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Pilot Application of Micropile Foundation in Mountainous Areas in Fujian

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Abstract. At present, the foundation of mountain transmission lines in Fujian is mostly manually dug foundations, with a depth of up to 10-15m, and there are risks such as poisoning and suffocation in limited space operations, object blows and high falls. In order to reduce the risk in the excavation of foundation pits, the pilot use of mountain micropile foundation in Fujian area, which is a multi-pile bearing foundation with small aperture, uses mountain micro drilling rig to excavate into holes, without personnel entering the foundation pit operation, compared with the traditional manual digging foundation operation, it can effectively reduce the risk of poisoning and suffocation, object blow and high fall in limited space operation.

Keywords. Mountain miniature pile foundations, limited space, fall from a height

1. Research Background

Zhangzhou Nuclear Power Plant ~ Wufeng Variable I and II 500kV Line Project (Nuclear Power Plant ~ JWG042 Section) #88 is a mountain micropile foundation pilot tower, located in mountainous hills, the terrain is relatively steep. As shown in figures 1, 2 and 3, legs A and B are moderately weathered granite from the surface; The surface of the C and D legs to a depth of 4.5m is sandy clay, and below 4.5m is moderately weathered granite. The approach road is about 2000m from the Sakai Line prefectural road to Tower #88, of which about 1500m of the original road is used, 500m of the new road, the width is about 2.5~3m, and the maximum slope is about 25°.

Figure 1. Site topographic map.

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Figure 2. Site topographic map.

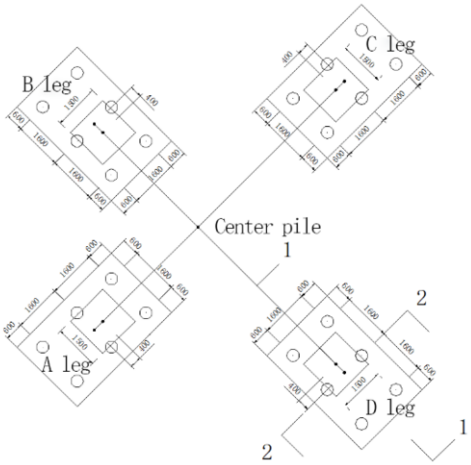

Figure 3. Schematic diagram of the basic type.

2. The Type of Foundation

#88 before the pilot, the rock embedded foundation is a micro-pile foundation, and the foundation size and concrete quantity before and after the pilot are shown in the following table 1. After the pilot, it is 6 piles and 1 pile foundation, the pile diameter is 400mm, the pile depth is 10000mm, the bearing size is 4400mm×2800mm×1400mm, and the column size is 1500mm×1500mm×1400mm.

After analysis, the amount of concrete in the foundation body decreased by 46.71m³ compared with before the pilot, and the amount of retaining concrete was reduced, and the overall amount of foundation concrete decreased by 89.85m³, a reduction ratio of 50.2%.

Table 1. Comparison table of foundation size and concrete quantity before and after the pilot.

Project	Number of piles (roots)	Number of Platforms (pcs)	Pile diameter (mm)	Pile depth(mm)	Base Ontology Quantity (m³)	Parapet square amount (m³)	Total (m³)
Before the pilot	4	0	2500	8500	135.85	43.14	178.99
After the pilot	24	4	400	10000	89.14	0	89.14
deviation	20	4	-2100	1500	-46.71	-43.14	-89.85

3. Introduction of the Drilling Equipment

The drilling equipment is selected from the WZFT300 mountain micro drilling rig produced by Jiangxi Dongrui Machinery Co., Ltd., as shown in figure 4, supporting 2 air compressors, of which the mountain micro drilling rig can walk in place by itself, and the air compressor needs to be towed-pulled by other vehicles. The size of the micro drilling rig is: the size of the drill bit is about 8.2m×2.7m in the raised state (walking state), and the size of the drill bit in the lowered state (working state) is about 11.2m×2.7m; The size of the air compressor is 4m×2m (2 sets), and the walking climbing slope is not more than 25° [1].

Figure 4. Actual diagram of a micro drilling rig.

