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Determination of shallow site dynamic characteristics using seismic techniques in Suez city, Egypt

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Determination of the site dynamic characteristics for shallow subsurface layers is of great interest in earthquake engineering applications. One of the most important parameters is the shear wave velocity (Vs) because it represents the key factor used in determination of most geotechnical parameters of a site including Vs,30 (average Vs up to 30 m depth) which in turn used for seismic site classification. In this study we employ microtremor passive technique in determination of shallow site parameters including Vs,30, site predominant frequency, and site class at Suez city which located in northeastern Egypt on the north coast of the Gulf of Suez. This area has been chosen for this study because it witnesses a land use planning in addition to its economic importance. Since the Suez city is heavily populated and occupied by many centers of Egyptian army, passive seismic techniques are more appropriate for the present study, this is to avoid disturbance for inhabitants and neighboring structures, in addition to the effectiveness of the passive techniques to investigate deep structures at reasonable cost.
In the present work microtremor array data is collected from six sites distributed in Suez city. In order to cover a wide frequency range, different array sizes are carried out at each observation site. Measurements are made using high performance accelerometers with a sampling rate 100 Hz. Data analysis is performed by employing the SPAC method, the new developed CCA method (Centerless Circular Array), and the HVSR method. Fortran codes are developed to manage data analysis. In SPAC and CCA methods, only vertical component of microtremor data is considered in analysis. The analysis includes two main stages; calculation of dispersion curves of surface wave and inversion process to infer the Vs profile of the ground. The obtained dispersion curves cover frequency range (2.0 Hz - 29.0 Hz) and show a good fitting between the observed and the calculated ones at all measured sites. In HVSR analysis, the three components of microtremor data are considered, and the ratio between the Fourier spectra of horizontal and vertical components is calculated, then the spectral ratio curves are produced and the predominant frequency and its corresponding amplitude of ground motion are reported for each observation site. The inferred Vs profiles are used for calculating the Vs,30 which in turn used in site classification at the investigated area.
The results demonstrate the following: A shear wave velocity (160 - 200 m/s) at the surface layer and (395 - 595 m/s) at the underlying rock. The developed site classification scheme includes only two classes (Class D and Class E), showing no significant variation in the characteristics of the surface/near surface sediments in Suez city. The site predominant frequency ranges between 1.7 Hz and 8.7 Hz and the amplitude of ground motion ranges between 2.1 and 4.8. These results show a good agreement with the geological setting of Suez city. The results of this study represent a good site model for seismic hazard studies and seismic risk reduction at Suez city.