A study on the strong motion prediction method based on the characteristics estimated by generalized inversion technique

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For the seismic design of seismically isolated buildings and high-rise buildings, it is necessary to evaluate strong motions at the construction site, and, set the seismic motions for design. On the other hand, the prediction of strong motions over a wide area with high density is indispensable for the planning of city-level disaster prevention plans. In both cases, we need to establish a simple and accurate strong motion prediction method to consider the effect of ground amplification at arbitrary sites accurately and/or quickly.

In this paper, the strong motion characteristics based on the generalized inversion technique (GIT) are evaluated and a strong motion prediction method for arbitrary points is proposed. Also, I performed the simulation for strong motions in a previous event to verify and validate the proposed method.

Firstly, I summarized the institutional and historical evolution of the present design input motions and the challenges of the present strong-motion prediction method, and I clarified the position of the proposed method. Followed by summary, I collected the strong motion records mainly from public institutions, and I constructed a database for strong motion records with approximately 450,000 waveforms.

Next, the strong motion characteristics were evaluated by GIT for the amplitude and phase information of the Fourier spectra converted from waveforms. Especially, I clarified the characteristics of the source term with the group delay time and its variance which have been unknown before. In addition, empirical parameters governing the level of high frequency in the source, and, regression equations were derived for engineering purposes.

Furthermore, I analyzed the strong-motion characteristics evaluated mentioned above in detail. It was found that the stress drop, which was one of the source characteristics, shows a strong dependence on the depth of the hypocenter and a clear regional feature. I proposed a spatial interpolation model for the site amplification at arbitrary locations throughout Japan. I constructed a correction function for easily considering the nonlinearity of soil material in the strong motions with large amplitude.

Finally, I proposed a strong-motion prediction method that combined a prediction model

for each of the proposed characteristics mentioned above. And I confirmed the validity of the proposed method through strong motion simulations of the M7.8 earthquake off the coast of Ibaraki prefecture, which was the largest aftershock of the 2011 Tohoku earthquake.

By these things, a new strong-motion prediction method applicable to arbitrary site with accurately and simply has been established.

［出典］仲野健一：スペクトルインバージョンに基づく強震動予測手法に関する研究，京都大学大学院工学研究科学位論文，2020. 3