Strong motion simulation considering frequency dependent radiation pattern characteristics

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Since strong motions around frequency of 1 Hz strongly affect the degree of structural damage, it is a major concern for us to simulate strong motions in this frequency range accurately for use in disaster mitigation. One of the important characteristics that control strong motions in this frequency range is the radiation pattern. However, the fundamental characteristics of radiation patterns of strong motions in this range are complex (Liu Hemlberger, 1985, Vidale & Bonamassa, 1993). The authors investigated the fundamental characteristics of high frequency strong-motion including 1 Hz using dense strong-motion network data (KiK-net) for an aftershock event (Mj5.5, depth=9km) of the 2000 Tottori-ken Seibu, Japan, earthquake and found that the frequency range of transition from deterministic to random phenomena of radiation patterns is approximately 1~2 to 5 Hz (Matsushima & Sato, 2002). This result was consistent with the radiation pattern model of strong motions derived from statistical analysis by Satoh (2002) using KiK-net data for mainshock and aftershocks of the 2000 Tottori-ken earthquake.

In this study, we incorporated the frequency dependent radiation pattern model into strong motion simulation and verified the validity of the model. We simulated strong-motion data by K-net for a moderate size earthquake (Mj5.4, 1998/4/22) that occurred beneath the Nobi, Aichi prefecture in central Japan, plain using a hybrid method, since we have a well constrained three-dimensional basin structure in this region. We assumed a point source for the simulation. For the low frequency range, we used a three-dimensional finite difference method (Pitarka, 1999). For the high frequency range, we used statistical Green's function method (Satoh, 1994) considering the frequency dependent radiation pattern model that has a transition frequency range of 2 to 6 Hz. In the transition range, the radiation pattern is assumed to change linearly along log f. In the hybrid method, these results were summed up after filtering them with a matching filter at 0.4 Hz. In order to verify the validity of the frequency dependent radiation pattern model, we did the same calculations using the statistical Green's function method considering the theoretical radiation pattern for all frequencies and another case without considering the radiation pattern at all. The results showed that the case considering the radiation pattern model proposed by Satoh (2002) matched the data very well, compared to the other two cases. We acknowledge NIED for the use of KiK-net and K-net data. This study was supported by the project 'Study on the master model for strong ground motion prediction toward earthquake disaster prevention' funded by Special Coordination Funds for Promoting Science and Technology, from MEXT (2000-2004). Dr. Toshimi Satoh, Mr. Takashi Hayakawa, and Mr. Motofumi Watanabe of Ohsaki Research Institute, Inc. helped us with this study.