High-density estimation of site amplification characteristics from DAS observation along Route 9

*Kumaki Kento[1], Hisashi Nakahara[1], Kentaro Emoto[1], Masatoshi Miyazawa[2], Takeshi Tsuji[3]

1. Solid Earth Physics Laboratory, Department of Geophysics, Graduate School of Science, Tohoku University, 2. Disaster Prevention Research Institute, Kyoto University, 3. Department of Earth Resources Engineering, Kyushu University

Distributed Acoustic Sensing (DAS) is a method of measuring seismic signals using fiber-optic cables. DAS has attracted increasing attention in the field of seismology. Compared to conventional observations using seismometers, the cost of the DAS observation is low, and its spatial density is high. In this study, we report the site amplification characteristics from the amplitude of direct S wave for local earthquakes, based on a DAS observation (Miyazawa et al., 2022) using an optical fiber cable deployed along National Route 9 in Kyoto Prefecture.

One component of the axial strain rate along the cable was measured at an interval of about 5 m along a 50 km long section of Route 9 from the Kyoto National Highway Office in front of Kyoto Station to the Tamba Exit. The observation period was for 33 days, from August 23 to September 24, 2021. We analyze 12 earthquakes whose magnitudes range from 0.9 to 3.9.

Band-pass filters of 0.1-1, 1-2, 2-4, and 4-8 Hz are applied to the strain rate records at each location. Based on the theoretical direct S wave travel time, the RMS value is calculated at each frequency band in a 10 s window starting 5 s before the arrival of the S-wave initial motion. Then the results are stacked over different earthquakes.

The difference in the range of S-wave RMS values between the earthquakes and frequency bands is small. The overall trend is that the values are slightly higher in the central part of the line, and there is an area with extremely low RMS values in Oue Kutsukake Town, Kyoto City. This may be due to the coupling between the fiber optic cable and the ground. The large-scale spatial distribution of the RMS amplitude coincides with that of the amplification factor between the engineering bedrock with Vs=400 m/s and the surface provided by NIED Japan Seismic Hazard Information Station (J-SHIS).

The method of obtaining the spatial distribution of site amplification characteristics based on DAS observations has already been applied to Route 4 in Miyagi Prefecture (Emoto et al., 2021). This study shows that that method can be applied to Route 9 as well. In the future, we plan to evaluate the effects of radiation pattern and epicentral distance, and to compare the results with topographic and geological information of the area.

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