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Field Test Study on Cantilever Circular Occluded Pile Supporting Structure

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Abstract

In order to explore the deformation of the pile body of the circular occluded pile retaining structure under earth pressure, this paper carries out on-site monitoring in combination with the actual project, and obtains the deformation characteristics and change rules of the occluded pile by measuring the strain and displacement of the pile body. The research conclusion can provide a certain reference value for the pile body design of bite pile in similar projects.

Keywords

Bite Pile, on Site Monitoring, Deformation Characteristics, Pile Shaft Design

1. Introduction

In recent years, the underground space has developed rapidly, and the excavation depth of the foundation pit has become deeper and deeper. The foundation pit support technology has become a key problem in the foundation pit construction [1]. Because of its many advantages [2] [3], occluded pile is widely used in foundation pit engineering. The earth pressure is the main load of the occluded pile retaining structure. Due to the complexity of engineering geology, the earth pressure acting on the occluded pile retaining pile is complex. However, the pile deformation calculated by the traditional earth pressure calculation method is quite different from the actual situation, so the law of pile deformation cannot be accurately obtained. Many scholars have studied the deformation of the occluded pile under earth pressure. For example, Li Dan [4] analyzed the changes of shear, bending moment and displacement of the supporting structure

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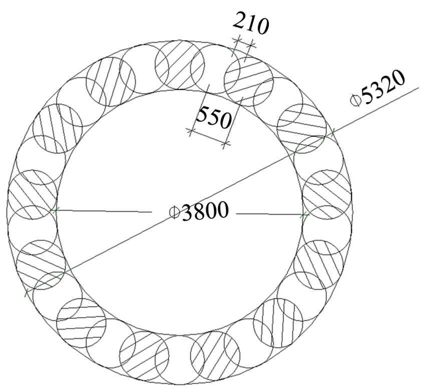
through midas/gts simulation software; Zeng Yihui [5] simulated the dewatering and excavation process of foundation pit by using Midas GTS NX finite element software, compared the calculation results with the monitoring data of foundation pit construction site, and analyzed the stress and deformation law of support structure in detail. Ji Yaobo [6] based on the measured data of Huayuan station of Tianjin Metro, analyzed the causes of earth pressure fluctuation with time, and studied the relationship between earth pressure and pile displacement. Lidong [7] carried out the stress analysis and structural optimization research on the occluded pile structure, and established the stress calculation and analysis method of the arc occluded pile support structure of deep foundation pit under complex geological conditions, providing technical support for the application of large-scale support engineering.

In order to deeply study the internal force distribution and change law of cantilever circular occluded pile, this paper carries out *in-situ* tests in combination with practical projects, and obtains the strain and displacement change law of the occluded pile retaining structure. The research results can provide auxiliary reference for the design of bite pile in similar projects.

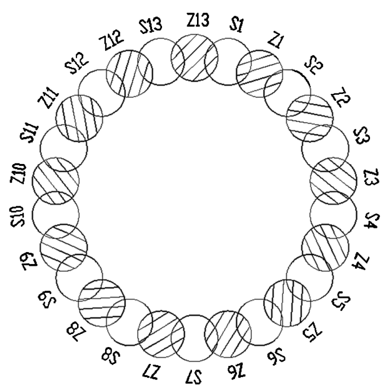
2. Project Overview

The proposed site is located in the north of Fushan Avenue in Xiaolan economic and Technological Development Zone. The terrain of the site is generally flat. The surface layer of the site is partially hardened. It belongs to the geomorphic unit of Ganfu alluvial proluvial plain.

The project is a circular underground foundation pit formed by the bite of plain pile (plain concrete pile) and meat pile (reinforced concrete pile). The size of the foundation pit is shown in **Figure 1(a)** and the construction sequence is shown in **Figure 1(b)**. There are 13 plain piles, including s1 - s13; 13 meat piles, including z1 - z13, including vertical longitudinal reinforcement and horizontal ring stirrup. The diameter of each pile is 760 mm, the central arc length of adjacent piles is 550 mm, and the bite amount is 210 mm. The inner diameter and



(a)



(b)

Figure 1. Schematic diagram of bite pile. (a) Dimension drawing, (b) construction sequence diagram.

outer diameter of pile group are 3800 mm and 5320 mm. Plain pile is 14.5 m long and meat pile is 18 m long. The main construction process of bite pile is shown in Figure 2 below.

