STATIC AND DYNAMIC TIME DEPENDENT PILE BEHAVIOR

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Research Funded By: Massachusetts Highway Department
Completed: Summer 1995

Piles driven into low permeability soils experience a gain in capacity over time. The capacity increase (a.k.a. "set-up" or "freeze") is believed to be controlled by two mechanisms: (a) the increase of effective stresses due to the dissipation of excess pore pressures built up during the penetration process and (b) stress independent phenomena such as a strength increase due to thlxotropic bonding. This research is aimed at understanding and formulating the controlling parameters of the phenomena such that they can be implemented in the design and construction stages. The incorporation of capacity gain effects in projects dealing with piles in clay strata will undoubtedly result in significant savings of direct (e.g., materials, installation, etc.) and indirect costs (e.g., construction difficulties, time delays, and contractor claims).

Based on radial consolidation theory, normalized relationships were established between the pile size and the dissipation time corresponding to a certain degree of consolidation. Parameters describing the rates of pore pressure dissipation (Hut) and capacity gain (Cgt) were defined. In order to investigate the "set-up" phenomenon through normalized relations, several data sets were gathered and analyzed. The data sets consist of pore pressure build up and dissipation records, capacity gain with time, and simultaneous measurements of both. The capacity gain data contain information related to static and dynamic pile monitoring.

The different data sets were used to study the following: (1) relationships between pore pressure dissipation and capacity gain rates, (2) validity of size normalization and time adjustment accounting for size effects, (3) the ability of dynamic analyses to monitor the capacity gain with time, and (4) the accuracy of pile settlement predictions determined through dynamic analyses.

Corresponding to the aforementioned areas of study, several important observations were made based on the analyses of the data sets. The average pore pressure dissipation and capacity gain rates compared very well to each other, strongly indicating pore pressure to be the major factor controlling set-up. Soil type and stress history were found to govern the magnitude and dissipation rate of the generated excess pore pressures. The extent of pore pressure build up within the zone of disturbance of closed shaped piles is dependent on pile radius. For normal to low overconsolidated, non-sensitive clays, the pore pressure magnitude and rate of dissipation is approximately constant. Pile size, therefore, controls the capacity gain phenomena which allows measurements of one size to be utilized for another, and hence the use of in-situ tests to evaluate the behavior of full scale piles.

Relationship between dissipation time required for 50% consolidation at a representative point along the shaft and a wide range of pile diameters (0.75 inch to 24 inch) affirmed the assumed size normalization. The use of size normalization for total capacity gain was found to be limited due to the different controlling factors of the dissipation process beyond that of radial consolidation (e.g., pile length, soil variability, tip resistance, etc.). It, therefore, did not match the normalization based on radial dissipation.