

Marine seismic observation by Distributed Acoustic Sensing using seafloor cable off Sanriku for long-term monitoring

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Distributed Acoustic Sensing (DAS) measurement is one of optical fiber sensing technologies and utilizes an optical fiber itself as a sensor. Seismic observation using DAS technology becomes popular because spatially high-density data can be obtained. In the DAS measurement, 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 spatial resolution, respectively. 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. Six spare (dark) optical fibers are included in the system for future extension. We performed DAS measurement using a spare fiber of the Sanriku system in February 2019. An interrogator was installed in the landing station temporarily, data were recorded continuously for 100 km length with gauge lengths of 10 m or 40 m and sampling frequency of 500 Hz. Channel interval was 5 m. Consequently, we obtained data with 20,000 channels. A recording period was approximately two days. Additional observation using a different interrogator was performed to confirm the performance of the DAS measurement in June, 2019. As a result, earthquakes including small local earthquakes occurring near the cable system, and deep earthquakes were recorded.

It is recognized that the DAS measurement using a seafloor cable with an optical fiber is useful for earthquake observation in marine environment. However, we have obtained temporally short dataset. To monitor seismic activity on seafloor, a long-term observation is needed. In addition, to understand the characteristics of the DAS measurement for earthquake observation, we need more dataset. Therefore, an experimental measurement for the long-term observation was carried out. The objective of this measurement, we made the measurement as long as possible. The recording period basically depends on a capacity of a recording device. We made a success of a continuous DAS measurement for approximately two weeks. The DAS measurement using the Sanriku seafloor cable system was started on 18th November 2019, and the measurement was finished on 2nd December 2019. We set the same recording parameters as those of the measurement in February 2019. To reduce a total amount of dataset, a total length of the measurement was set to 48 km for the first day and extended to 70 km after the second day. A total capacity of the dataset reaches 15 TB for two weeks. Many earthquake including deep earthquakes are also recorded by the DAS measurement. We will start development of a data processing and recording system for long-term monitoring using the obtained data.

Keywords: Seafloor optical cabled observation system off Sanriku, Distributed Acoustic Sensing (DAS) measurement, Long-term high-density seafloor seismic observation