Vibration table test simulating the installation environments of the cabled ocean bottom seismometer deployed to DONET and S-net

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Recently the oceanfloor networks such as DONET (Kaneda et al., 2015; Kawaguchi et al., 2015) and S-net (Kanazawa et al., 2016; Uehira et al., 2016) were constructed and have been operated for monitoring earthquakes and Tsunamis. Strong motions were recorded at DONET stations. Magnitudes calculated by using the DONET stations were overestimated than them by only land stations in influence of the sedimentary layer, the offset in the waveform and the DC level change (e.g., Nakamura et al., in submitted). These overestimations of the amplitude and the magnitude due to the non-linear response negatively affect to the earthquake early warning system, including for railroad one, by using the ocean bottom seismometers. Non-linear process might cause the errors to the source process analysis and the crustal deformation estimated by using ocean bottom pressure gauges. Although the non-linear responses might be caused by sensor characteristics and/or the ground responses such as liquefaction, more investigation is necessary to discuss them in detail. To discuss the response of the stations and around them to strong motion in detail, we experimented the vibration table test simulating the installation environments of the seismometers in deployed to DONET and S-net.

We put sand/marine muck and the two types of the metallic case as the sensor package in the metallic cuboid (the outer case: 600 * 400 * 600 mm); one is the cube type for DONET (DONET inner case: 300 * 300 * 300), the other is the cylinder type for S-net (S-net inner case: ϕ127*310 mm). To make the installation environments of the sensor packages on oceanfloor, we saturated the inside of the outer case by water. We vibrated them between 0.05 ~ 1.0 G at 5 Hz for two minutes by using the vibration table at Research Institute of Marine Engineering. We installed the three component accelerometers at vibration table, at top and bottom of the DONET inner case and at sides of the S-net inner case. We shot the video of the response from vibration table and DONET inner case. We attached the wooden frame in the outer case to simulate various pattern such as response between sensor package and casing and between sedimentary layer and casing.

We vibrated the long axis direction of the outer case, including the DONET inner case and sand, to simulate the DONET stations. The sand movements were observed at the cases that be vibrated by 0.5, 0.7 and 0.9 G. In attention to the amplitude of the vibration direction of the two accelerometers in the DONET inner case, the amplitudes during sand movement occurring were smaller than those during not occurring. On the other hand, the amplitudes of the other directions were mainly lager than those during the sand movement occurring. These amplitude changes were observed at higher frequency than 5 Hz and not observed at accelerometer at the vibration table. The larger amplitude in the vibration direction than that of vibration table was observed at the lower frequency than 1 Hz. These results might indicate that the non-liner ground response such as the liquefaction occurred and the DONET inner case moved at the timing vibrated by 0.5, 0.7, 0.9 G. The amounts of the amplitude change are -15 ~ -5 % in the vibration direction and -25 ~ 200 % in the other directions. After the sand moving the DONET inner case and sand are more stable than before then. These results might show that we can improve the data qualities by vibrating after deploying sensor on oceanfloor.

In the future we will conduct an additional analysis, such as the monitoring the position and attitude changes of the inner cases, in the various experimental patterns in addition to one described below to discuss the response of the sensor packages and around them in the strong motion.

Keywords: vibration table test, the installation environment on ocean floor, DONET, S-net, strong motion

