

An experimental study on the resistance and movement of short pile installed in sands under horizontal pullout load

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ABSTRACT: *In this study, the model tests were conducted on the short piles installed in sands under a horizontal pullout load to investigate their behavior characteristics. From the horizontal loading tests where dimensions of the pile diameter and length, and loading point were varied, the horizontal pullout resistance and the rotational and translational movement pattern of the pile were investigated. As a result, the horizontal pullout resistance of the pile embedded in sands was dependent on the pile length, diameter, loading point, etc. The ultimate horizontal pullout load tended to increase as the loading point (h/L) moved to the bottom from the top of the pile, regardless of the ratio between the pile length and diameter (L/D), reached the maximum value at the point of $h/L = 0.75$, and decreased afterwards. When the horizontal pullout load acted on the upper part above the middle of the pile, the pile rotated clockwise and moved to the pullout direction, and the pivot point of the pile was located at 150-360mm depth below the ground surface. On the other hand, when the horizontal pullout load acted on the lower part of the pile, the pile rotated counterclockwise and travelled horizontally, and the rotational angle was very small.*

KEY WORDS: Short pile; Horizontal loading test; Horizontal pullout resistance; Rotational angle; Loading point.

INTRODUCTION

For the construction of coastal harbor structures, there is a need to build offshore structures on the sea, unlike in the land. The foundation works of an offshore structure entails a considerable construction cost, the workability drops to a significantly low level, and in particular, the foundation works at the deep waters is a very difficult task. If the foundations of that structure are replaced with the suction piles, it will be advantageous as they can greatly save the construction costs and shorten the construction period, and make the construction works at the deep sea easier. The offshore structures built by the conventional construction method are very difficult to demolish once their construction has been completed. However, the structures which constructed with suction piles can be rapidly demolished or reconstructed if faults are found or if it is necessary to demolish them.

Suction piles, one of the foundation types used for offshore structures, can support the structure under or above the water by connecting mooring lines up to the suction pile. Up to date, there are a few studies on the bearing capacity of the suction pile considering the dimension, pullout angle, and loading point, etc. There have been several studies on the maximum resistance of the suction pile under the horizontal load with respect to different loading points, but little studies have been conducted on the movement patterns of the suction pile under the horizontal load.

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Therefore, the laboratory model tests on the short piles to simulate the suction piles were conducted in this study, to investigate the behavior characteristics of the suction pile. After embedding a short pile with a very small ratio of the pile length/diameter into sands under the water, then the horizontal load test was conducted. From the results of model tests, the horizontal pullout resistance of the short pile was evaluated and the characteristic of lateral movements was also investigated.

THEORETICAL CONSIDERATIONS

The conventional studies on estimating the horizontal pullout resistance of the pile embedded in sands have been conducted by Raes (1936), Broms (1964), Petrasovits and Award (1972), Meyerhof (1995), Prasad and Chari (1999), etc., and the bearing capacity of the suction pile was studied by Cho (2000), Bang and Cho (2002), Cho and Bang (2002), Kim and Jang (2011), etc. The Broms method is generally referred to as a representative method for calculating the lateral resistance of the pile in practice. Broms (1964) assumed the distributions of the deformation modes, soil reactions, and bending moments of a short pile under the horizontal load in sands, as shown in Fig. 1, where K_p is the coefficient of Rankine's passive earth pressure, and suggested a method to estimate the ultimate lateral resistance, as shown in Fig. 2. Hong (1983) proposed a method to calculate the ultimate lateral resistance by a theoretical analysis considering the failure modes between the pile and the ground.

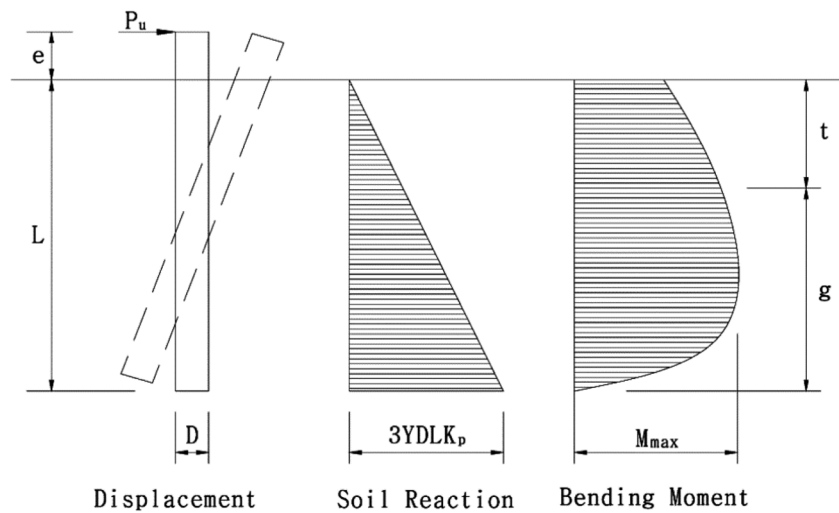


Fig. 1 Rotational and translational movements and corresponding ultimate soil resistance for the free headed short piles in sands under lateral loads (Broms, 1964).

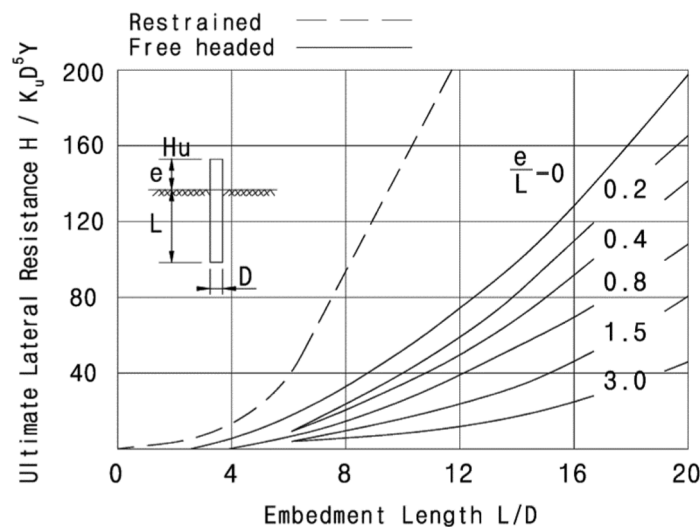


Fig. 2 Broms's solution for ultimate lateral resistance of the short piles in sands (Broms, 1964).

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