Research on Groundwater Control Technology in Construction Based on Foundation Pit Construction Condition

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Abstract. With the rapid development of national economy and the restriction of urban construction land, high-rise buildings are mostly concentrated in urban centers. The construction and development of high-rise buildings promote the rapid development of deep foundation pit engineering, and the number and scale of foundation pit engineering are increasing day by day. In urban construction, a large number of high-rise buildings appear, and with the need of subway engineering and civil air defence works, deep foundation pit engineering in buildings is very common. In order to ensure the safe construction of deep foundation pit, groundwater must be controlled. If the groundwater is mainly phreatic water, vadose water or confined water with low water pressure, it should be blocked mainly. The specific technology is to construct a water-stop curtain around the foundation pit to stop the groundwater outside the foundation pit. If the groundwater is confined water with high pressure, measures should be taken to remove the water in the pit to prevent the foundation pit from surging. By analyzing the relationship between deep foundation pit engineering and groundwater, this paper summarizes the control methods of groundwater in deep foundation pit engineering.

Keywords: Deep foundation pit engineering, Groundwater, City construction.

1. Introduction

With the rapid development of urbanization, the underground space is being developed and utilized, and the scale and depth are constantly increasing, so the foundation pit engineering has become an engineering content that must be faced. Because of its large scale, deep depth and uncertainty of underground space, foundation pit engineering has become the most frequent field of engineering accidents [1]. Deep foundation pit construction is a frequent project in construction projects. However, when deep foundation pit construction is carried out in a complex surrounding area, a series of problems will easily occur, such as the settlement of buildings and the damage to pipelines, which will have a great impact on the surrounding area [2]. Groundwater is one of the important factors affecting the construction quality and safety of deep foundation pit. The existence of groundwater will affect the overall stress of deep foundation pit to a certain extent, and will change the mechanical characteristics of soil around deep foundation pit. If the design is unreasonable, it will greatly increase the project management cost of investment projects, which is unacceptable to investors [3]. Therefore, the cost management personnel should actively participate in the effective formulation of the early design scheme of the project construction, so as to ensure that the project cost control can be fully implemented in place [4]. In order to ensure the structural safety of high-rise buildings, the surrounding buildings, municipal pipelines, groundwater conditions, etc. should be fully explored before the implementation of the deep foundation pit construction scheme, and corresponding disposal measures should be formulated to solve the deep foundation pit construction problem of high-rise buildings in complex environment [5].

With the continuous advancement of modernization, urban land is becoming more and more tense, so the application of underground space has become the inevitable trend of current and future development. Deep foundation pit construction of high-rise buildings is often carried out in a complex environment with dense pipelines, dense buildings, large traffic and people flow. The foundation deformation caused by deep foundation pit construction will endanger the adjacent buildings and municipal pipelines, and may affect the personal safety of the surrounding residents [6]. Zheng et al.

analyzed the comprehensive groundwater control of deep foundation pit in complex environment [7]. Zhao et al. have studied the design practice and innovation of deep and large foundation pit engineering [8]. Wang et al. studied the stability calculation method of confined water foundation pit in soft soil area [9]. Gong et al. studied the deformation control technology of foundation pit engineering in complex surrounding environment [10]. More than 60% of most accidents related to foundation pits are related to groundwater, which is the most active part of the geological environment and an important condition affecting the stability of geological engineering. Therefore, we must fully understand the construction geological conditions and surrounding environment of the project, and put forward the construction plan and scheme pertinently, so as to ensure the smooth progress of each link of the project. By analyzing the relationship between deep foundation pit engineering and groundwater, this paper summarizes the control methods of groundwater in deep foundation pit engineering.

