

Exploration of Construction Technology for Building Foundations under Complex Geological Conditions

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Abstract: *This article explores the key technologies in the construction of building foundations under complex geological conditions, including geological survey and analysis, foundation reinforcement, deep excavation support, and waterproof layer treatment. Through a detailed analysis of these technologies, it is explained how to address issues such as soft soil, loose soil layers, and high groundwater levels to ensure the stability and safety of building foundations. The article emphasizes the importance of these technologies in practical applications and points out that in the future, with technological progress, building foundation construction will be more efficient and safe in complex geological environments.*

Keywords: Complex geological conditions, Building foundation, Construction technique.

1. INTRODUCTION

In modern urban construction, the construction of building foundations under complex geological conditions has become a challenging task. The complexity of geological conditions includes factors such as soft soil, collapsible loess, sand layers, deep foundation pits, and abundant groundwater. These factors affect the design and construction of basic engineering, and different geological conditions require different construction plans and technical measures to ensure the safety and stability of buildings. With the acceleration of urbanization, more and more construction projects are entering complex geological areas. Therefore, how to cope with complex geological conditions and ensure the reliability of building foundations has become a focus of research in the field of construction engineering. For the construction unit, a reasonable assessment of geological risks and the adoption of advanced technological means are the key to ensuring the smooth implementation of the project.

2. THE CONCEPT OF BUILDING FOUNDATION CONSTRUCTION UNDER COMPLEX GEOLOGICAL CONDITIONS

Construction of building foundations under complex geological conditions refers to the process of constructing building foundations in areas with complex or special geological environments, such as soft soil foundations, unstable rock formations, and high groundwater levels. This type of construction requires consideration of the bearing capacity of geological layers, ground subsidence, the impact of groundwater, and other natural factors to ensure the stability and safety of the foundation. Special designs and techniques are usually required during construction, such as deep foundations (underground continuous walls, pile foundations, etc.), foundation reinforcement techniques, groundwater treatment measures, etc., to address the risks posed by adverse geological conditions. At the same time, the construction unit also needs to conduct detailed geological exploration and mechanical analysis to ensure that the foundation design can meet the load requirements of the building. Under complex geological conditions, the difficulty and risk of building foundation construction are relatively high. Therefore, higher requirements are put forward for the technical level, equipment requirements, and schedule arrangement of the construction team. It is necessary to ensure the precise execution and safety guarantee of every link in the construction process.

3. CHARACTERISTICS ANALYSIS OF BUILDING FOUNDATION CONSTRUCTION UNDER COMPLEX GEOLOGICAL CONDITIONS

The characteristics of building foundation construction under complex geological conditions are mainly reflected in design requirements, construction methods, and risk management. In complex geological environments, the foundation design of buildings requires detailed analysis and adjustment based on geological survey results. Unlike typical foundations, under complex geological conditions, there may be unfavorable factors such as soft soil layers,

deep sedimentary layers, abundant groundwater, and uneven rock layers. Designers need to carry out specialized reinforcement design or select appropriate foundation types based on these characteristics, such as deep foundations (pile foundations, underground continuous walls) or replacement foundations, to ensure the bearing capacity and stability of the foundation. This type of construction design typically requires high-precision geological survey data and takes into account possible changes during the construction process, such as fluctuations in groundwater levels, seismic activity, and other factors. Therefore, the construction of building foundations under complex geological conditions has high technical difficulty and requirements, and must rely on scientific analysis and rigorous engineering design. During the construction process, complex geological conditions pose severe challenges to construction techniques, equipment, and schedule arrangements. Due to the uncertainty of geological conditions, there may be sudden groundwater surges, soil layer changes, underground obstacles, and other issues during the construction process. This requires the construction unit to have strong emergency response capabilities and rich on-site experience. For example, areas with high groundwater levels may require precipitation measures such as precipitation wells and pumping equipment to reduce the impact of water levels and ensure construction safety. In addition, during the construction process, it is necessary to closely monitor the settlement and deformation of the foundation, and adjust the construction plan in a timely manner. Due to the high construction risks under complex geological conditions, the project schedule may be delayed. Therefore, a reasonable schedule, precise construction steps, and continuous quality control are key to ensuring the smooth progress of the project. In short, the construction of building foundations under complex geological conditions not only requires highly specialized technical support, but also requires meticulous project management and careful risk control.

