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Research on Mechanical Contact Channel

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Abstract: In the soft soil layer, the contact channel is usually constructed by mining method, and the surrounding soil is reinforced by grouting or freezing. The conventional freezing method has problems such as ' long construction period, high cost and quality hidden danger ', and grouting reinforcement has problems such as ' occupying ground space '. In order to solve the unfavorable factors caused by the above construction methods, this paper puts forward the technology of non-reinforcement and mechanical construction of contact channel. This technology has certain advantages in safety, construction period and cost. It is of positive significance to systematically carry out the research and development of mechanical connection channel technology to promote the development of the industry and improve the technical level of underground engineering. In order to deal with the difficulties and risks of the construction of the mechanical method connecting passage in the region, based on a tunnel project, the construction quality management system of the mechanical method connecting passage is expounded, and the on-site monitoring and analysis are carried out. The results show that the construction technology applied in this project is conducive to improving the construction efficiency and ensuring the construction safety. The research results can provide reference for the mechanical construction of the connecting passage under similar stratum conditions.

Keywords: Mechanical construction; contact channel.

1. Introduction

At present, the most widely used methods for the construction of subway connecting passages in China are freezing method reinforcement and mining method excavation. This technology has relatively mature theoretical research [1], but its shortcomings are also obvious, such as large settlement after freeze-thaw, many influencing factors of construction effect control, and large safety risks. As a new technology in line with the development trend and construction needs of the project, the construction of the connecting passage by mechanical method has been successfully applied in Ningbo and Wuxi. Zhu Yaohong et al. [2] studied the structural response and its variation law of the main tunnel during the whole construction process with Ningbo rail transit line 3 as the background. Based on the construction project of the connecting passage of Wuxi Metro Line 3, Wei Jiaying et al. [3] discussed the variation characteristics of soil settlement in the T-joint construction of the connecting passage by pipe jacking method from the aspects of measured analysis, numerical calculation and empirical model. Compared with non-mechanical construction, the advantage of mechanical construction is that it greatly shortens the construction period of the connecting passage. At the same time, it does not need to carry out large-area reinforcement to avoid the damage to the structure and the impact on the surrounding environment caused by the thawing settlement in the later stage of freezing reinforcement. However, most of the above studies are aimed at soft soil layers, and there are relatively few studies on the construction of the connecting passage in Bohai mudstone strata. In this paper, the construction quality management system of the project is studied, and the results of quality control are verified by the monitoring results. The research results can provide reference for the mechanized construction of the contact channel of similar projects. With the increase of the number of subway construction, the number of contact channels to be built is gradually increasing. Based on the previous domestic and foreign research and technical analysis [4-10], it is completely feasible to carry out the research and development of mechanical equipment, construction technology, structural design and waterproof under the conditions of no stratum reinforcement and narrow space. The mechanical method connection channel technology has great advantages in safety, construction period and cost. Systematic research and development of mechanical method connection channel technology has positive significance for promoting the development of the industry and improving the technical level of underground engineering, and has strong application prospects and vitality.

2. Construction Scheme of Mechanical Connection Channel

2.1. Construction process

2.2. Jacking equipment in place

2.2.1. Equipment in place

The main engine is wrapped in the sleeve and transported to the portal with the trolley. The launching attitude is adjusted by the bracket fine-tuning system, and the launching attitude is controlled by the elevation target + 20 mm when receiving.

2.2.2. Support system opening

After the jacking machine is transported to the position of the connecting channel, all pipelines and components are connected, and the support system cylinder is extended to make the support system close to the inner wall of the segment. After the support system is opened, each stage is loaded at an interval of 5 minutes.

