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Construction Technology of Deep Foundation Pit Support in Municipal Civil Engineering Foundation Construction

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Abstract: Municipal civil engineering is the key content of municipal construction, and the construction scale is usually large. The quality of the project plays an important role in the development of urban economy. Due to the rapid increase of high-rise buildings, skyscrapers and underground buildings, the construction technology of deep foundation pit support has gradually become an indispensable construction technology. Therefore, the selection of foundation pit support construction technology is crucial in ensuring that whether the foundation is firm and stable, and whether the subsequent construction activities can be carried out smoothly. In view of this, the article discusses the application of deep foundation pit support construction technology in municipal civil engineering, aiming to provide reference for subsequent projects.

Keywords: Deep foundation pit support; Civil engineering; Foundation construction; Concrete pouring pile technology; Row pile support technology

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1. Introduction

Deep foundation pit support construction technology is a crucial field in municipal civil engineering. Continuous urbanization and the increase in the scale of urban construction, more and more high-rise buildings, underground complexes and underground transportation facilities have been constructed. However, due to the limited land resources and increasingly complex geological conditions in the city, the construction and support of deep foundation pits has become extremely challenging. The construction of deep foundation pits involves many advanced technologies, and there are many factors to be considered during the construction process. For example, groundwater level, mechanical properties of soil, and the influence of adjacent buildings. If the foundation is not properly constructed and supported, it may lead to foundation pit collapse, ground subsidence, damage to adjacent buildings, and even pose a potential threat to the surrounding environment and the safety of residents.

2. Characteristics of deep foundation pit support construction

The construction of deep foundation pit support is a complex and critical task. The construction of deep foundation pit support are highly complex and difficult compared to other structures, and it is affected by many factors such as geological conditions, hydrological environment, urban traffic and environment. In terms of its characteristics, the main points are as follows.

2.1. Varying geological conditions

Urban geology is often complex and varied, and subsoil layers may contain different types of soil and rock. These geological conditions play a crucial role in the stability and support scheme of deep foundation pits. In the design of deep foundation pit support, detailed geological survey and soil mechanics test must be carried out to ensure the rational design and construction safety of the support structure [1].

2.2. High groundwater levels

Urban water tables are often high, especially in areas near rivers, lakes or oceans. During the construction of deep foundation pits, if effective water level control measures are not taken, groundwater may flow into the foundation pit, resulting in soil loss, instability of the pit bottom, and settlement of supporting structures. Therefore, a reasonable precipitation scheme and water level control means are crucial.

2.3. Susceptible to the influence of neighboring buildings

Urban foundation pits are often located near adjacent buildings, so the impact of construction on surrounding buildings must be reasonably evaluated and controlled [2]. Foundation pit construction may cause ground subsidence, structural vibration and other impacts, posing potential threats to the stability and safety of surrounding buildings. In the design stage, it is necessary to formulate corresponding monitoring plans, keep abreast of changes in adjacent buildings, and make adjustments and responses based on monitoring results.

2.4. Urban traffic and environmental factors

Deep foundation pit support construction is usually located in busy urban areas, so the impact of construction on traffic and the environment must be considered. During the construction period, roads and construction sites may be occupied, affecting traffic smoothness and daily life of surrounding residents. In the design of the construction scheme, it is necessary to comprehensively consider measures such as traffic control, noise control, and dust prevention to ensure that the impact of the construction process on the city is minimized.

2.5. High technical requirements for construction

The construction of deep foundation pit support requires relatively advanced construction technology. Many innovative support technologies have appeared over the years, such as cantilevered steel support, geogrid, prestressed anchor cable support, etc. [3]. The application of these new technologies can improve the construction efficiency and the stability of the supporting structure, and drive the development of urban civil engineering.

