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Opinion

Study on the Squeezing Effect of Large-Diameter and Small Spacing Static Pressure Pipe Piles

Penglin Li[1], Shaolong Guo[2], Qun Lu[2]* and Manman Liang[2]

[1]China Harbor Engineering Co., LTD., China

[2]School of Civil Engineering, Tianjin Chengjian University, China

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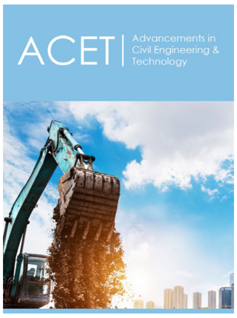

***Corresponding author:** Qun Lu, School of Civil Engineering, Tianjin Chengjian University, Tianjin 300384, China

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Opinion

Static pressure method is a commonly used method for engineering pile foundation construction, which has the advantages of high efficiency, low noise and no damage to the pile. Prestressed concrete pipe pile is the most common type of static pressure pile. In recent years, scholars have conducted extensive research on the characteristics of static pressure pile driving. The methods for studying the soil squeezing effect of static pressure piles include theoretical analysis, numerical simulation, on-site measurement and model testing. In terms of theoretical analysis, classic methods include cylindrical hole expansion method, spherical hole expansion method and strain path method. Cao et al. [1] derived a closed form expression for the excess pore water pressure and total stress, clarifying the pile driving effect of static pressure piles in saturated clay. Chow and Teh [2] used elastic theory to provide a matrix form for the uplift number of adjacent piles and analyzed the variation of uplift amount with the modulus ratio and aspect ratio of piles and soil. Sagaseta [3] improved the theory of undrained cylindrical hole expansion in soft soil based on the modified Cambridge model. In terms of model and field tests, Huang et al. [4] conducted on-site measurements of soil horizontal displacement, surface uplift and excess pore pressure. Sagaseta [5] predicted the displacement of surface soil. Lu et al. [6] pointed out through on-site observations and finite element simulations of single pile penetration into layered foundations that harder soil will "squeeze" into the softer soil above and below it under the compression of piles. This kind of 'squeezing' becomes more pronounced as it approaches the edge of the pile, and weakens as the distance from the pile increases. In terms of numerical simulation, Ye et al. [7] used particle flow numerical simulation software to study the bearing characteristics of single piles in sandy soil, and compared the working characteristics of static pressure driven piles and embedded piles.

Previous studies on the squeezing effect of static pressure piles have mostly focused on cases where the pile diameter does not exceed 800mm and the pile spacing is not less than 3.5 times the pile diameter, while research on the soil squeezing effect of large-diameter piles (such as piles with a diameter of 1000mm) and piles with small spacing (such as 2.5 times the pile diameter) has not been in-depth. The finite element simulation of the soil squeezing effect of large diameter and small pile spacing group piles is difficult to implement and often time-consuming, making it difficult to meet the needs of engineering progress. There are certain limitations to studying the soil squeezing effect of static pressure piles through a single research method. Therefore, it is necessary to study the squeezing effect of large diameter and small pile spacing through on-site measurement, numerical simulation, and theoretical analysis synthetically.

An et al. [8] studied the soil squeezing effect of large-diameter pipe pile groups based on a subway project under construction in Colombia, using on-site testing, theoretical analysis and numerical simulation methods. Conduct pile driving tests on the project site and monitor the displacement of the pile top and the soil around the pile. Establish a finite element model of pile group using finite element software and simulate the process of pile group penetration. Estimation of soil displacement using cylindrical hole expansion theory. Research has found that: During the pile penetration process, the pore water pressure of the soil around the pile will rapidly increase and reach a relatively high initial value. Afterwards, the excess pore pressure of the soil around the pile will quickly dissipate; As time goes by, the dissipation rate of pore water pressure will gradually slow down and tend to stabilize. The simulated values of the horizontal displacement at the top of the piles group are in good agreement with the measured values and both show a pattern of larger displacement at the top of the piles which is first penetrated and smaller displacement at the top of the piles which is penetrated later. The measured horizontal displacement of the soil layer at each observation point of the group of 7 piles shows a turning point at a depth of about 2.5 meters and fluctuated with increasing depth. The measured displacement reached its maximum value between 25 and 30 meters, and then rapidly decreased thereafter. The measured horizontal displacement below a depth of 40 meters is already very small. The finite element simulation results of squeezing effect of the group of 20 piles show that the squeezing effect of the soil around the pile caused by pile penetration within the depth range of the pile length is very obvious and the horizontal displacement of the soil below the depth of the pile length rapidly decreases. The reasons for the errors between the finite element simulation values and the measured values were analyzed. The research results of this paper can provide technical reference for the construction of large diameter and small spacing PC pile group. The pile penetration model in this paper only considers the radial compression of the surrounding soil, and does not consider the downward compression process of the soil when the pile is inserted. In the following research, the model should be further optimized to analyze the influence of continuous pile penetration on the deformation and excess pore pressure of the soil around the pile.

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