Transactions on Economics, Business and Management Research
ISSN: 2960-1789, eISSN: 2960-2254 | Volume 8
EMEHSS 2024

Study on cost and economy of Mountain micro-piles

Jingshuang Gan [1], Han Xiao [2]

[1] PowerChina Henan Electric Power Survey and Design Institute Co., Ltd., Zhengzhou 450007, China

2 Southwest Electric Power Design Institute CO, LTD. Of China Power Engineering Consulting Group, Chengdu 610057, China

Abstract. The State Grid Corporation of China has formulated relevant measures for further strengthening the management of mechanized construction, in order to promote the high-quality construction of the power grid and raise the level of mechanized construction of the power grid construction, improve the safety quality and efficiency of construction projects. At present, the construction of pole-tower foundation in mountain area mainly depends on manpower. It is very important to improve the level of power grid construction mechanization. This paper briefly introduces the characteristics and advantages of the mountain micro-pile foundation, discusses the cost items of the micro-pile in detail, and studies the economy of the mountain micro-pile by comparing the cost of the micro-pile with that of the common single pile.

Key Words: Mountain micro-piles, Cost items, Cost Analysis.

1. Introduction

The concept of micro-pile was first proposed by Italian engineers in the 1950s, and was used in underpinning of building foundation engineering in Italy.Brucw et al.[1]used the combination of micro-pile and upper cap beam as an embankment restoration project in southern Ontario, Canada. Macklin et al.[2]used micro-piles to support a project in Colorado, USA. Dino et al.[3]applied the micro-pile in the deep foundation pit support, acting as the deep foundation pit retaining wall. Yu Guihong et al.[4]used micro-piles to reinforce a high slope of jing-zhu expressway temporarily, and achieved a timely and remarkable reinforcement effect. Ma Zhou quan[5]used micro-piles to reinforce a section of yu-xiang expressway, combined with retaining wall treatment, the reinforcement effect is obvious.

Although a great deal of experience has been accumulated in the field of technical research, especially in the field of load bearing and engineering application, the application of micro-piles in transmission line engineering is still in its early stage, there is still no uniform standard for cost calculation, so it is urgent to study and analyze the cost structure of micro-piles to guide engineering practice. Based on the brief introduction of the mountain micro-pile, this paper puts forward the principles of the mounting quota of the mountain micro-pile and the pile foundation testing cost, by comparing the cost with the traditional single pile foundation designed under the same external conditions, the paper studies the economy of the mountain micro-pile, and provides the cost basis for further popularizing and using the mountain micro-pile foundation.

2. Introduction of Mountain micro-piles

The mountain micro-pile foundation is a kind of foundation composed of the ground micro-pile foundation with the diameter of 300-400mm, the reinforced concrete micro-pile formed by the pouring of fine stone concrete and the pile cap connected to the top of the pile, the utility model can be applied to the transmission line foundation engineering under the rock geological condition in the mountain area, and has a wide range of application. The advantages of mountain micro-pile Foundation are as follows: the diameter of foundation is suitable, the bearing capacity of single pile is higher than that of Anchor Pile Foundation, and the application range is wide; It can meet the needs

of foundation selection for overburden, soft rock and broken rock foundation about 4m-10m, adopting micro-pore-forming machine, which can be well adapted to different topography, low safety risk, fast pore-forming speed and high mechanization degree.

Mountain micro-pile is a new type of foundation, which requires little geological condition and rock integrity in mountain area. Combined with the existing research results and the geological conditions of this project, the recommended application areas are as follows:

(1)Hard rock, harder rock, softer rock, soft rock, extremely soft rock available；

(2)Weathered, lightly weathered, moderately weathered, strongly weathered and fully weathered rocks are available；

(3)Complete, more complete, more broken, broken rock, extremely broken rock available；

(4)The thickness of overburden is 4m-10m, which can be used according to the results of design calculation and test research when the thickness of overburden is large；

(5)Terrain gradient should not be greater than 25 degrees, tower leg local terrain is not greater than 30 degrees, tower traffic can be appropriately relaxed.

3. Cost structure of Mountain micro-piles

Because the 2018 line quota lacks the quota of mechanical excavation of micro-pile foundation, it is calculated with reference to the corresponding pricing quota of rotary drilling rig. Micro-pile cap cover with earthwork excavation, steel production and installation, concrete casting quota.

The vertical bearing capacity should be checked and accepted according to the code for pile foundation testing, which can be referred to the high strain method. For piles with diameter less than 0.6m, the acceptance code for pile foundation should not use embedded acoustic pipe for pile integrity testing. The low strain method can be used to test the integrity of the pile body.

Considering the mechanized construction in mountain area, the road repair and green compensation cost should be considered when the rotary drilling rig enters the site.

4. Compared with the cost of digging single pile foundation

Principle of enumeration

(1) According to“Power construction project budget quota” 2018 edition-volume IV overhead transmission line project pricing quota.

