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Application of pile integrity testing, downhole and crosshole methods in geotechnical studies, case study: Residential construction site in Kelarabad

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Extended Abstract

Summary

Recently, geophysical methods have been used successfully to determine geotechnical characteristics or parameters of subsurface layers. In this research, the integrity of vertical piles, the dynamic elastic parameters of soil and the thickness of the piles in a residential construction site in Kelarabad, located in west of Mazandaran, Iran, were delineated using pile integrity testing (PIT), downhole and crosshole methods.

Introduction

A pile is a slender element cast in the ground or driven into it. In building piles, integrity determination of the product at the end is very difficult because it is not possible to evaluate the integrity directly. However, primary controls such as sampling of concrete before pouring in the well or record the volume of the poured concrete for the pile is carried out in all pile building projects. Despite this, there are always some problems like collapsing the wall of the well and making a thin region in the pile section or occurring a disorder or pausing in drilling or concrete pouring operation that makes further pile integrity tests necessary. One of these tests is impulse response non-destructive test. The purpose of integrity testing is to discover such flaws before they can cause any damage. This method covers the procedure for determination of the integrity of individual vertical piles by measuring and analyzing the velocity and force response of the pile induced by an impact device usually applied axially and perpendicularly to the pile head surface. The impactor is usually a 1-kg sledge hammer with a built-in load cell in the hammer head. Response to the input stress is normally measured using a geophone. This receiver, namely geophone, is preferred to accelerometers because of its stability at low frequencies and its robust performance in practice. By processing the obtained data and interpretation of them, some indexes are obtained that are useful to evaluate the integrity of the pile.

Furthermore, construction of foundation systems for civil structures often requires detailed information of the site soil properties. Bore logs provide soil samples for soil type classification and laboratory testing to determine the strength and consolidation parameters with respect to depth. Downhole and crosshole methods have been developed to measure shear wave velocity and consolidation parameters with regard to depth. The downhole seismic investigations require only one borehole to provide shear and compressional velocity wave profiles. This method uses a hammer source at the surface to impact a wood plank and generating shear and compressional waves. The energy from this impact is then received by a pair of matching three component geophone receivers, which have been lowered downhole and are spaced 3 m apart. Crosshole seismic investigations are performed to provide information on dynamic soil and rock properties for earthquake design analyses of structures, liquefaction potential studies, site development, and dynamic machine foundation design. These investigations determine shear and compressional wave depth versus velocity profiles. Other parameters, such as Poisson's ratios and moduli, can be determined from the measured shear and compressional wave velocities.

Methodology and Approaches

The evaluation of PIT surveys was carried out based on the information from 80 piles in the field site. In addition, crosshole seismic test was carried out in 20 boreholes drilled in the investigated site in order to evaluate the thicknesses of the piles. On the other hand, to measure the vertical changes in seismic velocity and geotechnical parameters, the

downhole test was also carried out in 2 boreholes.

Results and Conclusions

According to the results of the PIT, the frequency chart, velocity map of the concrete structures and the velocity graph of the tested piles in terms of consumable cement have been obtained to illustrate the strength of the pile structures. Using the velocities of P and S waves and geotechnical parameters from 2 boreholes, the dynamic elastic parameters of soil have been computed. After applying conventional pre-processing methods, travel time curves have been obtained. On the basis of seismic downhole surveys carried out in 2 boreholes, the ground has been classified as class II in terms of the Iranian code of practice (Standard No. 2800). Finally, according to the results of crosshole test, the thicknesses of the pile structures with an acceptable approximation of 0.5 to 0.8 m have been calculated.