Abstract

Jacked piles are increasingly becoming a popular method to install piles in urban environments because of the low noise and vibrations involved in the process. The method works well in soft soils but can be more difficult in granular dense soils due to the large loads encountered during pile penetration. If this happens, it is common practise for the machine operator to reverse the displacement on the pile head by extracting the pile for a given stroke following which the pile is reinserted. It has been empirically demonstrated that this procedure, known as “pile surging”, reduces the pile installation load. The main objective of the current research work is to find a theoretical background to support the effectiveness of pile surging. If this is known, the method can be used by the piling industry to aid pile installation in dense sand.

Centrifuge tests were carried out in order to prove the effectiveness of pile surging. The tests were performed with a cylindrical pile, closed at its tip and equipped with strain gauges to measure the base and shaft capacity. Data shows that the amount of shaft resistance mobilised depends on the ratio between the pile surface roughness and the soil grain diameter. When the pile is axially cycled, the shaft friction decreases to a near zero value. The decrease is linked to soil densification at the soil-pile interface which leads soil grains to rearrange reducing the horizontal effective stress.

The second part of the thesis focuses on the measurement of soil stresses both along the pile shaft and in the surrounding soil. A relatively new type of stress cell is presented, these being implemented on a square pile for the first time. Data shows that the soil stresses on the pile can be larger than geostatic for a rough pile surface installed in fine sand. The result is significant for piles driven in fine sands or for piles that are rusted or ridged. The square pile was also used as a measurement pile while a cylindrical pile was installed next to it. The variation of soil stresses around the cylindrical pile was also monitored via stress sensors embedded in the soil.

Lastly, the results of the centrifuge tests are compared with the current design methods for the calculation of soil stress changes within a uniform soil type such as the Boussinesq Theory and the Cavity Expansion Theory. The latter is shown to give a good prediction of stresses measured within the soil during the centrifuge tests at horizontal distances between 5 and 35 times the pile radius.