(2) Because the 2018 line quota lacks the quota of mechanical excavation of micro-pile foundation, it is calculated with reference to the corresponding pricing quota of rotary drilling rig.

(3) The micro-pile foundation in mountain area is excavated by special machinery, and the road-building scheme is designed according to the site condition.

(4) According to the 2018 edition of the quota, mechanical construction does not include human transportation, so when the use of micro-pile mechanical excavation construction does not include human transportation costs.

(5) Topography according to the engineering design documents, terrain coefficient and fee in accordance with the 2018 edition of the fixed standard calculation.

Cost Analysis

Straight Tower

Table 1.Comparison analysis table of straight line tower cost

Serial number	Geological conditions	Base type	Tower type	Body cost(¥10000)	Road repair(¥10000)	Green seedling compensation(¥10000)	Total(¥10000)
1	Ordinary soil 4m，Loose gravel 3m，Rock＞5m	Common single pile with digging hole	Z1、Z2、Z3、Z4	173.426	0	0	173.426
2		Mountain micro-piles	Z1、Z2、Z3、Z4	150.441	15.840	12.935	179.216
3		Mountain micro-piles-Common single pile with digging hole		-22.985	15.840	12.935	5.790
4	Ordinary soil 6m，Loose gravel 3m，Rock＞5m	Common single pile with digging hole	Z1、Z2、Z3、Z4	194.168	0	0	194.168
5		Mountain micro-piles	Z1、Z2、Z3、Z4	151.550	15.840	12.935	180.325
6		Mountain micro-piles-Common single pile with digging hole		-42.617	15.840	12.935	-13.842
7	Ordinary soil8m，Loose gravel 3m，Rock＞5m	Common single pile with digging hole	Z1、Z2、Z3、Z4	207.631	0	0	207.631
8		Mountain micro-piles	Z1、Z2、Z3、Z4	155.811	15.840	12.935	184.586
9		Mountain micro-piles-Common single pile with digging hole		-51.820	15.840	12.935	-23.044

Table2 The cost index table of common manual hole digging pile

(Geological conditions：Ordinary soil4m，Loose gravel3m，Rock > 5m)

Serial number	Project name	Unit	Works	Composite unit price(¥10000/m³/t)	Total Price(¥10000)	Notes
1	Earth excavation	m³	404.04	0.03	13.12	Geological conditions：Hard soil42%，Loose gravel31%，Rock27%
2	Fabrication and installation of steel bars	t	33.18	0.91	30.03	
3	Base pouring	m³	292.76	0.29	83.48	
4	Wall pouring (including over-irrigation)	m³	130.20	0.36	46.80	
Total					173.43	43.36 ¥10000/basis

Table 3 The cost index table of common manual hole digging pile

(Geological conditions：Ordinary soil 6m，Loose gravel3m，Rock > 5m)

Serial number	Project name	Unit	Works	Composite unit price (¥10000/m³/t)	Total Price (¥10000)	Notes
1	Earth excavation	m³	452.28	0.03	13.4289	Geological conditions：Hard soil57%，Loose gravel28%，Rock15%
2	Fabrication and installation of steel bars	t	37.924	0.91	34.3264	
3	Base pouring	m³	323.52	0.29	92.2643	
4	Wall pouring (including over-irrigation)	m³	150.6492	0.36	54.1484	
Total					194.168	48.54 ¥10000/basis

Table 4 The cost index table of common manual hole digging pile

(Geological conditions：Ordinary soil 8m，Loose gravel3m，Rock > 5m)

Serial number	Project name	Unit	Works	Composite unit price (¥10000/m³/t)	Total Price (¥10000)	Notes
1	Earth excavation	m³	494	0.03	12.5662	Geological conditions：Hard soil 70%，Loose gravel 24%，Rock6%
2	Fabrication and installation of steel bars	t	40.34	0.91	36.5132	
3	Base pouring	m³	352.32	0.28	98.9701	
4	Wall pouring (including over-irrigation)	m³	165.7656	0.36	59.5819	
Total					207.6314	51.91 ¥10000/basis

Table 5 Cost Index Table of micro-pile body engineering

(Geological conditions：Ordinary soil 4m，Loose gravel3m，Rock > 5m)

Serial number	Project name	Unit	Works	Composite unit price (¥10000/m³/t)	Total Price (¥10000)	Notes
1	Earth excavation(Platform)	m³	622.889	0.002	1.2494	Geological conditions：Hard soil100%
2	Mechanical drilling	m	672	0.113	75.7998	Geological conditions：Hard soil 38%，Loose gravel29%，Rock33%
3	Fabrication and installation of steel bars	t	49.856	0.825	41.1364	
4	Base pouring	m³	291.376	0.111	32.2556	
Total					150.4412	37.61 ¥10000/basis

Table 6 Cost Index Table of micro-pile body engineering

(Geological conditions：Ordinary soil 6m，Loose gravel3m，Rock > 5m)

