

Construction Technology of Large-deformation High Geostress Soft Rock Tunnel

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Abstract: In the process of tunnel construction, if large-deformation occurs in high geostress soft rock, it will likely cause geological disasters. This situation will not only seriously affect the smooth progress of tunnel construction, but also cause serious safety threat to the construction personnel. Therefore, with the continuous growth in the number and scale of tunnel construction in recent years, the construction technology for high geostress soft rock with large-deformation has begun to receive more and more attention from the society. Based on this, this paper takes an actual project as an example to analyze the specific application of the technology in order to improve the construction effect and avoid the damage caused by the large-deformation of the high geostress soft rock.

Keywords: Tunnel construction; High geostress soft rock; Large-deformation; Construction technology

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1 Introduction

The total length of a certain tunnel is 3127 m. In this tunnel, the design end at 1863m is in the Class V soft rock geology. At the position where the tunnel body passes through, the rock mass in the geological layer has obvious fragmentation, and has the characteristics of high porosity, prone to weathering, etc., and the whole geological body is very unstable. From the perspective of overall plate structure, because each plate will be squeezed by many surrounding plates, a large principal stress is formed. This condition

will bring many difficulties to the construction of underground tunnel projects, and there are also big problems in construction safety. Therefore, in the specific construction, the construction team needs to use corresponding technology to prevent the adverse effects of large-deformation in high geostress soft rock, and to ensure the construction progress, construction quality and safety.

2 Analysis on the Deformation Characteristics of High Geostress Soft Rock in Tunnel

In the construction of the tunnel studied this time, the main deformation characteristics of the high geostress soft rock include the following aspects: The first is greater deformation strength and faster deformation speed. In this area, the total dome subsidence can reach about 0.5m, and the maximum convergence can reach about 0.11 m. The horizontal convergence is much larger than the dome subsidence, which shows its strong squeezing characteristics. The gastritis has a very large deformation rate in the initial stage, which shows that the compression is very serious, and the soft rock in the tunnel is very weak, prone to breaking, and poor stability. The second is a longer deformation time. Under the action of high geostress and construction, the soft rock in the tunnel will show a trend of continuous deformation, which will cause serious obstacles to the construction process and construction safety, and even damage the initial support. The third is the uneven spatial distribution of the deformation. In the tunnel area, the soft rock deformation is mainly characterized by asymmetry and unevenness between left and right. After the initial support was completed, there will still be deformation on left and right sides of the tunnel, and

the difference in deformation amplitude on the same level is very significant. The fourth is the phasal sudden change. During the excavation process, the steps up and down often sink suddenly, which will cause serious adverse effects on the construction. Fifth, sudden changes are likely to occur under construction interference. After excavation and support of the rock mass, the deformation speed of soft rock will gradually increase due to disturbances from the processes, especially after blasting and other processes, the deformation will become more severe. It can be seen that during the construction of this soft rock geological tunnel, the construction team should take reasonable technical measures to control the soft rock deformation to avoid large deformation of the soft rock caused by high geostress, and to ensure the safety of the construction.

3 Analysis of the Control Technology for Large-deformation High Geostress Soft Rock in Tunnel

3.1 Pay Attention to Advance Geological Forecast

During the specific construction of a high-geostress soft rock tunnel, it is necessary to use advanced geological forecast to make timely judgments of the geological conditions that props up ahead, and determine a reasonable control plan based on construction experience^[1]. In this construction, the TSP203 advanced geological forecasting system was mainly used to obtain advanced geological forecasts, and to achieve organic integration with the advanced geological drilling on the working surface. In this way, the actual geological deformation and its development trend before the tunnel excavation construction can be predicted in time, so that effective countermeasures can be adopted in time.

3.2 Modify the Shape of the Tunnel from Straight Wall to Curved Wall

In this project, most of the tunnel shapes are side-walls. Due to the high geostress during construction, the tunnel wall has a rapid and large-scale deformation. Observation of the deformation inside the tunnel found that the concrete cracking at the deformed sites was very obvious, and there were distortions and cracks in the inner drum of the support and the arch, which seriously affected the construction safety. Through the study of its force

action principle, it was found that in the process of excavating the inclined shaft section, the circular excavation can effectively prevent the concrete cracking, and then play a role in dispersing the force, thereby reducing the concentration of forces; and with the help of a closed-form of round and curved sections, high geostress can be slowly released. In this way, large deformation of soft rock caused by high geostress can be effectively avoided, effectively guaranteeing construction progress, construction quality and construction safety.

