

Common Problems and Countermeasures of Deep Foundation Pit Supporting Construction in Geotechnical Engineering

Jianan Zhang*, Zhongqi Sun

China Solibase Engineering Co.,Ltd, Beijing, China 101300

*Corresponding author: 241202846@qq.com

Keywords: Geotechnical engineering; Deep foundation pit support; Construction problems; Countermeasures

Abstract: With the extensive utilization of underground space, the underground construction projects are gradually increasing, and the foundation pit supporting construction is inevitable in the construction of underground projects. In the construction of deep foundation pit supporting, the actual geotechnical engineering must be considered to guide the construction of deep foundation pit supporting system and ensure the safety and reliability of deep foundation pit supporting construction. In order to reasonably avoid risks such as deformation of supporting structure and water leakage of supporting wall, on-site investigation and survey should be strengthened in the project design stage to understand the main influence of geotechnical engineering on deep foundation pit support and explore the main mechanical parameters. This work mainly discussed the construction problems of geotechnical deep foundation pit support, clarified the common problems in its construction and put forward effective solutions, so as to realize the scientific deployment and optimal control of foundation pit support construction, ensure the practical effect of deep foundation pit support, and effectively ensure the construction quality.

1. Introduction

In the development of underground space, the surrounding environmental factors of the foundation pit must be fully considered. Based on the complexity and multi-factor attribute of the surrounding environment of the foundation pit, construction technology and scheme must be properly selected in the foundation pit supporting construction to reduce the adverse impact of the surrounding environment like geotechnical engineering, so as to ensure the effective standard of the deep foundation pit supporting construction and lay the foundation for subsequent construction. In order to explore the influence of geotechnical engineering on deep foundation pit support construction, it is necessary to analyze the common operation problems [1]. Through the prevention and response of these problems and conventional treatment and preparation, the deep foundation pit supporting construction of geotechnical engineering can be put into practice to ensure the safety and efficiency of the operation, so that the construction project can achieve the established construction objectives and give full play to its application value.

2. Main Problems of Deep Foundation Pit Support Construction in Geotechnical Engineering

2.1 Mechanical parameter problem

The deep foundation pit support in geotechnical engineering is a supporting structure composed of piles, walls, braces or staggered bars used to support vertical rock slope. Support structure will be affected by soil pressure, which is directly related to soil geology. Geotechnical mechanics parameters will directly affect the design of support structure and make the construction restricted and affected. Especially in some of the more complex geological site construction, the construction of supporting structure will become more complex. Rock and soil composition is different in different places, so its mechanical parameters such as cohesion, water content and internal friction are also different, and

these parameters will change correspondingly with the destruction of geology by construction [2]. Therefore, these uncertainties will directly affect the accuracy of the real bearing capacity calculation of the supporting structure. The mechanical parameter determination is one of the most important and difficult problems to solve in the construction of deep foundation pit in geotechnical engineering.

2.2 Deformation problem of supporting structure

Deformation manifests in two aspects: horizontal and vertical deformation. When the foundation pit excavation is shallow, the deformation of retaining structure is mainly horizontal displacement towards the foundation pit direction, and the surface also deforms. With the increase of excavation depth, the release of soil weight stress increases, and the range of surface deformation and displacement increases. At the same time, the wall of support structure rises or sinks, which changes the depth of the pit bottom. The horizontal displacement of retaining structure mainly depends on the width of foundation pit, the depth of excavation, the nature of stratum, the stiffness of retaining structure and the depth of excavation. The exposure time of foundation pit, the timeliness and location of anchor bolt, or the prestress applied by anchor bolt play an important role in reducing the displacement of retaining structure. Under the action of soil pressure, the support structure built first may be deformed, leading to the failure of the subsequent deep foundation pit support construction, the failure of the overall support structure and the improvement of risk.

2.3 Water leakage problem of the supporting wall

The supporting wall is an important part of the geotechnical deep foundation pit support structure, and plays a supporting role. The foundation pit supporting structure is underground, and some are even directly near the groundwater source. The underground soil will contain a certain amount of water, resulting in the support wall in a wet environment for a long time, once the construction of the support wall problems, it is easy to produce water leakage. Water leakage will greatly damage the strength of the wall and reduce the supporting capacity, once beyond a certain critical point, the support wall will collapse, resulting in the whole supporting structure to fall apart.

2.4 Inadequate control problem

The deep foundation pit supporting construction of geotechnical engineering consists of several links, each of which may affect the final construction quality, so the construction quality monitoring is an essential link in the construction process [3]. However, many engineering construction management is relatively loose, and there is no special supervision system, resulting in insufficient supervision, and engineering construction in each link often appear a variety of problems.

3. Optimization Strategies for the Deep Foundation Pit Supporting Construction in Geotechnical Engineering

3.1 Optimize the parameter value of deep foundation pit

In the process of supporting structure design, each parameter is an important index to measure the stability and safety of supporting structure, so the parameters of deep foundation pit supporting structure also need to be optimized constantly. The main parameters in the design process include pile diameter, pile spacing, and embedded depth. These data parameters have a great impact on the deep foundation pit design. Especially, the parameter setting of pile diameter and pile spacing has direct influence on the stability of deep foundation pit design. Generally, the larger the pile diameter is, the less likely the deep foundation pit is to deform, but there is also a certain range, and the influence will be much smaller to a certain extent. In addition, the larger the pile diameter is, the higher the cost will be, so it is necessary to set a reasonable pile diameter data. However, if the distance between piles is too large, it is easier to deform deep foundation pit. However, if the distance between piles is too small, it will increase the cost. Therefore, a reasonable value should be determined according to the actual situation to ensure safety and stability and save cost. When setting

the parameter of the pile embedding depth, it needs to be verified and adjusted repeatedly, so as to ensure its rationality.

