Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

STT056-P08 Room:Convention Hall Time:May 26 16:15-18:45

Estimation of transfer function with long-period linear vibrator

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We have made experiments on accurately controlled seismic source based on the concept of ACROSS. Conventional source that are used in ACROSS are of rotational type, in which rotation of an eccentric mass generates centrifugal force. In spite of the simplicity of the principle, the conventional source has a shortcoming that the force in lower frequency is much smaller than that in higher frequency range because the force is proportional to the square of the rotational frequency. Seismic source with linear mass motion (linear vibrator) can overcome this shortcoming, which is essential especially for the region of high scattering characteristics. We made an experiment on the linear vibrator by courtesy of Kajima Corporation in Awaji ACROSS site to compare it with the rotational type vibrator, and confirm that we can obtain transfer functions with operational method of signal processing.

Based on the result, we made the next experiment on a linear vibrator in the area of dense seismic network, which are deployed by Oya Community Development Public Corporation at Oya town, Utsunomiya city. The purposes of the experiment are 1) comparison of the result in different geological condition with that of Awaji, 2) research on the effect of subsurface vacancy to transfer function, 3) verification of velocity structure that is used in hypocenter determination by the seismic network. The vibrator was deployed in a garage of Kawasaki Coop. at the northwestern part of the network. The vibrator was operated in perpendicular directions in the frequency range of 1.0 to 10.0 Hz with an interval of 0.2 Hz. It was operated for 29 minutes for each frequency. Transfer functions are obtained by the deconvolution with the acceleration of the mass on the vibrator. Unlike the rotational ACROSS source, the linear vibrator is not synchronized to GPS. Therefore the acceleration of the mass is recorded with a data-logger whose sampling timing is synchronized to GPS.

The signal is received continuously by 126 stations that are operated by Oya seismic observatory. All the stations are located within the distance of 3km from the vibrator. Each station is deployed with a velocity sensor of vertical component with the natural frequency of 14 Hz except for 11 stations, where three component sensors are deployed. We also deployed three component sensors with a natural frequency of 2.2 Hz at 7 stations in order to compare the signal with the existing sensors. The vibration just around the vibrator is also measured. All but for 6 stations can record the vibrations above the ground noise. At the poster, the transfer functions both with radial and transverse vibrations are presented.

Keywords: control source, vibrator, ACROSS, Oya, subsurface vacancy