Young Members Column

Empirical Methods for Predicting Precast Jacked Pile Capacity – Case Studies in the Philippines

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This paper details case studies of precast jacked piles tested with high-strain dynamic load pile tests in the Philippines. The study explores the relationship between pile slenderness ratio (L/D), ultimate capacity, and final jacking force (P_{jack}). It also evaluates empirical lower-bound predictions of capacity that utilize slenderness ratio and P_{jack}, and proposes lower-bound formulas more suitable for the collected data. 135 jacked, square, precast piles with slenderness ratios from 5 to 64 are included. The piles were installed using hydraulic static pile drivers that utilize dead weights for a reaction force, with the P_{jack} applied ranging from 132.5 to 378 tons.

The ratio of an ultimate capacity to P_{jack}, also known as pressure ratio, was found to be a function of the slenderness ratio. Pressure ratios generally exceeded 1.0 for piles with slenderness ratios above 30, as seen in Fig. 1. This increase in pressure ratios for more slender piles is likely due to the greater dependence of these longer piles on skin resistance, with long-term skin friction being significantly greater than the friction at the end of jacking.

Cases of pressure ratios below 1.0 were observed for L/D < 30. Zhang et al. (2006) hypothesized that the toe resistance mobilized for these lower slenderness piles estimated in load tests was less than the resistance mobilized during pile jacking. For lower slenderness piles with pressure ratios closer to or above 1.0 observed, may have had similar toe resistances during the load test and during installation, accompanied by some shaft resistance increase.

Actual pressure ratios and ultimate capacities were compared to two previously established empirical predictions from Zhang et al. (2006) and AS-2159 (2009). All 135 jacked piles had actual pressure ratios above the 95% confidence line predicted by Zhang et al. (2006), even when piles with relatively small sets during the dynamic load test (<2 mm needed for good correlations with static load test capacity estimates) are included. Furthermore, 125 of the 135 (93%) jacked piles in the case studies had actual capacities above a predicted geotechnical ultimate capacity (R_{UG}) from AS-2159, which was obtained using the final jacking force P_{jack} and empirical coefficients of jacking pressure (g_p).

Finally, two new lower-bound pressure ratio formulas that are a function of slenderness are proposed, particularly to deal with low-slenderness piles that cannot be adequately modeled by Zhang et al. (2006), which predicts negative pressure ratios for L/D < 10. These new lower-bound functions are presented in Equations 1 and 2 and are graphically illustrated in Fig. 1.

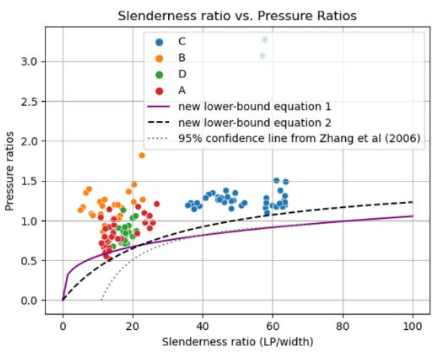

Fig 1. Alternative lower-bound formulas proposed for four cases studies

$$\alpha = 0.298\,(L/D)^{0.28} \tag{1}$$

$$g_2 = \alpha = \frac{x}{18.188+0.631x} \tag{2}$$