Distributed Acoustic Sensing measurement by using seafloor optical fiber cable system off Sanriku for dense seismic observation

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Recently Distributed Acoustic Sensing (DAS) measurement which utilizes an optical fiber itself as a sensor becomes popular for security surveillance, monitoring of oil pipe line system. etc. In addition, DAS measurement begins to be applied to seismic prospecting such as vertical seismic profiling for an exploration of energy resources. As DAS measurement is thought to be useful for earthquake observation, there is a trial to observe an earthquake using a seafloor optical fiber. DAS measurement is one of optical fiber sensing technologies. A coherent laser pulse with short duration is transmitted continuously to a single mode optical fiber, and backscattered light is observed. When a small deformation of a fiber occurs by a vibration near fiber, a pattern change of the backscattered light is observed. Travel time of light and pulse length correspond to distance of measurement point and spatially resolution, respectively. Spatially resolution is 1 - 20 m in the highest case. From these characteristics, DAS measurement enables a linear array seismic observation. A length of the array with short sensor interval corresponds to that of a deployed optical fiber. Using the present technology, the maximum length of a DAS measurement reaches more than 70 km. On the other hand, development of data processing is needed because the principle of measurement by the DAS differs from that of conventional seismic measurement using a pendulum. In 1996, a seafloor seismic tsunami observation system using an optical fiber cable was deployed off Sanriku by Earthquake Research Institute, the University of Tokyo. The system still continues the observations experiencing an interruption by a damage of the 2011 Tohoku-oki earthquake. The system has six spare (dark) optical fibers for future extension. The length of dark fibers is about 120 km without a repeater. The dark fibers are suitable for DAS measurement due to dispersion shifted single mode fiber. Therefore we start development of a seafloor seismic observation system by the DAS technology with Sanriku cable observation system as a next generation of marine seismic observation system. The observation system using the DAS measurement can increase spatial resolution on seafloor seismic observation. In February 2019, we made a pilot observation of DAS measurement using a dark fiber of Sanriku seafloor observation system. An interrogator was installed in the landing station temporarily, data were recorded continuously for 100 km length with spatial resolution of 10 m or 40 m and sampling frequency of about 500 Hz. As a result, earthquakes including small local earthquakes occurring near the cable system, deep earthquakes were recorded. We will develop data processing using the obtained data.

Keywords: Seafloor optical cabled observation system off Sanriku, Distributed Acoustic Sensing (DAS) measurement, High dense seafloor seismic observation

