Identification and Treatment Technology of Geotechnical Problems in Underground Municipal Engineering

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Abstract: Underground municipal engineering occupies an important position in promoting urban infrastructure construction, but geotechnical problems have always been the key factors restricting its safety and efficiency. Through an in-depth understanding of common geotechnical problems identification and treatment techniques in underground municipal engineering, the two core challenges of stratum stability and groundwater control are analyzed in focus. On this basis, targeted improvement strategies are proposed to provide a multi-rigorous and diversified development path for underground municipal engineering.

***Keywords*:** underground municipal engineering; geotechnical problem identification; treatment technology

1. Introduction

As an important part of modern urban development, the construction of underground municipal engineering faces complex and variable geotechnical problems. With the acceleration of urbanization, the demand for urban space is increasing, and underground space development has become an effective way to solve urban problems. However, underground municipal engineering often encounters various geotechnical problems, such as ground stability, groundwater control, and geotechnical improvement, when traversing different geological formations and geotechnical body types, which are directly related to the safety and economy of the project.

It is of great practical significance to study the identification and treatment technology of geotechnical problems in underground municipal engineering. First of all, accurate identification of geotechnical problems can ensure the safety of the project in the process of design, construction and operation, and avoid the occurrence of geologic disasters and engineering accidents. Through detailed investigation and analysis of the geotechnical body, key information such as stratigraphic structure, geotechnical properties, groundwater conditions and so on can be understood, providing scientific basis for engineering design and construction. Secondly, reasonable geotechnical treatment technology can reduce engineering costs and improve economic efficiency. Targeted treatment measures for different types of geotechnical problems, such as foundation reinforcement, groundwater control, and geotechnical body improvement, can optimize the engineering structure, reduce material consumption and construction delay, and thus reduce the project cost.

In addition, the research on the identification and treatment technology of geotechnical problems can also promote the innovation and development of related technologies. With the progress of science and technology and the deepening of engineering practice, new geotechnical investigation technology, treatment technology and monitoring means keep emerging, providing more choices and optimization space for underground municipal engineering construction. Through technological innovation and research and development, the technical level of China's underground municipal engineering construction can be continuously improved to provide strong support for the sustainable development of the city.

2. Identification of common geotechnical problems in underground municipal projects

2.1 Ground settlement

Ground settlement is one of the common and serious problems in underground municipal engineering. When the project traverses the weak strata or carries out deep foundation pit excavation, it may lead to the uneven settlement of the surrounding strata due to the disturbance of the strata. This settlement will not only lead to subsidence and deformation of the engineering structure, but also may cause damage to the ground buildings and underground pipelines, or even cause geologic disasters. Therefore, in the process of design and construction, it is necessary to carry out detailed investigation of the strata, predict and assess the risk of settlement, and take necessary measures such as foundation reinforcement and pit support to

reduce and control the settlement of the strata.

2.2 Groundwater infiltration

Groundwater infiltration is another important geotechnical problem in underground municipal works. Since underground municipal works usually involve the control and discharge of groundwater, groundwater seepage may cause serious impacts on the project structure and the surrounding environment. For example, groundwater seepage during foundation pit excavation may lead to foundation pit instability, and groundwater influx into tunnels or pipeline corridors may damage the engineering structures or even lead to safety accidents. In order to effectively control and prevent groundwater seepage, measures such as descending wells, curtain grouting and groundwater recharge need to be taken to ensure the safety and smooth progress of the project.

2.3 Geotechnical body to be reinforced

Geotechnical body reinforcement is one of the common and important tasks in underground municipal engineering. Due to the large differences in the physical and mechanical properties of geotechnical bodies, some geotechnical bodies may not be able to meet the requirements of the engineering structure, and need to be reinforced. For example, for soft ground with low bearing capacity, its bearing capacity can be improved by reinforcement treatment; for geotechnical bodies with poor water permeability, their water permeability can be improved by grouting or drainage measures. There are various methods of geotechnical reinforcement, including physical improvement, chemical improvement and biological improvement. In the actual project, it is necessary to choose the appropriate reinforcement method according to the specific conditions of the geotechnical body and engineering requirements, and strictly control the quality and technical parameters of the reinforcement process to ensure that the reinforcement effect meets the design requirements.

