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Comparison of DAS surface waves records at geotechnical scales using telecom fiber optic with different cable and ground coupling

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It is now established that existing telecom fiber optic cables (FOC) may be used to record interpretable DAS seismic signals at seismological and reservoir scales, but their use at geotechnical scales remains an active topic of research.

In this work, we present a comparison study of DAS surface waves records on a 600 m long FOC containing both tight and loose standard fiber optics spliced between each other. 2x300 m portion of the FOC are deployed next to each other horizontally at 40 cm depth in a shallow trench located along a road. The first 300 m portion of the FOC lays on the bottom of a PVC pipe (gravity coupling), and the second 300 m portion of the FOC is buried in the soil (soil coupling) ; so that a total of 4 couplings is tested along an optical path totalizing 1200 m: (1) gravity coupling on loose fiber optic, (2) soil coupling of loose fiber optic, (3) gravity coupling on tight fiber optic, and (4) soil coupling on tight fiber optic. We performed hammer shots recorded using DAS with 2.4 m, 4 m, 6 and 10 m gauge length. The resulting DAS data are compared to data from standard vertical and horizontal geophones regularly spaced along the line, as well as data from gimbal mounted vertical geophones towed behind a vehicle along the line.

Our results show that gravity coupling on loose fiber optic using gauge length shorter than 5 m gives interpretable surface waves dispersion image up to 50 Hz for the fundamental Rayleigh wave mode, with a quality which is competitive with results from gimbal data. Therefore, our results suggest that the leveraging of existing telecom FOC for low-cost and fast geotechnical characterization is promising.