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Estimation of shear-wave velocity and quality factor using vertical array data: towards new insights into soil-structure interactions

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In order to better estimate the damage to a structure during earthquake shaking, it is necessary to understand non-linear soil behaviour from in situ measurements, as well as the dynamic response of the structure and soil-structure interaction. In order to reach this goal, standard geophysical analysis of borehole data and structural engineering monitoring for the characterization of buildings should be accompanied by newly developed interferometric methods. Deconvolution analysis, which is generally carried out in the frequency domain, can be extended to the time-frequency domain, therefore allowing the estimation of possible temporal variations in the transfer function of the medium (here considered to be both the soil and the building), indicating changes in their mechanical parameters and damping. The installation of arrays of sensors in boreholes and in nearby buildings offers new and unique opportunities to develop methodologies for enhancing our understanding of such processes. In the recent years, we have overseen the installation of two such installations (Istanbul, Turkey, and Bishkek, Kyrgyzstan). Such activities have allowed the development of different data analysis applications that aim to provide a more complete overview of the ground, building and soil structure interaction during earthquake ground shaking. These innovative methods provide results that would find their application in seismic risk assessment and mitigation in large urban areas, early warning and rapid damage assessment (in particular for residential and industrial areas), and structural health monitoring.