4. ANALYSIS OF CONSTRUCTION TECHNOLOGY FOR BUILDING FOUNDATIONS UNDER COMPLEX GEOLOGICAL CONDITIONS

4.1 Geological Exploration and Analysis

Geological survey and analysis are fundamental tasks in the construction of building foundations under complex geological conditions. Firstly, geological exploration techniques comprehensively understand geological layers, soil properties, groundwater levels, and hydrogeological characteristics through drilling, sampling, laboratory analysis, and on-site testing. Drilling technology is a commonly used survey method that can obtain important information such as the depth, thickness, soil type, and bearing capacity of geological layers, providing data support for subsequent foundation design. Common drilling methods include power drilling, rotary drilling, and groundwater level monitoring, which are suitable for different geological conditions and construction environments. In addition, on-site static penetration tests (CPT) and standard penetration tests (SPT) can also provide indicators such as soil compaction and shear strength, providing intuitive data for foundation design. These survey methods, combined with modern geological detection technologies such as ground penetrating radar (GPR) and seismic wave detection, can provide more accurate geological analysis for foundation construction in complex geological areas. Secondly, the survey results require a comprehensive geological analysis. Through comprehensive analysis of geological survey data, the stability, bearing capacity, and deformation characteristics of soil layers can be evaluated, providing a basis for optimizing construction plans. Especially under complex geological conditions, analyzing soil compaction, plasticity index, moisture content, and groundwater flow characteristics will help engineers determine the most suitable foundation type. For example, in soft soil areas, it may be necessary to improve the bearing capacity of the foundation through techniques such as foundation reinforcement and soft soil compaction. In areas with abundant groundwater or hydrological anomalies, special attention should be paid to factors such as water level fluctuations and groundwater flow velocity, and waterproof and drainage measures should be considered. On this basis, using geomechanical analysis methods and combining geological models for numerical simulation, it is possible to predict the settlement, displacement, and stress change trends of different soil layers, further ensuring the scientificity and safety of foundation design. In short, geological exploration and analysis not only provide theoretical support for basic design, but also provide data basis for technical decisions during construction.

4.2 Ground Reinforcement Treatment

Under complex geological conditions, the bearing capacity of the foundation is often insufficient to support the load of the upper structure, resulting in excessive or uneven settlement, which affects the safety of the building. Therefore, foundation reinforcement treatment is a key measure to ensure the stability of building foundations. One of the common methods for foundation reinforcement is dynamic compaction technology. Dynamic compaction technology uses large hammers to repeatedly strike the foundation, using the impact force to compact

the soil and improve the bearing capacity and stability of the foundation. Dynamic compaction is suitable for conditions such as soft soil layers, fill layers, and loose soil layers. By improving the compactness of the soil, reducing the voids in the soil layer, and thereby enhancing the compressive strength and anti settlement ability of the foundation. The advantage of this method is that it has a shorter construction period, relatively lower cost, and can effectively solve the problem of foundation reinforcement in large areas. Dynamic compaction technology is particularly suitable for areas with poor geological conditions, soft soil or loose fill, and can provide more solid support for building foundations. Another commonly used method for foundation reinforcement is grouting reinforcement technology. Grouting reinforcement technology injects specific slurry (such as cement slurry, chemical slurry, or resin slurry) into the foundation soil layer, utilizing the permeability and hardenability of the slurry to change the physical and chemical properties of the soil, achieving the purpose of reinforcing the foundation. This technology is particularly suitable for areas with loose soil layers, gaps or cracks, such as soft soil layers, sandy soil layers, and fractured rock layers. Grouting reinforcement can effectively improve the compactness of soil, enhance its bearing capacity, and prevent foundation softening caused by groundwater infiltration. During the implementation process, different grouting methods can be selected, such as deep grouting, surface grouting, or single point grouting, which can be adjusted according to specific geological conditions and reinforcement requirements. Grouting reinforcement technology has strong adaptability and can customize solutions for different soil conditions. The advantage of this technology is that it can quickly reinforce the foundation without large-scale excavation, avoiding the impact on the surrounding environment, and is particularly suitable for foundation reinforcement in urban areas and underground engineering.

