DAS observation of Mj6.6 earthquake on January 22, 2022 in Hyuga-nada using optical fiber cable along railway

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DAS (Distributed Acoustic Sensing) measures the strain changes along an optical fiber cable using variations of the phase of backscattered laser pulses traveling in the optical fiber cable (e.g., Hartog 2017; Lindsey et al. 2020; Ide et al., 2021). DAS is expected as a low-cost and long-term monitoring geophysical tool, and a variety of seismic waveforms have been observed (e.g., Biondi et al., 2017; Lindsey et al., 2017; Wang et al., 2018; Ide et al., 2021). However, there has been no report that evaluates and discusses the reliability of the amplitude of seismic waveforms recorded by DAS. This is because it is difficult to determine the following two points that have influences on the amplitude recorded by DAS;
(i) Coupling between optical fiber cable and installation surface;
(ii) Particle motion and arrival direction.
The purpose of this study is to consider the reliability of amplitude recorded by DAS applying to an existing optical fiber cable. Here, we discuss seismic waveforms of a Mj6.6 earthquake that occurred on January 22, 2022 in Hyuga-nada, observed at reginal distance by DAS system with the cables lying along a Shinkansen railway.
DAS is connected to the cable along the Kyushu Shinkansen operated by the Kyushu Railway Company, and the earthquake observation was carried out from January 12 to February 10, 2022. We installed the DAS system from Shin-Yatsushiro to Shin-Omuta stations over about 75km distance. This area has several types of railway structure; bridge, viaduct, embankment and tunnel. The optical fiber cables lying above these structures next to the rail track. The DAS is a commercial product of AP Sensing (model N5200A) and the interrogator was deployed near the Shin-Yatsushiro station. The parameter settings for our observation are a 500Hz temporal sampling rate, 5m spatial sampling interval, and 10m gauge length. There were 15082 channels in the 75km section of cable. We also installed five temporary accelerometers above and/or below the railway structures in order to compare the observed seismic waveforms between DAS and seismometers.
We successfully observed the Mj6.6 earthquake on January 22, 2022 in Hyuga-nada and its aftershocks with the DAS observation over 75km along the Kyushu Shikansen and the seismographs. The epicentral distance between the source and the cable is ranged from 130 to 160km. We find that signal-to-noise ratios of the seismic waveforms are high in the channels from 0 to 60km, on the other hand, the ratios indicate low from 60 to 75km.
Numerous signals of vibration caused by Shinkansen trains were recorded with DAS. We consider that these data could be useful to investigate the fiber installation environment, such as the coupling and the structural differences. We would utilize not only seismic signals but also train-induced vibrations to estimate the site amplification.

Keywords: DAS, earthquake, railway