3. Identification and treatment technology of geotechnical problems in underground municipal engineering

3.1 Ground Stability Assessment and Reinforcement Technology

Stratum stability is undoubtedly the most basic and critical issue in underground municipal engineering, which is directly related to the safety, stability and long-term durability of the project. In the process of underground space development, due to the need to traverse various complex geological conditions, such as weak strata, faults, fracture zones, and karst, landslides and other undesirable geological phenomena, these geological factors may pose a serious threat to the stability of the strata, which in turn affects the quality and safety of underground municipal engineering.

Therefore, it is crucial to carry out detailed and accurate geological investigation before construction. Geological investigation can not only help the staff to understand the geological structure of the underground space, the distribution of strata, the nature of geotechnical bodies and groundwater conditions and other basic information, but also reveal the potential risk of geologic hazards and the stability of the strata. Through geological investigation, we can make a scientific assessment of the stability of the strata, and provide a reliable geological basis for the subsequent engineering design and construction.

When identifying ground stability problems, we usually use a variety of technical means to carry out in-depth detection and analysis. Geo-radar, as a non-destructive detection technology, can make use of the propagation characteristics of electromagnetic waves in the underground medium to carry out high-resolution imaging of strata, so as to reveal the structural characteristics of strata and potential geological problems. Drilling sampling is the process of drilling samples of underground geotechnical bodies for laboratory analysis and testing, in order to obtain key information such as the physical and mechanical properties, chemical composition and water content of the geotechnical bodies. In-situ testing involves direct testing of the geotechnical bodies in the field, such as static touch probing and standard penetration testing, to assess the bearing capacity and deformation characteristics of the geotechnical bodies.

Once ground stability problems are identified through geological investigation and probing analysis, targeted reinforcement measures need to be taken immediately. For weak strata, due to its low bearing capacity and high compressibility, it is easy to lead to problems such as foundation settlement and pit instability. Therefore, grouting reinforcement technology can be used to fill the voids and cracks in the geotechnical body by injecting high-strength grouting materials into the strata to improve the overall strength and stability of the strata. At the same time, pile foundation reinforcement technology is also an effective method to reinforce weak strata, which ensures the safety of the project by driving pile foundations into the ground and transferring the load of the superstructure to the deep and stable geotechnical body.

For faults, fracture zones and other adverse geological conditions, it is easy to cause geological disasters and engineering accidents due to its loose structure and poor stability. Therefore, technical means such as anchor support and steel

support need to be used for reinforcement. Anchor support is provided by burying anchors in the underground rock and soil body and utilizing the friction or bonding force between the anchors and the rock and soil body to provide support force, thus enhancing the stability of the stratum. Steel support, on the other hand, is a temporary support structure that can provide stable support force during construction to prevent deformation and destabilization of the strata.

3.2 Groundwater control and drainage technology

As a crucial geotechnical problem in underground municipal engineering, the impact of groundwater cannot be ignored. It may not only slow down the construction progress and reduce the construction efficiency, but also directly threaten the structural safety and long-term stability of the project. Therefore, in the planning, design and construction of underground municipal projects, strict control and effective drainage of groundwater is a crucial aspect.

In order to accurately identify groundwater problems, a series of scientific methods and means are usually adopted. Water level observation is the most basic and direct method, through the regular measurement of groundwater level changes can understand the dynamic characteristics of groundwater, including the height of the water level, the rate of rise and fall and seasonal changes. Meanwhile, hydrogeological investigation is also an indispensable link, which reveals the source, flow direction, recharge and discharge conditions of groundwater, as well as the distribution and nature of aquifers and other key information through a comprehensive study of the groundwater system. This information provides an important basis for our subsequent development of groundwater control and drainage programs.

Once groundwater problems are detected by means of water level observations and hydrogeological investigations, targeted control and drainage measures need to be taken immediately. For the higher groundwater level, if it is allowed to exist, it will cause great trouble and safety hazards to the construction process. Therefore, the technique of descending wells can be used, by drilling descending wells in the stratum and pumping out the groundwater with pumping equipment, thus reducing the groundwater level and providing a relatively dry environment for the construction. In addition, curtain grouting technology is also an effective groundwater control method. By constructing a curtain wall underground and utilizing the filling and curing effect of the grouting materials to block the seepage channels of groundwater, the purpose of lowering the groundwater level and preventing groundwater seepage is achieved.