3. Application of deep foundation pit support construction technologies

3.1. Row pile support

Row pile support is a commonly used and effective technology in deep foundation pit support construction. By laying neatly arranged reinforced concrete piles on the edge of the foundation pit, a strong support wall is formed to resist the lateral earth pressure of the soil wall of the foundation pit, as shown in **Figure 1**. Row pile support is widely used

in municipal civil engineering, and is favored for its stable structure, simple construction, and adaptability. Before the construction of the deep foundation pit, the construction site should be cleaned and leveled to ensure that it is free from obstacles [4]. Geological survey and soil mechanics test are then conducted to obtain relevant geological information in order to determine the appropriate row pile support scheme. The positions and spacing of pile rows are planned and arranged according to the geological survey results and the design requirements of the foundation pit. They are usually arranged evenly at the edge of the excavation to form a continuous pile wall. The reinforced concrete is then poured into the pre-excavated holes to form the pile body by using the drilling method or the extrusion method. The size and strength of piles should be designed according to geological conditions and bearing requirements. Each pile is connected together by connectors to form an overall pile-wall structure. This ensures sufficient stiffness and stability of the pile wall against lateral earth pressure. Horizontal support are installed on the inner side of the pile wall to support the bottom and side walls of the foundation pit [5]. The supporting structure is usually supported by steel, wood, or concrete to keep the foundation pit stable.

Figure 1. Row pile support technology

The pile wall formed by row pile support technology is rigid and stable It can effectively withstand lateral earth pressure and groundwater pressure, thus maintaining the stability of the foundation pit. Moreover, its construction is relatively simple and does not require complicated equipment and processes. The pouring of piles can be done on-site or prefabricated to improve construction efficiency. There is no need for supporting structures in the foundation pit for row pile supports, which saves the construction space and makes the inside of the foundation pit available for other construction operations.

3.2. Cast-in-place concrete piles

Cast-in-place concrete piles is a commonly used technology in deep foundation pit support construction. The pile body is formed by pouring reinforced concrete at the edge of the foundation pit excavated underground or inside the foundation pit to support the side wall and bottom plate of the foundation pit and prevent the soil from collapsing and instability of supporting structures. The concrete pouring pile technology has the advantages of simple construction, strong bearing capacity, and wide adaptability, so it is widely used in municipal civil engineering.

Before the construction of the deep foundation pit, several preparation works are done, including cleaning the construction site, conducting geological surveys and soil mechanics tests to determine the location and size of the cast-in-place piles. The layout and spacing of the concrete pouring piles are determined according to the geological survey results and the design requirements of the foundation pit. In general, concrete pouring piles

will be evenly distributed on the edge of the foundation pit or inside the foundation pit to form a continuous pile wall or pile network. The boreholes for the cast-in-place piles are excavated using a drilling machine or other suitable equipment. The depth and diameter of the holes must meet the design requirements to ensure the stability and bearing capacity of the pile. After the borehole is formed, reinforced concrete is poured into the borehole to form a pile [6]. When pouring concrete, it is necessary to control the construction quality to ensure the compactness and uniformity of the concrete. A connector can be reserved on the top of the cast-in-place pile to facilitate connection with other supporting structures, such as steel supports or beams.

The cast-in-place concrete pile is made of reinforced concrete. It has a high bearing capacity, thus it can effectively resist lateral earth pressure and groundwater pressure, and maintain the stability of the foundation pit. This technology is applicable to different types of foundation pits, such as slope type and foundation pits with large changes in cross-sectional dimensions, etc., and has strong adaptability. It should be noted that in order to ensure the quality and safety of deep foundation pit construction, the dewatering system supported by row piles should be reasonably designed and constructed to ensure that the groundwater level inside the foundation pit is controlled within a suitable range [7].

3.3. Soil nailing

Soil nailing involves pre-embedding soil nails made of metal or composite materials inside the foundation pit or at the edge of the foundation pit. The soil nails interact with the surrounding soil to form an overall support structure, as shown in **Figure 2**. Soil nailing is relatively simple, and it is adaptable. Therefore, it is widely used in deep foundation pit construction.

The construction site is surveyed before the construction begins, and the impurities on the site are cleaned up, soil mechanics tests are performed, and the specific size specifications and positions of the soil nails are determined. The layout position and spacing between the soil nails is determined according to the geological survey results and the design requirements of the foundation pit. The soil nails can be evenly distributed on the edge or inside of the foundation pit to form a supporting structure. Then, holes are drilled on the edge or inside of the foundation pit to install the soil nails. The nails are inserted into the holes and high-strength grouting materials are injected to enhance the bonding force between the soil nail and the soil. In order to further stabilize the edge of the foundation pit, slope treatment measures are usually taken, such as spraying concrete or setting a sprayed concrete retaining wall [8]. In addition, special attention should be paid to the protection of adjacent buildings to avoid the impact and damage caused by construction.