2. Influence of groundwater on deep foundation pit engineering

Generally speaking, there are many factors that affect the change of groundwater table. For example, when the diameter of particles contained in aquifer is relatively small, it will seriously affect the water penetration. When the thickness of vadose zone of aquifer is insufficient, the distance between capillary zone and the surface will be greatly reduced, and then the saturation deficit of soil will be reduced. When the height difference between groundwater layers is not obvious, it will affect the mobility of water bodies and cause difficulties in the discharge of groundwater. There are many kinds of existing states of reclaimed water, while the existing forms of groundwater include upper stagnant water, phreatic water and confined water. In the process of foundation pit excavation, the water in the foundation pit is often in a flowing state. Because the water pressure in some soils is hydrostatic or one-dimensional seepage, only Rankine's theory is applicable, but the plane seepage is not applicable. When the height difference between groundwater layers is obvious, and the surrounding rock property and particle diameter in the flow direction change, it will block the flow of water body and bring adverse effects to drainage work. In the construction area of deep foundation pit engineering, when there are recharge sources of groundwater, such as rivers and reservoirs, it will lead to the continuous infiltration of surface water, which will affect the drainage work. When the water behind the retaining wall is two-dimensional seepage, the Rankine theory is not applicable because the seepage force direction is not all vertical. At this time, the results calculated by Rankine theory and Coulomb theory are quite different. In addition, the different direction of seepage force will affect the water and soil pressure of foundation pit.

When the hydrogeological environment around the underground water body is artificially changed during the construction process, the construction quality of deep foundation pit will be affected. For example, when the discharge of groundwater during the construction period far exceeds its natural recharge, the groundwater level will drop rapidly and a cavity will be formed. In severe cases, the surface will collapse. The water source of deep foundation pit is often complicated, and surface water or groundwater, rainwater or water seepage from the original pipeline may directly cause the groundwater level to be too high. In urban construction, a considerable number of foundation pit accidents are caused by groundwater changes caused by foundation pit excavation. When the underground water body is not disturbed by human factors, its pressure is usually maintained in a relatively balanced state. However, during the construction period, due to the influence of human factors, the equilibrium state of water pressure will be destroyed and the water flow will be intensified. When the surrounding rock strength of deep foundation pit is not enough to resist the pressure of water flowing, water will gush out, which will affect the construction safety. The excavation of deep foundation pit should not only ensure the stability of the foundation pit, but also meet the requirements of deformation control to ensure the stability of buildings, structures, underground pipelines and roads around the foundation pit.

3. Groundwater control technology in foundation pit construction

3.1. Construction control measures for deep foundation pit

Before the project construction, the geological department should survey the geological data and hydrological data in a certain area around the construction site accurately, so as to prevent the occurrence of construction accidents caused by imperfect and inaccurate geological data. Designers should thoroughly study the geological data, be familiar with the stratum conditions and water conditions in the construction area, and carefully study the construction scheme in strict accordance with the data of the data. Through the discussion of schemes by various departments, a safe and economical construction scheme is finally obtained. In practice, the leakage of waterproof curtain often occurs, accompanied by a large number of water and sand leakage, slope instability, collapse, pile dumping and uneven settlement of nearby buildings and pavement. Its internal cause is mainly its own defects, such as the seam of underground continuous wall does not match or there are honeycomb holes in permeable layer. For rainwater, drainage should be done in time after the rain, especially when cracks have been found at the foundation pit edge, so as to prevent rainwater recharge and further development of cracks, which will eventually lead to ground collapse and overall instability of foundation pit. The construction process of deep foundation pit is shown in Figure 1.

Figure 1. Construction process of deep foundation pit engineering

Excavation of deep foundation pit has different effects on adjacent buildings. Improper excavation of foundation pit may lead to tilt, cracking or even more serious damage of adjacent buildings. According to the theory of foundation bearing capacity, the excavation of deep foundation pit will also affect the bearing capacity of existing adjacent buildings, because the excavation of foundation pit means the reduction of overload around the adjacent buildings. Because the existence of groundwater has a great negative impact on the construction of deep foundation pit, it is usually necessary to maintain the construction environment in a relatively dry environment during the construction at this stage. Flood control and emergency measures should be taken to prevent the deep foundation pit being excavated in the rainy season from being flooded. In construction, it is often the measure of pouring reinforced concrete retaining wall to cut off the main water inlet channel. At the same time, the water in the pit should be drained as much as possible, and special water pipes or passages should be set up, including intercepting ditches or large-diameter water pipes at the side of the pit, which should be introduced into the sewer or designated places.