4. The Application Situation of 500 KV Transmission Line Project of Zhangzhou Nuclear Power Plant

The #88 tower hole pile part is excavated into holes by mountain micro drilling rigs throughout the process, as shown in figure 5, considering the mechanical position and convenient walking, the excavation sequence is C leg→ A leg→ B leg →D leg. The C and D legs are located on the side of the lower slope, the terrain is flat, the surface layer is sandy clay, the ground elevation is 1.2m higher than the top of the pile, and the pile pouring needs to be carried out through a small hook machine or manual excavation to find the bearing position, and then carry out the platform construction. A and B legs are located on the side of the upper slope, the terrain is relatively steep, the surface layer is rock geology, it is necessary to use hook machine and air compressor to excavate the bearing position first, and the micro drilling rig drills holes at the bottom of the platform.

Figure 5. Hole forming physical drawing.

4.1. Design of Walking Undercarriage Module

In order to meet the needs of micro drilling rig entry and construction operations, the original 1500m approach road width is insufficient, the turning radius is too small, the slope is large and other areas are trimmed with a hook machine to ensure the smooth passage of the micro drilling rig. Before the foundation surface is levelled, the corresponding auxiliary pile is nailed and recorded in detail to facilitate the restoration of the central pile. In order to reduce the damage to the original natural vegetation around the base of the tower, the excavated earth and rock were packed and run to a suitable place outside the tower for stacking.

4.2. Excavation of the Bearing Platform

Excavation is carried out according to the size of the bearing platform with a hooking machine, and the position of the excavated bearing platform needs to be convenient for the micro drilling rig station and formwork support, and the slope is graded according to the slope coefficient of different soil types, and gradually excavated to the bottom of the bearing platform. At the same time, a pavement is trimmed from the base surface to the bottom of each leg platform, and the width of the pavement should be convenient for the passage of micro drilling rigs, and the slope should not be more than 25°.

4.3. Pile Center Positioning

According to the position relationship between each pile and the anchor bolt center, the center position of each pile is determined with a theodolite and a steel tape measure, and GPS is used to review it to ensure that the position of the pile center is correct. According to the central position of the hole pile, the site surveyor leads two auxiliary piles around the hole pile, and the two auxiliary piles introduced cannot affect the construction, and must be firm, and the auxiliary pile must not be damaged during construction.

4.4. Excavation into Holes

4.4.1. Rig in Place

After the working platform is levelled, the drilling rig is in place, the drilling rig is moved to make the center of the drill bit roughly aligned with the foundation center, lift the drill bit, adjust the position of the drill bit before and after adjusting the hydraulic rod of the drill bit, so that the center of the drill bit is facing the pile position, and measure the verticality of the drill bit with a horizontal ruler to ensure that the drill bit is plumb. The pile position deviation should be controlled within 20mm, and the pile verticality deviation should not be greater than 1% [2].

4.4.2. Mechanical Drilling

The drill bit is hammered by high-frequency vibration, and the drill bit is rotated synchronously, crushing the soil or stone and grinding it at the same time. The air compressor injects compressed air into the bottom of the hole through the ventilation hole at the bottom of the drill bit, blows the crushed stone powder or fine gravel out of

the hole, and the remaining residue that cannot be blown out is fished out by replacing the slag drill bit.

After the hole is cleared, the hole should be sealed immediately, and the hole should be covered with a hole cover plate of 800×800, and a bamboo rubber board of 600×600 should be covered on the hole cover plate to prevent items from falling into the hole.

4.5. Hole Detection

Hole forming inspection method: directly use laser wire hammer and steel tape measure for detection and detection.

After the hole reaches the design elevation, the hole depth, hole diameter, hole wall verticality, muck depth, etc. are checked, and the drilling rig is used to repair and clear the hole in time when it is unqualified. Measurements were repeated with measuring instruments and all bore pile sizes met design and specification requirements.

4.6. Rebar Cage Processing and Hoisting

Before the processing of steel bars, check the specifications and quantity of steel bars in the construction drawings in detail. In order to ensure the thickness of the protective layer of the steel bar, the main reinforcement needs to be welded with a protective plate or a lashing cement pad.

Use a crane or hook to hoist the rebar cage into the pile hole, when hoisting, the rebar cage is in a vertical state, and the bottom is aligned with the hole to avoid the rebar cage colliding with the friction hole wall; Before the rebar cage enters the hole, it is necessary to check the hole depth again to meet the design requirements, so as not to avoid the rebar cage cannot reach the design depth.