Serial number	Project name	Unit	Works	Composite unit price (¥10000/m³/t)	Total Price (¥10000)	Notes
1	Earth excavation(Platform)	m³	622.889	0.002	1.2494	Geological conditions：Hard soil100%
2	Mechanical drilling	m	744	0.100	74.509	Geological conditions：Hard soil 52%，Loose gravel26%，Rock23%
3	Fabrication and installation of steel bars	t	51.6	0.825	42.581	
4	Base pouring	m³	301.13	0.110	33.2108	
Total					151.5502	37.89 ¥10000/basis

Table 7 Cost Index Table of micro-pile body engineering

(Geological conditions：Ordinary soil 8m，Loose gravel3m，Rock > 5m)

Serial number	Project name	Unit	Works	Composite unit price (¥10000/m³/t)	Total Price (¥10000)	Notes
1	Earth excavation(Platform)	m³	622.889	0.002	1.2494	Geological conditions：Hard soil 100%
2	Mechanical drilling	m	824	0.090	74.5697	Geological conditions：Hard soil 62%，Loose gravel 23%，Rock 15%
3	Fabrication and installation of steel bars	t	55.372	0.826	45.7256	
4	Base pouring	m³	311.92	0.110	34.2666	
Total					155.8113	38.95 ¥10000/basis

(2)Corner Tower

J1, J2, J3, J4 of turret, under different geological conditions, comparative analysis of the cost difference between ordinary hole digging pile and micro pile, as follows:

Table 8 Corner tower cost comparison analysis table

Serial number	Geological conditions	Base type	Tower type	Body cost(¥10000)	Road repair(¥10000)	Green seedling compensation(¥10000)	Total(¥10000)
1	6m Silty clay/3m Strong weathering in the form of fragments/15m Moderate weathering	Common single pile with digging hole	J1/J2/J3/J4	353.131	0	0	353.131
2		Mountain micro-piles	J1/J2/J3/J4	407.417	15.840	12.929	436.186
3		Mountain micro-piles-Common single pile with digging hole		54.286	15.840	12.929	83.055
4	8m Silty clay/3m Strong weathering in the form of fragments/15m Moderate weathering	Common single pile with digging hole	J1/J2/J3/J4	369.115	0	0	369.115
5		Mountain micro-piles	J1/J2/J3/J4	405.799	15.840	12.929	434.568
6		Mountain micro-piles-Common single pile with digging hole		36.684	15.840	12.929	65.453

The cost of turret project includes the cost of earth and rock excavation, the cost of making and installing steel bars, the cost of pouring foundation and the cost of transportation. The principle of calculation is to take J1、J2、J3、J4 four tower-type foundations respectively according to different geological conditions and calculate them separately according to the common excavated foundation and the micro-pile foundation, when the micro-pile is used, it is considered that the distance of road repair is 1.12 km/base, and the cost of road repair is increased accordingly. The concrete square of micro-pile foundation (including cap and pile body) is reduced by 40% , and the steel bar is increased by 150% Because of mechanical casting, the cost of micro-pile foundation casting is reduced by about 70% compared with that of Hole Pile Foundation.The valuation standard of micro-pile foundation is calculated by“Quota of track rotary drilling rig for digging pile foundation”, which is obviously higher than the cost of conventional foundation, mainly reflected in: the cost of mechanical drilling from scratch and a large number of piles, steel production and installation costs caused by the doubling of the increase in the amount of steel, and construction of roads and green compensation costs are also from scratch, it is not enough to offset the cost of base pouring saved.

5. Conclusion

This paper briefly introduces the application scope and advantages of the mountain micro-pile, studies and analyzes the cost composition of the mountain micro-pile, and obtains the following conclusions by comparing with the traditional foundation:

1) Compared with the traditional foundation, the mountain micro-pile has the advantages of short construction period, saving earthwork excavation, convenient construction and high mechanization；

2)Considering the total cost, the quota of track-type rotary drilling rig is used to calculate the micro-pile in mountain area, because there is no applicable quota, the cost of mechanical drilling and the cost of making and installing rebar increase exponentially, which leads to the economy is not obvious;

3)It is urgent to draw up the quota of micro-pile with better research pertinence.

References

[1] Hu Qiaomei.Calculation of micropile internal forces when reinforce the slope[D].Chang'an University, 2009.

[2] YAN Jin kai, YIN Yue ping, MA Juan.Large scale model test study on single micropile in landslide reinforcement[J].HYDROGEOLOGY & ENGINEERING GEOLOGY, 2012,(04):60-65.

[3] LU Ying fa. Deformation and failure mechanism of slope in three dimensions[J]. Journal of Rock Mechanics and Geotechnical Engineering, 2015, 7(2): 109－119.

[4] YU Gui hong, LI Hong chao.Landslide′s control with minipiles in the course of anchor construction[J].Chinese Journal of geological hazards and their prevention and control,2001 (02).

[5] HE Yong qiang, YANG Shi jiao, LUO Hui, CHEN Rong.Simplified method for steel micropiles in treatment of excavation landslide[J]. Chinese Journal of Geotechnical Engineering ,2014,36(S2):174-179.