3.3 The Application of ‘Soft First Followed by Steel’ and ‘Release before Resistance’ Control Technologies

The ‘soft first followed by steel’ refers to the setting of a flexible supporting structure first and the setting of secondary lining as a rigid structure. In this construction, the main components of the flexible supporting structure included steel frame, concrete and steel mesh. The secondary lining structure was constructed by filling concrete with a rigid mould, and its bearing capacity should be consistent with the design requirements of the actual project. The so-called ‘release before resistance’ refers to that a certain level of deformation can be allowed after the completion of the initial support construction as long as the deformation is controlled within the preset range^[2]. Then, on this basis, the lining construction in the form of two-mould injection concrete was carried out.

3.4 Application of Multiple Support Reinforcement Control Technology

In this tunnel construction, it was decided to carry out the initial support reinforcement construction in the form of double-layer steel-frame net shotcrete based on the previous construction experience and the actual deformation characteristics of the soft rock. In the process of the first layer support construction, I-shaped steel-frame was mainly used. This kind of steel-frame is very rigid and can effectively reduce the deformation speed of the soft rock. Then the second layer support construction was carried out. The main construction purpose of the supporting layer is to prevent the further expansion of soft rock deformation, avoid damage to the overall supporting system, or minimize the degree of damage to ensure the supporting effect. The following are the

main technical parameters of multi-layer support reinforcement to control large deformation of high

geostress soft rock in this tunnel construction:

Table 1. The Main Technical Parameters of the Multi-layer Support Reinforcement to Control Large-deformation of High Geostress Soft Rock in this Tunnel Construction

Serial No.	Item	Parameter
1	Reinforcement frame model of the first layer supporting arch wall	H175
2	Concrete spray thickness of the first layer supporting arch wall	30cm
3	Reinforcement frame model of the second layer supporting arch wall	116
4	Concrete spraying thickness of second layer supporting arch wall	20cm

In specific construction, the construction of the second layer of supporting arch wall should be carried out 6 days after the completion of the first layer of construction or when the support deformation reaches 70%.

3.5 Reasonably Increase the Reserved Deformation

In the specific construction process, the increase of the reserved deformation can effectively prevent the intrusion of the clearance part of the secondary support after the spray layer is deformed. According to the different requirements of different sections in this construction, the amount of deformation reserved is also very different. For example, during the construction of the high geostress soft rock section of the main tunnel, it is necessary to reserve a deformation of 25cm on the left and right sides to reserve enough space for the subsequent construction of the secondary supporting arch wall^[3].

3.6 Reinforcement Treatment for Bottom and Surrounding Rock

When constructing tunnels under high geostress soft rock conditions, strengthening the bottom treatment can effectively prevent the soft rock from uplifting, and strengthening the surrounding rock can effectively avoid soft rock deformation. Therefore, in this construction, these two treatment methods were specially applied reasonably to meet the actual needs of this project for supporting strength. In the construction section with large deformation strength, the supporting construction was mainly carried out in the form of a full-ring steel-frame, and the concrete thickness is 42cm. After the initial reinforcement of the surrounding rock, it was found that the deformation of the soft rock was effectively prevented, but this effect was only generated in the surrounding rock part, and there would still be serious deformation at the bottom, which brought a great degree of adverse effects to the tunnel construction.

Based on this, the tunnel bottom was specially strengthened in this construction to effectively avoid the adverse effects of soft rock deformation on the overall construction effect and safety, so that the construction can be carried out in a safe and orderly manner.

4 Conclusions

In summary, in the process of tunnel construction, soft rock geology is the construction condition that is most prone to safety incidents, especially under the action of high geostress. Once the surrounding rock of the tunnel undergoes large deformation, the safety progress and quality control of the overall construction will be seriously threatened and even cause major construction safety incidents. Therefore, in the specific construction, the construction team must comprehensively analyze the specific characteristics of the soft rock geological conditions, and make a construction plan based on the actual engineering requirements, then control through reasonable technical measures based on it. Only in this way can the construction quality be effectively guaranteed, the construction safety can be ensured, and a better safety guarantee can be provided for the later application of the tunnel project.

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