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Combined DAS and seismic nodes acquisition for shallow geophysics purposes around the Scrovegni Chapel in Padua, Italy

Olga Nesterova[1], Ilaria Barone[1], Giorgio Cassiani[1,2], Alessandro Brovelli[3], Verónica Rodríguez Tribaldos[4], Andrea Galtarossa[2,5], Luca Schenato[5], Luca Palmieri[5], Luca Peruzzo[1], Jacopo Boaga[1,2], Mirko Pavoni[1], Haleh Karbala Ali[6], and Rita Deiana[2,7]

[1]University of Padova, Department of Geosciences, Padova, Italy
[2]CIBA, University of Padova, Italy
[3]Isamgeo Italia, Gallarate, Italy
[4]GFZ German Research Centre for Geosciences, Potsdam, Germany
[5]Department of Information Engineering, University of Padova, Padova, Italy
[6]Silixa Ltd, Elstree, UK
[7]Department of Cultural Heritage, University of Padova, Italy

Active and passive seismic measurements using conventional point sensors (geophones or seismometers) are usually performed to characterize the near surface in urban areas. However, high-resolution studies depending on the measurement scale, require hundreds to thousands of seismic sensors, which involves costly and time-consuming deployments. In recent years, DAS (Distributed Acoustic Sensing) has enabled standard optical fibers to be used as a continuous streamer of seismic sensors, allowing low-cost, high-resolution seismic surveys. The use of DAS technology has become standardized in the oil and gas industry. However, it is still under-exploited in shallow geophysics, where mainly dark fibers (unused telecom fibers) are exploited.
Here, we show preliminary results from a seismic investigation using a combination of DAS and seismic nodes conducted in the vicinity of the Scrovegni Chapel in Padua, Italy. As the site includes buried archaeological remains from various eras, including a Roman amphitheatre, seismic measurements can be used for archaeological prospection. Moreover, to ensure the preservation of this cultural heritage, understanding the mechanical properties of the underlying soil is key for seismic risk assessment.
Active seismic measurements were conducted on November 15, 2023 using a sledgehummer as the active source. Data were recorded using a Silixa iDAS interrogator unit along a 440 m long fiber optic tactic cable deployed in loop configuration inside three 20 m deep boreholes drilled around the chapel connected through a shallow (few cm) horizontal trench. A combination of 1C and 3C seismic nodes were also utilized as surface receivers along six receiver lines, deployed from the well heads and covering different azimuths. Shot points were located every second receiver position along each line. The acquired in-well DAS and surface node data was integrated for a first-arrival travel-time tomography study, allowing the retrieval of compressional-wave velocity vertical sections.

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