3.2 Select foundation pit supporting reasonably

In the construction of deep foundation pit support, the geological and topographical conditions of deep foundation pit support should be strictly investigated, the type of soil layer and water content should be defined, and the relevant soil tests should be done well. In the actual construction process, it is necessary to judge the stability around the rock and soil. If the stability meets the requirements, the construction can be directly carried out, but slope discharge and other operations are needed to make the depth meet the standard, so as to ensure the quality of deep foundation pit construction. The traditional single supporting form has been unable to meet the design and construction requirements of complex foundation pit, and often requires a combination of various support forms to adopt different construction methods according to different construction scope and construction conditions [4]. Different construction methods are adopted according to different construction scope and construction situation. There are mainly the following supporting forms in the construction of deep foundation pit: first, the supporting system. The supporting system mainly includes type steel combination support, reinforced concrete support and steel pipe support. In the actual construction, the supporting system is selected to avoid the excessive displacement of deep foundation pit; second, soil retaining system. According to the construction requirements, the pressure of deep foundation pit can be reduced in the construction process, mainly including reinforced concrete pile, cement mixing pile, and steel sheet pile; third, water retaining system. The water retaining system is mainly designed according to the hydrology of the construction site to prevent the occurrence of pit water seepage, pit bottom heave and other accidents, so that the reliability and safety of the foundation pit can be guaranteed. Therefore, the construction needs to choose the appropriate construction form according to the actual requirements.

3.3 Scientific treatment of supporting wall leakage problem

In view of the water leakage problem of the supporting wall, countermeasures can be selected according to the amount of water. When the amount of water is small, the seepage area can be filled with mortar or concrete; when the leakage is more serious, the leakage point is found on the supporting wall, and 0.5-1 m excavation is conducted around the point, and concrete is finally used to fill it. Both of the above cases are late remedial measures, and can not fundamentally solve the problem. In order to solve the leakage problem of the support wall fundamentally, it is necessary to attach importance to the connection and cooperation of each link in the process of foundation pit supporting. For example, when mixing slurry, proper amount of sodium silicate should be added to prevent slurry condensation in the mixing process. Modulation should be monitored to avoid segregation and pay attention to control the modulation time. During grouting, the phenomenon of broken grouting should be avoided as far as possible and grouting should be carried out in accordance with the grouting sequence.

3.4 Take multiple measures to strengthen quality control

First, it is necessary to complete the preparation of deep foundation pit supporting work before construction, including the design and modification of construction drawings, understanding of geological conditions, and mastery of surrounding construction environment and weather conditions. Second, it is necessary to strengthen the monitoring of site work. During the construction process, the frame structure is deformed because of exceeding its bearing capacity range, and the deformation of underground pipeline and slope is also common. If the structure is seriously deformed, it will affect the progress of the project to some extent, thus affecting the efficiency of the project. In order to better prevent the occurrence of this problem, the relevant site staff should strengthen the monitoring of the site. In addition, detailed measurement and analysis of field data are required to develop a reasonable design plan to reduce structural deformation. Furthermore, it is necessary to strengthen talent training. The management and control of the site personnel should be strengthened to ensure

that the front-line personnel should not make mistakes. This places greater demands on the field personnel, and the scheme will be modified according to their own wishes. Relevant preparations must be made before commencement, corresponding exploration must be carried out before implementation, and reasonable plans must be formulated according to the local actual situation [5]. In the process of implementation, it is necessary to control the completion efficiency of the project, solve the problems in time, and minimize the impact on the project schedule. Finally, it is necessary to focus on the innovative application of technology. For example, introducing BIM technology into geotechnical investigation and deep foundation pit supporting construction can drive the construction of 3-dimensional geological model. It makes the display of engineering geological information more intuitive and clear, and the extraction of data information more convenient, and provides effective reference for design, construction and scheme modification. The parameters and data information in the BIM model can not only be displayed in time, but also guide the staff to carry out the macro planning and analysis of the project, timely find the problems in engineering geology, improve the design of deep foundation pit supporting, and reduce engineering risks.

4. Summary

Geotechnical engineering investigation must be emphasized in deep foundation pit supporting construction. Through comprehensive analysis of the construction site conditions, the design and construction of foundation pit supporting can be guided, the perfect investigation scheme can be used to guide the reasonable avoidance and reasonable response to the risk problems caused by uncertain factors in foundation pit supporting. In this way, the construction quality of geotechnical engineering can be effectively improved, and the deep foundation pit supporting construction can be proceed smoothly, so as to truly guarantee the quality of construction.

References

- [1] He, X. X., Zhou, H. B., & Yao, H. (2006). Construction risk identification and assessment of a deep foundation pit in Shanghai. *Chinese Journal of Geotechnical Engineering*, 28, 1912-1915.
- [2] Xiao-cui, W. Z. X. B. (2007). The design and construction of deep foundation pit support [J]. *Shanxi Architecture*, 9.
- [3] Lei, G., & Gong, X. (2021). Analysis of lateral displacement law of deep foundation pit support in soft soil based on improved MSD method. *Advances in Civil Engineering*, 2021.
- [4] Weiwei, X. U. (2021). The Effecton Analysis of Geotechnical Investigation on Foundation Pit Supporting Construction. *Frontiers Research of Architecture and Engineering*, 4(1), 26-31.
- [5] WanYan, D. (2020, April). Application of deep foundation pit support technology based on big data analysis in construction engineering construction. In *Journal of Physics: Conference Series* (Vol. 1533, No. 4, p. 042001). IOP Publishing.