3. Monitoring Process

The monitoring process is shown in Figure 3. Before the test, arrange reinforcement meters on the inner and outer sides of 3 m, 7 m, 9 m and 11 m of z13 reinforced concrete pile according to the monitoring scheme, as shown in Figure 3(a), and record the stress value measured each time through the detector; Bury the inclinometer pipe in the reinforcement cage, monitor and record the horizontal and vertical displacement each time, as shown in Figure 3(b). Bury

(a) (b) (c)

(d) (e) (f)

(g) (h)

Figure 2. Construction site of bite pile. (a) Pile bottom—cone, (b) pile top—Circular, (c) drilling rig—48 m high, (d) Earth squeezing, (e) pressure pouring concrete, (f) inserting reinforcement cage, (g) Pouring crown beam, (h) pile group.

the surface strain gauge in the four directions of the crown beam of the foundation pit, monitor and record the strain value each time, as shown in Figure 3(c).

4. Result Analysis

4.1. Strain Results

The reinforcement meter is used for axial force monitoring, and the data are shown in Table 1. The surface strain gauge is used to monitor the strain on the crown beam surface. See Table 2 for the strain data.

(a)

(b) (c)

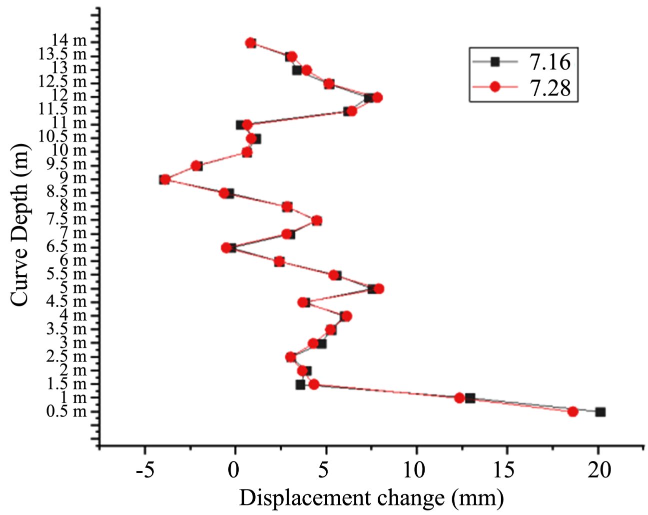
Figure 3. Monitoring process. (a) Welding reinforcement meter; (b) detects displacement; (c) Detect the axial force and crown beam strain.

Table 1. Monitoring data of pile shaft axial force (Unit: KN).

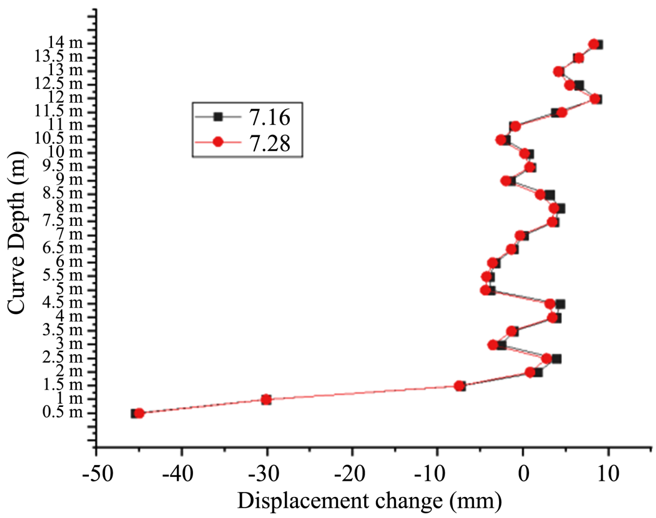
date	Inner 1	Inner 2	Outer 2	Outer 3	Inner 4	Outer 4
7.17 (water level 4 m)	−0.01002434	0.0499	−0.010056	−0.02089	0.07909	−69.634
7.17 (water level 9 m)	0.2005	−0.1796	−0.2913	−0.1149	−0.1284	−69.861
7.18	0.03007	0.07993	−0.3515	−0.3861	−0.1777	−69.964
7.18 (water level 11 m)	0.1203	0.15991322	−0.3214	−0.4591	−0.1975	−70.05
7.19 (water level 13 m)	0.0701		−0.22107	−0.6882	−0.7	−70.395
7.20	0.3412		−0.0502	−0.52166	−0.7	−70.262
7.27	0.6405		0.847	0.491	−0.513	−70
7.28	0.386		0.715	0.261	−0.7	−70.1

4.2. Displacement Results

The variation of the displacement detected by the inclined tube is shown in Figure 4 and Figure 5, and it can be seen: the variation is very small.



