Young Members

Load-Settlement Behavior of Precast Jacked Concrete Piles from Static Load Tests and High-Strain Dynamic Pile Load Tests in the Philippines

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Installing precast displacement piles by pile jacking is a relatively new technique but growing in popularity because of the reduced noise and vibration compared to traditionally driven piles. Estimating the ultimate capacity and settlement of jacked piles for specific subsurface conditions is of interest to piling stakeholders. The jacked pile installation method allows for the measurement of a static capacity during the installation, which in some cases can be a reliable estimate of the pile's ultimate capacity as measured by a compressive static load test (SLT) [1]. SLTs and high-strain dynamic compressive pile load tests (HSDPTs) can also be performed after a certain amount of time has elapsed since installation to estimate the increase in skin friction due to pile "set-up". While SLTs have been referred to as the most reliable predictor of long-term pile capacity and behavior [2], HSDPTs are more commonly used in the Philippines for evaluating the capacity of jacked piles and in some cases, have completely replaced SLTs. HSDPTs, while providing a good approximation of results from SLTs, are typically more affordable to conduct, less time-consuming, and can be done on a greater number of piles at a project than SLTs [3]. An estimated pile top load-settlement curve can also be generated from an HSDPT, similar to what is measured in a SLT. However, a common limitation encountered when conducting HSDPTs is the incomplete mobilization of ultimate capacity relative to what can be obtained in an SLT. Nevertheless, there remains uncertainty regarding which load test to use for certain projects, as well as the equipment and load required to fully mobilize ultimate capacities in test piles, particularly because of significant increases in pile capacity due to pile setup in certain types of soils.

Presented here are SLT and HSDPT results of tests conducted on ten (10) prestressed, jacked, square concrete piles with 45 cm width, 30 m length, and a specified allowable capacity of 750 kN installed with a hydraulic static pile driver in silty clay in the Luzon, Philippines region. Final jacking forces applied on the piles during installation ranged from 456 to 2018 kN. Four (4) piles were subjected to SLTs following the "Quick Test" procedure, while six (6) piles were subjected to HSDPTs. These tests were conducted as non-destructive proof tests to prove that the piles can support at least a certain multiple of a provided allowable capacity. SLTs were conducted up to 2.5 times the allowable capacity, while a target capacity of 2.0 times the allowable capacity was used for the HSDPT. Signal matching analysis was conducted on HSDPT data to generate ultimate capacity estimates and estimated load-settlement behavior.

Significant capacity increases, or pile setup, were found between the date of installation and the date of load tests for all 10 piles tested. All target capacities were attained during both SLTs and HSDPTs. Additionally, the measured capacities were 1.19 to 5.43 times the final jacking force measured during installation, indicating that capacities had increased. However, using the Davisson Offset Limit Method, a widely used method for static load capacity estimation [4], capacity estimates from HSDPTs were found to be closer to actual ultimate capacities compared to estimates from SLTs, despite smaller target capacities used during the HSDPT. Load settlement curves from the HSDPTs (also called PDA tests) and SLTs, as well as the Davisson-Offset Line, can be seen in Fig. 1. This is likely because of the relative ease in mobilizing additional capacities during a HSDPT, which typically requires increased hammer drop heights. Additional reaction piles or dead loads are typically needed to increase loads in a SLT. As such, HSDPTs may be a superior option for maximizing measured capacities when a significant and uncertain amount of capacity increase is expected in a project.

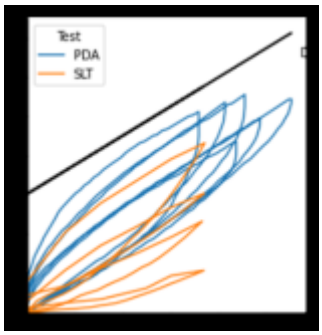

Fig. 1. Load-settlement curves of jacked piles from SLTs and estimated by HSDPTs

References

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