When there is an aquifer in the upper part of the deep foundation pit, the water content of the aquifer and the surrounding rock should be investigated in detail. When the aquifer exists for a relatively long time, the water body is small, and its surrounding rock has high hardness, high density, and is not easy to penetrate, drainage measures may not be taken, but the changes of its water body and surrounding rock should be closely observed. When the formation time of aquifer is short, the water body is large, and the hardness of surrounding rock is low, the particle density is small, and the permeability is obvious, the water body should be discharged by collecting well. In order to reduce

the impact of deep foundation pit excavation on surrounding buildings, a row of dewatering points can be set between dewatering well points and buildings. When dewatering well pumps water, water pumped from dewatering well is poured into this row of dewatering points to ensure the original groundwater level balance and avoid cracking of surrounding buildings due to settlement due to dewatering construction. After the precipitation starts, monitor the dynamic changes of the surrounding buildings, especially the high-rise buildings, such as settlement and inclination, and control the precipitation time and interval according to the measurement and observation records to ensure the smooth progress of the deep foundation pit construction.

3.2. Construction measures of large foundation pit under complex geological conditions

When curtain grouting method is used for waterproofing, the height of the curtain should be determined according to the actual construction. It can be selected to reach the deep waterproof rock layer, or the curtain depth can exceed the deep foundation pit, and the water flow is not enough to have adverse effects on the construction. Well-point dewatering is in the construction site. According to the design requirements, one or more well points are selected to discharge the groundwater, so that the water level reaches the range of 15 meters below the surface, thus effectively avoiding water infiltration. When the overlying strata of the confined water body are not enough to resist the water pressure, and there is a risk of seepage to the bottom of the deep foundation pit, and the method of blocking the water body is not suitable due to geological conditions, it is necessary to adopt technical means to reduce the water pressure to the safety standard. In the process of depressurization, the rock stratum at the bottom of the deep foundation pit should be analyzed first, and its pressure should be calculated accurately, so that after the water pressure is released, it cannot penetrate into the bottom of the deep foundation pit. Groundwater control of foundation pit construction is shown in Figure 2.

Figure 2. Groundwater control in foundation pit construction

Because of its high water pressure, the permeability of confined water is obviously enhanced in the process of construction. When the construction of deep foundation pit is far away from the confined water body, the continuous wall and other control technologies are usually adopted, and the continuous wall hits the confined water body and enters the rock layer with relatively high hardness and density, which can hinder the connection between the confined water body and the deep foundation pit project, and then the confined water body is discharged by means of drainage equipment. When the precipitation effect is not obvious in the concrete construction process, the wall of deep foundation pit can be consolidated by strengthening steel piles, thus ensuring the construction quality and progress. When strengthening is needed, high-grade concrete can be added into the steel pipe. Because it is a strengthening section, it is required to strictly control the mixing time of concrete, effectively improve the uniformity of mixing, and thus improve the overall quality of the structure. Today, the urban construction land is becoming more and more tense, and the high-rise buildings are facing more and more complicated surrounding environment. The construction technology of deep

foundation pit needs to be continuously improved. Through the strict management of the construction process, it is further combined with the actual complex environment of the construction site.

4. Conclusions

The construction of deep foundation pit is relatively complicated, and the required construction technology covers many fields, which is a systematic project. In the design and construction of deep foundation pit support in complex engineering environment, factors such as site engineering, hydrogeological conditions, surrounding environmental conditions, construction machines and tools, restriction of side wall displacement of foundation pit, protection of underground pipelines, meteorological conditions, etc. should be considered comprehensively. Precipitation is a complex subject related to many factors, and it is a systematic project. Survey, design, construction, monitoring and management are several closely linked links, which require not only knowledge of related disciplines, but also rich construction experience and scientific management methods. During the construction process, all departments should perform their duties, observe the changes of buildings around the construction site, monitor the groundwater situation in real time, and formulate emergency treatment plans according to the local weather conditions. According to different types of houses around the foundation pit and different groundwater levels, different control measures are adopted. At the same time, a reliable on-site measurement and monitoring system should be established, and monitoring information should be timely fed back to implement dynamic control in each stage of construction.

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