
Pore Pressure Build-Up and Dissipation Around Piles Penetrating in Clays

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ABSTRACT

Gain of pile capacity with time after driving (pile set-up) is a well-known occurrence. Although factors such as thixotropy and aging contribute to this phenomenon, the most significant cause for gain of capacity with time is associated with the migration of pore water. Pile penetration in clay causes compression and disturbance in soil which results in the generation of extremely high excess pore pressures adjacent to the pile. These pore pressures decay with time in a radial consolidation process, leading to an increase in effective stresses, which in turn increases the friction along piles installed in clay.

This investigation of pore pressure behaviour was undertaken in order to acquire a better understanding of time effects on pile foundations in clay. Such a study provides the basis from which a method accounting for capacity gain with time in design, testing, and construction can be developed. As a first stage, typical initial excess pore pressure distributions, and their dissipation patterns, possibly as a function of the soil overconsolidation ratio (OCR) and/or confining pressure, were examined.

Two data sets of pore pressure measurements around piles were gathered at the University of Massachusetts Lowell. The first, PU, contains information from 21 sources on the initial excess pore pressures generated by full-scale/model pile installation at and away from the wall. The second data set, PUT, comprises of data on dissipation of excess pore pressures with time at the pile shaft, and is drawn from 18 sources. Both data sets contain information from various locations with an emphasis on Boston Blue Clay.

The results of the presented study show that the location of the pore pressure measurement is critical. There is a zone of disturbance around the full-scale/model pile tip which leads to generation of higher excess pore pressures. The excess pore pressures measured at a distance of greater than 17 pile radii from the tip of the full scale/model pile are more representative of steady state conditions, and are more meaningful when considering the radial consolidation of soil. The relationship of the shaft's steady state pore pressures with OCR was found to be different than that observed for the pore pressure measured at the tip.

Analysis of the dissipation data yielded a clear pattern of higher OCRs leading to faster dissipation times for Boston Blue Clay. Dissipation data for other soils with OCR between one and two, were consistent with that observed in Boston Blue Clay with similar OCR. Analysis of dissipation time relative to the size of the penetrating object shows that for fully-closed shapes, simple normalization allows the prediction of pore pressure dissipation around one pile size based on measurements on another size.