Figure 2. Soil nailing technology

3.4. Slope protection piles

Slope protection piles are also known as geogrid wall. Through this technology, a strong support structure is formed by embedding reinforced concrete piles into the soil to resist the lateral earth pressure of the soil on the side wall of the foundation pit. Slope protection piles are widely used in municipal civil engineering, and is favored because of its advantages such as structural stability, rapid construction, and economical efficiency.

The arrangement and spacing of the slope protection piles are determined according to the geological survey results and the design requirements of the foundation pit. They are usually evenly arranged on the edge or inside of the foundation pit to form a continuous support structure. Firstly, holes are drilled on the edge or inside of the foundation pit. The reinforced concrete slope protection piles are then embedded in the drilled holes, and high-strength grouting materials are injected to enhance the bonding force between the slope protection piles and the soil. Subsequently, the slope protection piles are connected with the support structure in the foundation pit or other stable strata to form an overall support system. Slope protection piles can be quickly constructed, allowing for rapid completion of large-scale pile construction, which facilitates project progress control. Furthermore, this construction technology generates minimal environmental pollution during the process, aligning with environmental protection standards.

4. Application strategies of deep foundation pit support construction technologies

4.1. Field survey in the early stage

Preliminary field survey is the first and most critical step in deep foundation pit support engineering. Proper on-site survey should be performed to understand the geological conditions of the area where the foundation pit is located, including geological structure, stratum distribution, rock and soil properties, etc. In the field investigation, it is necessary to conduct soil quality tests, which includes the determination of soil density, shear strength, permeability, and other parameters. Observing and recording changes in the groundwater level can help formulate a precipitation plan to ensure that the groundwater level in the foundation pit is within a controllable range and avoid problems such as foundation pit collapse caused by the influx of groundwater. It is also necessary to investigate and record the location and direction of underground pipelines. Collection of data from the construction area can aid the design of the support structure and the formulation of the construction plan, so that the foundation pit support can suit different geological conditions [9].

4.2. Accurate excavation and filling of foundation pit

The excavation and filling of the foundation pit are crucial aspects in the construction of deep foundation pit support. The size and shape of the foundation pit should be consistent with the design requirements, and the angle of the side slope should be strictly controlled to avoid soil erosion and landslides. The filling soil should meet the engineering requirements to ensure the uniformity and compactness of the filling soil to provide stable soil support [10]. At the same time, the drainage system should be reasonably designed and constructed to keep the groundwater level inside the foundation pit within a controllable range, so as to prevent the foundation pit from collapsing or the supporting structure from being damaged due to the influx of groundwater. In addition, it is necessary to utilize advanced technology for real-time monitoring of the excavation and filling process of the foundation pit, so as to facilitate timely detection and resolution of emergencies.

4.3. Optimization of construction scheme design

Optimizing construction scheme design of the deep foundation pits can improve engineering efficiency

and reduce costs. By rationally planning the construction process and selecting appropriate equipment, the construction process can be optimized and the duration of construction can be shortened. Safety and environmental protection factors should also be considered when designing the project to ensure project quality and safety.

4.4. Selection of foundation pit support construction method

It is crucial to choose a suitable method for constructing the foundation pit support. The selection of method depends on the depth of the foundation pit, soil conditions, groundwater level and other factors, such as steel support, concrete pouring pile, soil nailing support, slope protection pile, etc. Reasonable selection of support methods can improve construction efficiency, reduce costs, and at the same time ensure the stability and safety of the project.

5. Conclusion

In summary, with the expansion of municipal civil engineering construction scale, deep foundation pit support construction has grown popular. In order to ensure the quality and stability of the foundation of the project and improve the overall construction quality, full on-site investigations are required, and suitable technology should be utilized.

Disclosure statement

The author declares no conflict of interest.

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