(a)

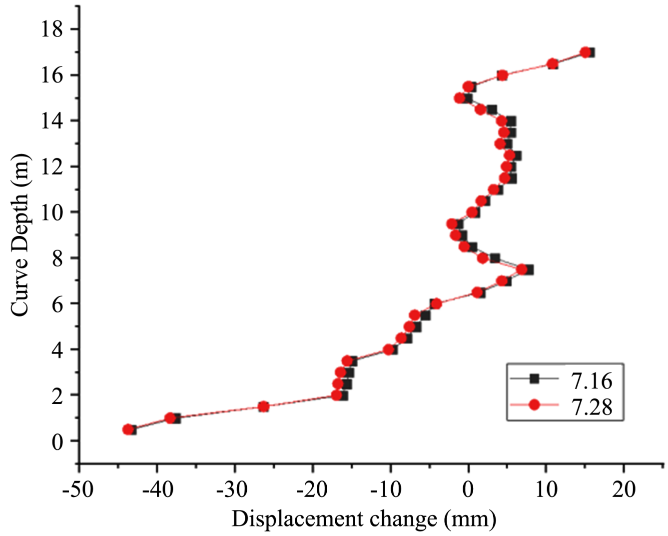


(b)

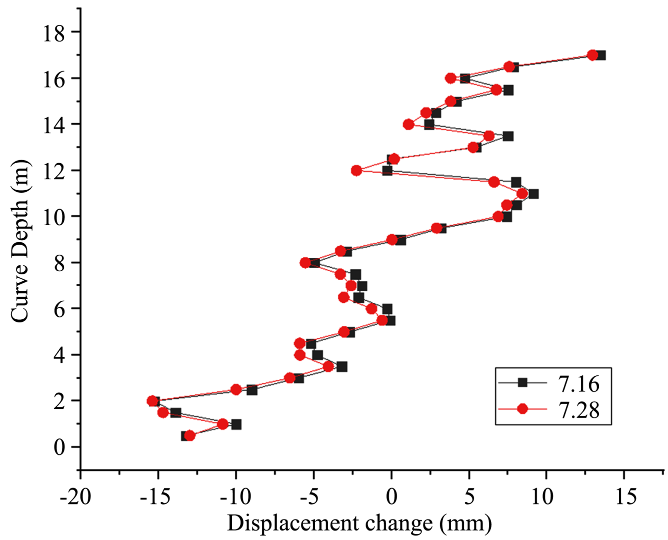
Figure 4. Displacement curve of pipe 2. (a) 7.16 - 7.28 comparison of horizontal displacement change, (b) 7.16 - 7.28 comparison of vertical displacement change.

Table 2. Monitoring data of crown beam surface strain.

Date	North	East	South	West
7.17 (water level 4 m)	−1.53	−24.6	−8.9	−4.05
7.18	1.914	−21.01	−10.52	−5.18
7.20	86.53	−42.86	−35.51	−27.42
7.27	99.21	−34.02		504.68
7.28	−117.9	−38.7	−22.02	498.822



(a)



(b)

Figure 5. Displacement curve of pipe 4. (a) 7.16 - 7.28 comparison of horizontal displacement change, (b) 7.16 - 7.28 comparison of vertical displacement change.

5. Conclusions

1) The variation range of axial force of reinforced concrete pile shaft is very small, and the force on the pile shaft in the outside direction of foundation pit is generally greater than that on the inside.

2) The strain of the crown beam of the foundation pit varies greatly, and the maximum strain of the West crown beam reaches 502.872, indicating that the crown beam bears a relatively large stress in the support.

3) The variation range of horizontal displacement and vertical displacement of the pile is very small. The horizontal displacement of the pile increases first and then decreases along the soil depth, and the horizontal displacement of the pile top is the largest.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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