Establishment of the Underground Structure Model for Seismic Damage Estimation

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1.Introduction
To develop subsurface structure models for estimating earthquake damage on a real-time basis, we studied subsurface models capable of evaluating ground motion characteristics at a broad range of frequencies. We combined a shallow subsurface model and a deep subsurface model by collecting boring data and soil property data, which are crucial for explaining the ground motion in the vicinity of each period (0.5 to 2.0s), as such ground motion affects soil both near the surface and deep in the ground. In this study, we developed a widearea subsurface structure model (250m grid cell) and a more detailed subsurface model (50m grid cell), as well as a microtremor measurement system and a subsurface structure information management system to support model development. A brief description of each of the following themes will be provided in the sections below.

(1) Construction of wide-area subsurface models for estimating earthquake damage
(2) Understanding of ground motion characteristics and development of a microtremor observation system
(3) Development of a construction technique for a detailed subsurface model through public-private collaboration

2. Construction of Wide-Area Subsurface Models for Estimating Earthquake Damage
Wide-area subsurface models were constructed for the entire Kanto and Tokai regions. Here, we will mainly report on the progress made with the model for the Kanto and Tokai area. To develop a shallow subsurface model, we primarily used approximately 440,000 sets of boring data gathered by NIED. We created an initial integrated model for shallow and deep subsurfaces by combining this shallow subsurface model with an existing deep subsurface model (J-SHIS) and adjusting the engineering bedrock. Records compiled by K-NET, KiK-net, JMA, and local governments were used as seismic observation records. To gather continuous microtremor data, two types of observation techniques, namely miniature and irregular arrays and large arrays (R = 25 to 800 m), were used at approximately 20,000 and 800 points, respectively.

3. Understanding Ground Motion Characteristics and Development of a Microtremor Observation System
To obtain a large number of microtremor array measurements and ensure that results are managed effectively until the results of analysis are produced, it is necessary to minimize and simplify the steps required to collect observation data, analyze them, and evaluate the results. To achieve these goals, we developed a mechanism that can perform all the steps quickly, including on-site data sorting and analysis while minimizing human error. More specifically, we developed i-Bido, which transmits data between seismometers and computers, tablets, and other computing devices without corrupting the data while preserving its quality, and sends the data to the database described below.

4. Development of a Construction Technique for a Detailed Subsurface Model Through Public-Private Collaboration
Our goal is to construct detailed subsurface models with 50m grid cells capable of predicting liquefaction

and landslides while accounting for factors such as ground irregularity and artificial sites, using both public and private boring data, building confirmation applications, topographical information, old topographic maps, and other data. A slope map developed by the Geospatial Information Man-made structures were excluded. The distribution of small artificial valley fills that could not be identified by topographical maps derived from an algorithm for calculating and comparing slopes was obtained. Finally, the buffer region was applied to the water systems identified from the results of water system analysis to develop a model. The model is consistent with the distribution of large-scale artificial sites and also appears to show small artificial sites.

Keywords: subsurface velocity structure, bore-hole, array microtremor, strong ground motion