland and plateau of Tokai region. It consists of 4-point miniature array with a radius of 60 centi-meters and 3-point irregular array from 5 to more than 10 meters on a side. These measurements were made on the road and near seismic ground-motion stations such as K-NET and KiK-net. The total number of measurement sites has reached about five thousand and nine hundred, as of February in 2019. In addition, the measurement was conducted for around 15 minutes per site at intervals of 1km using JU210/215 or JU410 which was an all-in-one microtremor measurement unit [Senna et al., 2008]. And sampling frequency was set at 200Hz.

About analysis of miniature and irregular array microtremor data, we evaluated one-dimensional S-wave velocity structure using shallow velocity structure exploration method based on microtremor measurements. The method has been proposed and advanced in recent researches [Cho et al., 2013]. The analysis was made using a microtremor analysis tool such as “BIDO” or “Microtremor Array Tools [Cho et al., 2016].”

3. Improvement of initial shallow velocity structure models based on results of array microtremor explorations
Last year, initial shallow velocity structures were modeled using the existing bore-hole data and surface geological data. In basis of results of miniature and irregular array microtremor exploration, 1-dimensional S-wave velocity structures in the initial models were modified at each microtremor measurement point. And then, they were interpolated spatially by means of Kriging method and three-dimensional shallow

velocity structures were modeled.

On the improved models in this study and the conventional models based on geomorphologic land classification [Wakamatsu et al., 2013], ground amplification index was compared in spatial distribution. From a general viewpoint, the improved models have wider areas with large amplification in lowlands and they tend to have large local variation in ground amplification. In addition, for the improved models, distribution of ground amplification rates was evaluated by each period in basis of 1-dimensional multiple reflection theory. Amplification rates seem to be larger in different areas by each period.

4. Summary and future challenge
In this study, initial shallow velocity structure models, which were constructed based on a lot of bore-hole and geological data, were enhanced for Tokai region using results of array microtremor explorations. Also, it can be suggested that it is important to evaluate ground motion characteristics using both of amplification and period characteristics. In the close future, improved subsurface velocity structure models will be validated using moderate seismic records at strong-motion stations.

Keywords: S-wave velocity structure, shallow ground, array microtremor exploration, strong ground motion