4.3 Deep Foundation Pit Support Technology

Deep foundation pit support technology is one of the important technologies in the construction of building foundations under complex geological conditions. Its main purpose is to ensure the stability of the soil around the foundation pit, prevent pit collapse or ground settlement, and ensure construction safety. One of the common deep foundation pit support techniques is bored pile support. Drilled pile is formed by drilling holes around the foundation pit and pouring cement slurry to form a pile structure. These piles can effectively withstand the lateral pressure of the foundation pit soil and play a supporting role. Grouting pile support is suitable for geological conditions such as soft soil and sandy soil, especially in the construction of deep foundation pits. It can effectively reduce the risk of foundation pit collapse and prevent damage to surrounding buildings due to foundation pit settlement. Grouting piles can not only provide strong support, but also enhance the stability of the foundation pit through the bonding force with the soil layer. The advantage of this technology is that it has a fast construction speed, and the depth and diameter of the pile can be adjusted according to actual needs, with strong adaptability. Another common deep excavation support technique is underground continuous wall support. Underground continuous wall support is a support method that uses mechanized construction to continuously install underground walls and isolate the foundation pit from the surrounding soil. This technology excavates and fills reinforced concrete walls around the foundation pit to form a complete enclosed enclosure structure, effectively preventing groundwater infiltration, soil loss, and deformation of the foundation pit. Underground continuous walls have high bearing capacity and water resistance, and are suitable for areas with high groundwater levels, soft or weak soil layers. During the construction process, it is necessary to first excavate the soil using excavation equipment, then set up the steel reinforcement skeleton and pour it. The construction quality requirements are high, but it can effectively improve the stability of the foundation pit support and reduce safety risks during the construction process. In addition, underground continuous wall support also has a long service life, and its sturdy wall structure can provide good support for other construction work in the foundation pit, avoiding the impact on the surrounding environment and structure. Due to the large amount of earthwork and mechanical operations involved in the construction process, the construction period of underground continuous walls is relatively long, but its long-term support effect is very significant, especially in complex geological and hydrological conditions where it performs well.

4.4 Waterproof Layer Treatment Technology

In areas with high groundwater levels or strong groundwater mobility under complex geological conditions, the construction of building foundations often faces problems of soil and water infiltration and foundation pit water accumulation. To address these issues, waterproof layer treatment technology has become an important construction technique, mainly by setting up waterproof layers to prevent water from entering the foundation area, ensuring the stability and dryness of the foundation. One of the common methods for treating aquitards is waterproofing and anti-seepage membrane technology. Waterproof and anti-seepage membrane is a complete waterproof barrier formed by laying special waterproof membrane materials such as high-density polyethylene

(HDPE), polyvinyl chloride (PVC), etc., to prevent groundwater from seeping into foundation pits or soil. This membrane material has good waterproof performance and corrosion resistance, which can effectively isolate the infiltration of groundwater, prevent moisture from the soil layer from entering the foundation soil, and reduce the risk of softening and instability of the foundation soil. The construction of waterproof membrane is relatively simple and suitable for areas with high water levels or strong soil permeability. It can provide long-term waterproof protection, especially from the construction stage to the completion of the foundation. Waterproof membrane can play a crucial role. Another commonly used technique for treating aquitards is groundwater pressure reduction technology, which mainly uses groundwater drainage systems to reduce the water pressure inside and outside the foundation pit, and minimize the impact of water on the soil of the foundation pit. Common precipitation techniques include deep well precipitation method and well point precipitation method. The deep well dewatering method sets up deep well pumps through drilling holes, and uses pumping equipment to extract groundwater, thereby reducing the groundwater level and creating a low water pressure environment to avoid water infiltration pressure on the foundation pit. The well point precipitation method is to set up multiple small well points around the foundation pit, combined with pumping equipment, to lower the water level of the surrounding soil layer, reduce the erosion of the foundation pit wall by water, and minimize the disturbance of the soil around the foundation pit. The well point dewatering method has a more precise control of water level during the construction process, which can achieve water level control in a shorter period of time, ensuring the dryness of the foundation pit and facilitating the reinforcement and construction of the foundation. The combination of these two methods can effectively deal with high water levels and highly mobile groundwater, ensuring that the excavation environment is in a dry and stable state.

5. CONCLUSION

Under complex geological conditions, building foundation construction faces many challenges. However, by applying advanced technologies such as geological exploration, foundation reinforcement, deep excavation support, and waterproof layer treatment in a reasonable manner, these problems can be effectively solved to ensure the safety and stability of the project. The comprehensive application of these technologies not only improves the efficiency of infrastructure construction, but also reduces the risks during construction, providing a solid guarantee for the smooth completion of building projects. With the development of technology, there will be more innovative means to assist in the construction of building foundations under complex geological conditions in the future.

REFERENCES

- [1] Zhang Shuchao, Niu Lei Construction technology of ultra deep underground continuous wall under complex water rich geological conditions [J]. Building technology, 2023, 54(3):274-277.
- [2] Zhang Weifeng Research on Optimization Strategies for Construction Technology of Building Foundations under Complex Geological Conditions [J]. Modern Engineering Technology, 2024, 3(17):13-16.
- [3] Niu Jindong Exploration of Application Strategies for Transportation Engineering Construction Technology under Complex Geological Conditions [J]. Building Materials Development Direction, 2024, 22 (1): 146-148.