Analysis of microtremors from aftershock observation in damaged area of the Kumamoto earthquake using seismic interferometry

*Masaki Watanabe[1], Hiroaki Yamanaka[1], Kousuke Chimoto[1], Seiji Tsuno[2], Masahiro Korenaga[2]

1. Tokyo Institute of Technology, 2. Railway Technical Research Institute

The 1995 Hyogo-ken Nanbu Earthquake caused an elongated area of heavy damage, which is known as the narrow zone of the seismic intensity 7. The cause of the generation is considered to be due to the constructive interference of the surface wave generated by the S-wave at a basin edge and S-wave transmitted vertically from the sedimentary layer occurred (e.g., kawase1996). In the case of the 2016 Kumamoto earthquake, Mashiki town with heavy damage is located bear a fault suggesting effects of subsurface structure just like the Hyogo-ken Nanbu earthquake. However, such influence has not been considered yet. This study aims at understanding the relation between subsurface structure and wave propagation in Mashiki town using microtremors from aftershock observation of the 2016 Kumamoto earthquake using the seismic interferometry.

First, a cross-correlation function between the observation points in Mashiki town and a rock site in the earthquake observation by Yamanaka et al. (2016) was calculated from the vertical records. The cross-correlation function is characterized by dispersive features of the surface wave (Rayleigh wave). It was confirmed that this major phases is surface wave components of the Green function between the two stations. Furthermore, we found that the amplitude of the surface wave was different by the observation point pairs, indicating that there was a change in the subsurface structure in the center of the Mashiki town in the damaged area.

Next, we estimated the Rayleigh wave group velocity between the two points by multiple filter analysis of the cross-correlation function. We made a one-dimensional model from the existing subsurface structural data of the Headquarters for Earthquake Research Promotion, and compared the theoretical group velocity value for the one-dimensional model with the observation value calculated from the cross-correlation function. The theoretical group velocity is similar to the observed ones in non-damaged area, while they are different at the observation point pairs across the damaged areas.

We finally conducted two-dimensional simulation of wave propagation due to a vertical surface source using two models. The first model was derived from the existing data of deep soil layers with almost horizontally flat interfaces. The second model has a fault structure with a rapid step-structure with the low S wave velocity on the near-surface layers. We simulated the propagation of two-dimensional P-SV waves using a difference method The virtual epicenter was placed on the surface of the observation point to extract vertical components of the Rayleigh wave. In the calculation of the previous model, the dispersion of the surface wave has uniform characters in the whole area of the model. In the synthetic motions of the fault structure model, the complex secondary-generated waves such as the wave which had been diffracted by the soft layers from the fault location. We also compared the synthetic motions with the observed correlation function, and found that the computed waveform of the fault structure model is much more similar to the features seen in the observation correlation function than the existing model.