Even with the above measures, sometimes it is still difficult to completely avoid groundwater seepage. In this case, it is necessary to take more delicate and professional waterproofing measures. Waterproofing sheet is a commonly used waterproofing material, which has good waterproofing performance and durability, and can effectively stop the infiltration and erosion of groundwater to the project. Meanwhile, grouting plugging technology is also an effective means of waterproofing, which fills and solidifies the leakage channels by injecting grouting materials into the leakage areas, thus achieving waterproofing and leakage plugging effect.

3.3 Improvement and reinforcement technology of geotechnical body

The physical and mechanical properties of the geotechnical body are the cornerstone of the quality control of underground municipal engineering, and they directly determine the stability and durability of the underground structure. Different strata, different types of geotechnical bodies, their physical and mechanical properties often have significant differences, these properties include but are not limited to bearing capacity, shear strength, compressibility, permeability, etc.. The advantages and disadvantages of these properties are directly related to the safety and efficiency of the design, construction and operation of underground municipal projects.

In order to accurately identify the problems existing in the geotechnical body, engineers usually adopt a series of scientific and rigorous test methods. Field tests, such as plate load test, static touch test, standard penetration test, etc., can directly measure the bearing capacity, deformation characteristics and shear strength of the geotechnical body and other key parameters in an environment close to the actual engineering conditions. Indoor tests, such as straight shear test, triaxial compression test, penetration test, etc., can analyze the geotechnical samples more finely under controlled conditions and obtain detailed data on their physical and mechanical properties.

Once it is found through the test that the geotechnical body has insufficient bearing capacity, low shear strength, poor permeability and other problems, it is necessary to immediately take targeted improvement and reinforcement measures. For weak strata with low bearing capacity, such as silty soil, loose sandy soil, etc., the replacement method can be used, i.e., digging out the defective soil layer and replacing it with high-strength, low-compressibility materials, such as crushed stone, concrete, etc., in order to improve the overall bearing capacity of the strata. Strong tamping method is used to compact the soft soil layer and increase its compactness and bearing capacity through the huge impact force generated by the free fall of heavy hammer.

For rock and soil bodies with low shear strength, such as rocks and soft soil with fissure development, the reinforced

soil technology is used to form a composite soil body by burying high-strength reinforcing materials, such as geogrids and geotextiles, in the soil body, which significantly improves the overall shear strength and stability of the soil body. Anchor support, on the other hand, utilizes the friction or bonding force between the anchor and the geotechnical body to fix the unstable geotechnical body in the stable rock layer or soil body, and enhances the integrity and shear-resisting capacity of the geotechnical body.

For geotechnical bodies with poor permeability, such as clay, dense rock, etc., the grouting technology fills the pores and fissures by injecting high-pressure slurry into the geotechnical body, improves the permeability of the geotechnical body, and improves the ability of groundwater flow, while enhancing the overall strength and stability of the geotechnical body. Drainage measures, such as the installation of drainage holes and drainage belts, can effectively reduce the groundwater level, reduce the pore water pressure in the geotechnical body, and improve the shear strength and bearing capacity of the geotechnical body.

4. Summary

The geotechnical problems of underground municipal engineering are complex and variable, and need to be identified and dealt with by a variety of technical means. Ground stability assessment and reinforcement is to ensure the basis of engineering safety, through geological investigation and testing, identify potential risks, take targeted reinforcement measures to improve the overall stability of the ground. Groundwater control and drainage is the key to ensure the smooth progress of construction, through the water level monitoring and hydrogeological analysis, to develop an effective water control program, the use of precipitation, waterproofing, plugging and other technical means to ensure that the construction environment is dry, to prevent groundwater on the quality of the project caused by adverse effects. In conclusion, scientific identification of geotechnical problems, reasonable selection and application of treatment technology is an important guarantee for the successful implementation of underground municipal engineering, which is of great significance for promoting the development of urban underground space and upgrading the level of urban infrastructure.

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