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Seismic and geological bedrock depth estimation at Cavezzo site (Po Plain, Northern Italy): example of passive geophysical survey in the assessment of soil liquefaction potential

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Recent events have demonstrated that earthquake induced liquefaction effects are responsible for severe structural damages and fatalities, causing in some cases important economic losses. This work was carried out as part of the European project LiquefACT (http://www.liquefact.eu), in the framework of which four test sites were characterized from the geomorphological, geological, hydrogeological, seismological, geotechnical, and geophysical viewpoint. In this work the passive geophysical surveys performed in correspondence of Cavezzo site (Northern Italy) were presented. Cavezzo municipality is located 20 km SW of the 2012 Mw 6.1 Emilia main shock (http://cnt.rm.ingv.it), in the central part of the Po plain, the larger (48.000 km2) and deeper (thickness of sediments up to 6 km) Italian alluvial basin. During the 2012 Emilia seismic sequence Cavezzo suffered severe structural damages due to local site amplification of ground motion, in many case worsened by liquefaction phenomena occurred in the surficial sandy and silty deposits. Geophysical surveys consisted in 25 single ambient noise measurements and 2D ambient noise arrays (instrumentation: 24 bits Reftek 130 recording systems coupled with Lennartz LE3D-5s seismometers). At each single point horizontal to vertical spectral ratio (HVSR) were analyzed by the Nakamura (1989) technique. The 2D ambient noise arrays were performed with a ray of 90 m and 180 m respectively, allowing to well capture the dispersion of surface waves in the range 0.2-5 Hz. The arrays were analyzed with FK (Lacoss et al., 1969) and MSPAC (Aki, 1957; Bettig et al., 2001) methods. The techniques were considered for defining both Rayleigh and Love dispersion curves (fundamental and higher modes). To proceed with the inversion, the ellipticity was estimated considering the flanks of the HVSR curves, where the influence of the Rayleigh waves is higher. In general the results show, from North to South, a clear decrease of the amplified frequencies attributable to the Seismic Bedrock (BS), moving from 0.95 Hz, in correspondence of Mirandola ridge zone (North) to 0.5 Hz (Southern part). The Vs profile highlights the BS horizon at 140 m of depth, in agreement with Mascandola et al. (2018). On the basis of the knowledge about the buried discontinuities of the area (Martelli et al., 2017), the BS can be associated to the SERS horizon (acquifer-A, 45my, ENI-AGIP 1998; 2002; Geomol Project), where the Vs increases from 450 m/s to 920 m/s. A secondary change in the Vs profile (from 230 m/s to 440 m/s) is evident at 40 m of depth, in correspondence of the AES7 subsurface (Martelli et al., 2017). Finally, a stiffer uniform layer reaches about 730 m of depth, where marl deposits are present (http://unmig.sviluppoeconomico.gov.it/videpi/pozzi/pozzi.as). This layer represents for the area the geological bedrock. Considering a Vs30 value of 232 m/s the studied site is classified as soil class C of Eurocode (CEN 2004).
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