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Evaluation of Internal Friction Angle in Overconsolidated Granular Soil Deposits Using P- and S-Wave Seismic Velocities

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Abstract : Determination of the internal friction angle (φ) in natural soil deposits is an important issue in geotechnical engineering. The main objective of this study was to examine the evaluation of this parameter in overconsolidated granular soil deposits by using the P-wave velocity and the anisotropic components of S-wave velocity (i.e., both the vertical component (SV) and the horizontal component (SH) of S-wave). To this end, seventeen pairs of P-wave and S-wave seismic refraction profiles were carried out at three different granular sites in Iran using non-invasive seismic wave methods. The acquired shot gathers were processed, from which the P-wave, SV-wave and SH-wave velocities were derived. The reference values of φ and overconsolidation ratio (OCR) in the soil deposits were measured through laboratory tests. By assuming cross-anisotropy of the soils, the P-wave and S-wave velocities were utilized to develop an equation for calculating the coefficient of lateral earth pressure at-rest (K_0) based on the theory of elasticity for a cross-anisotropic medium. In addition, to develop an equation for OCR estimation in granular geomaterials in terms of SH/SV velocity ratios, a general regression analysis was performed on the resulting information from this research incorporated with the respective data published in the literature. The calculated K_0 values coupled with the estimated OCR values were finally employed in the Mayne and Kulhawy formula to evaluate φ in granular soil deposits. The results showed that reliable values of φ could be estimated based on the seismic wave velocities. The findings of this study may be used as the appropriate approaches for economic and non-invasive determination of in-situ φ in granular soil deposits using the surface seismic surveys.

Keywords : angle of internal friction, overconsolidation ratio, granular soils, P-wave velocity, SV-wave velocity, SH-wave velocity
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