4.7. Pile Foundation Pouring

Due to the small diameter of the pile and the small spacing of the main reinforcement, fine stone concrete is used for pouring, and the slump is 50mm. The particle size of crushed stone requires 5-10mm, considering the fluidity of the concrete in the hole, according to the layered pouring and tamping every 500mm, the vibrating adopts a special extended 12m vibrator rod into the hole for vibrating.

4.8. Bearing Platform Steel Bar Lashing and Pouring

After the pile foundation is cured, all pile foundations should be tested with low strain, and 1 piece of each leg should be selected for uplift bearing capacity testing, and only after passing can the pile steel bar lashing and pouring be carried out, and the construction of the bearing part is consistent with the traditional construction method, which is not described in this article [3].

5. The Analysis of Economic Benefit

Time investment: since the equipment entered the site, the effective drilling construction time is 57 days, the average drilling and slag removal time of each pile is 2.38 days; the foundation is poured for 2 days, and the pile construction is 15, for a total of 74 days, of which the pile construction needs to be carried out after the pile body is maintained for 28 days and the test is qualified. The construction period of the traditional manual excavation foundation is about 60 days, and the micropile foundation is about 14 days longer than the traditional manual excavation foundation due to the many processes.

Equipment and personnel investment: the investment in micro pile foundation construction and traditional manual digging foundation is shown in table 2 (mixer and other undifferentiated comparison items are not counted and compared), and the construction of micro pile foundation increases the investment of mountain micro drilling rig, hook machine and mechanical operator, but the cooperation work is greatly reduced compared with the manual digging foundation.

Table 2. Micropile foundation construction and traditional manual excavation foundation input table.

project	Miniature pile foundations	Manually drilled foundations	remark
Mountain Micro Drilling Rig (machine-team)	57	/	
Hook machine (machine-team)	8	/	Site leveling, traction air compressor, steel cage hoisting
Micro rig operator (machine-team)	104	/	
Fit the work (machine-team)	132	480	

Safety benefits: the aperture of the micropile foundation pile body is 400mm, personnel cannot enter, and mechanical excavation is used to form holes, drilling, steel cage installation, pouring and other construction processes do not require personnel to go up and down the foundation pit operation, so as to effectively avoid the risk of poisoning and suffocation, object blow and high fall in limited space operation. Compared with traditional manual digging, the foundation is greatly safer.

6. Conclusion

Compared with traditional manual excavation foundations, mountain micropile foundations have the following advantages and disadvantages:

- Advantages:

(a) Low personnel input. The pile body part is mechanically excavated into holes, and the operation of foundation pit excavation and reaming at the bottom of the pit is realized by micro drilling rigs. The excavation process can be completed by 1 mechanical operator and 1~2 auxiliary operators. Nowadays, facing the shortage of

human resources and the continuous rise of labor costs, the promotion of mechanized construction and the reduction of personnel input construction methods are bound to be the direction of future development of construction technology [4].

(b) Good quality of holes. The special drill bit is used to excavate the hole, and the important parameters affecting the quality of the pile body, such as hole diameter, verticality and pile depth, are easy to control. Especially for rock geology, it can effectively avoid the shortcomings of traditional detonator blasting construction methods that are not easy to control and poor hole quality.

(c) High security. The mountain micro drilling rig does not require personnel to go up and down the foundation pit during the drilling process, which can effectively avoid the risks of poisoning and suffocation, object blows and high falls in the traditional deep foundation pit operation [5].

- Disadvantages:

(d) High equipment cost. At present, the mountain micropile foundation has not been widely used in a large area, the cost of a single equipment is high, and the fuel consumption of the equipment is large, the average fuel consumption per pile is 322 liters, the cost investment is larger than that of traditional manual excavation, and the equipment has higher requirements for terrain and roads, and further improvement of equipment is needed in the future, reducing the cost of single equipment and improving equipment adaptability.

(e) Great environmental damage. In order to meet the requirements of mountain micro drilling rigs, hook machines and other machinery in place, it is necessary to level a larger site on the base surface in advance, which has a certain pressure on environmental protection and subsequent site greening.

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