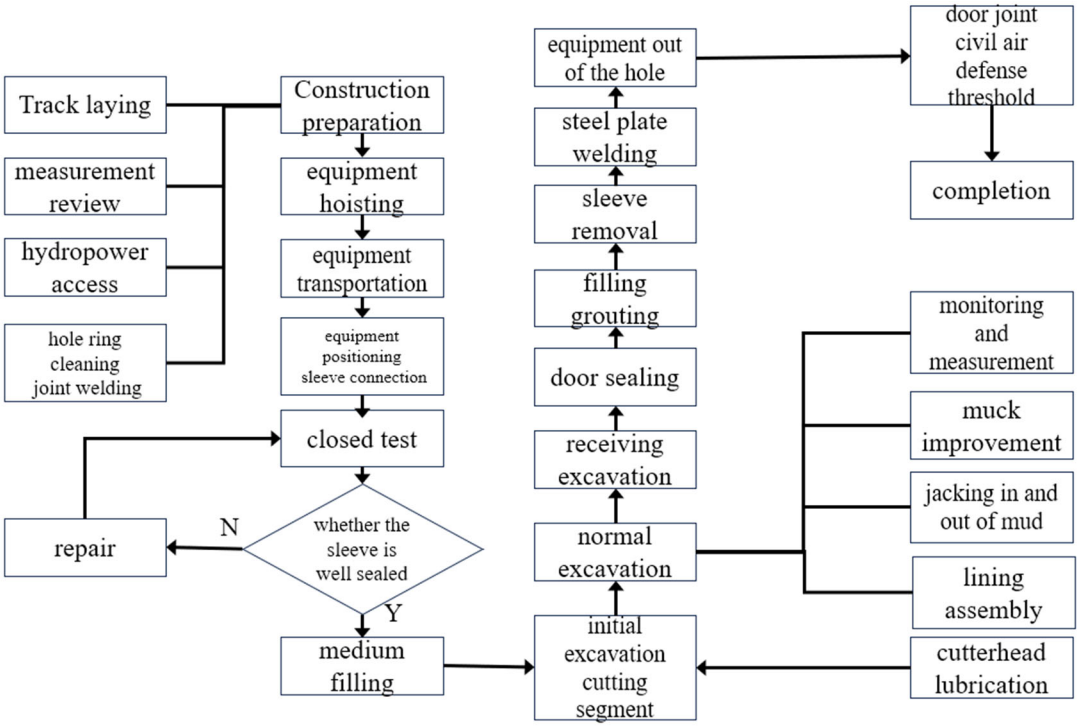

Figure 1. Construction process

2.3. Sleeve installation and sealing

2.3.1. Sleeve installation

The material of the cylinder is 30 mm thick Q235 steel plate, and the longitudinal and circumferential ribs are welded around each section of the cylinder to ensure the stiffness of the cylinder. The thickness of the ribs is 20 mm, the height is 45 mm, and the interval is about 300 mm × 350 mm. The joint surfaces are welded with flanges. The flange is 30 mm thick Q235 plate, which is connected by 10.9 grade M20 bolts, and the intermediate interface is O-shaped sealing strip.

2.3.2. Sleeve sealing test installation

After the inspection of the welding of the steel sleeve is completed, the steel sleeve, the originating sleeve and the receiving sleeve are respectively filled with grouting filler, bentonite and water glass mixture, and thick slurry is filled. In order to transport the filler to the steel sleeve, a trolley is used to transport the slurry to the sleeve. A conveying pipe is introduced from the slurry truck to the inlet of the JYB-3 squeeze grouting machine, and then a conveying pipe is connected from the outlet of the grouting machine to the grouting hole at the top of the steel sleeve. The filler is transported to the steel sleeve through the grouting machine and the pipeline until the mortar is completely filled with the steel sleeve.

2.4. Exit hole construction

2.4.1. Earth storehouse construction pressure

After the pipe jacking machine cuts to the concrete crushing of the portal, the external water and soil pressure is transmitted to the steel sleeve. In order to achieve the purpose of balancing the external water and soil pressure, after the sleeve seal is formed, the pressure test value is reached by injecting bentonite into the reserved injection pipe.

2.4.2. Cutting hole door concrete

The construction parameters such as cutter speed, penetration, thrust, cutter torque and propulsion speed are collected. The construction stage is adjusted according to the difference of different working conditions, and corresponding measures are taken to prevent the rotation of the roadheader. Bentonite lubrication is added to the soil bin during the cutting process.

2.5. Pipe jacking propulsion

1. Foam agent is used to improve the soil during the excavation of the normal section, and dispersant is added if necessary. The slump of the improved slag is required to be 120 ~ 140mm, which is convenient for mud production.

2. During the jacking process, it is found that there is a deviation in the attitude. Firstly, the pressure distribution of the pushing cylinder is adjusted to adjust the attitude of the pipe jacking machine. If the effect is not significant, the hinge adjustment of the jacking pipe is adjusted to strengthen the correction. After the hinge is opened, the deformation of the formed pipe joint should be carefully observed.

3. Top in and out of mud. Each ring is unearthed about 7.6 square. A small bucket is placed at the exit of the screw machine, and the soil is transported to the muck truck behind the No.4 trolley through the small bucket. In the process, the jacking speed and the amount of mud are matched, and the change of earth pressure is strictly monitored.

4. Anti-friction grouting. The anti-friction grouting adopts sodium bentonite, which mainly plays a role in reducing the friction between the pipe section and the soil. Sodium bentonite : water = 1 : 8 (mass ratio), stirring evenly, standing for 12 h. Grouting pressure should not be too high, controlled at 20 ~ 50KPa, the pressure is too high easy to take slurry, not easy to form slurry sleeve. At the same time, when the pressure is too high on the pipe, it will increase the positive pressure on the edge of the pipe, but increase the jacking force when jacking. In principle, the grouting volume is controlled at 2 ~ 3 times of the theoretical gap outside the pipe section.

5. Filling grouting. After the pipe jacking stops, the outer wall bentonite is replaced to ensure the safety of the ground building. The cement-water glass slurry is used for filling grouting, and the grouting pressure is controlled within 0.35

Mpa.After the grouting is completed, the grouting hole must be sealed.

6. Material transportation. The vertical transportation of the wellhead is completed by a 25 t truck crane. The horizontal transportation in the tunnel is completed by a battery car marshalling. The marshalling includes a head and a flatbed. The trolley part uses a crane system to complete the material transportation. The segment is designed in blocks (two blocks) and transported to the rear of the host through a crane. The bottom part is lifted by a single crane, and the top part is lifted by two cranes.

7. Pipe assembly. The tube section is assembled in blocks, which is composed of upper and lower parts. The upper 150 ° first assembles the lower part, and then assembles the upper part.

3. Quality Management System and Measures

3.1. Quality management system

According to the characteristics of the project, we should construct and improve the safety and quality assurance system, implement standardized and procedural management, and implement the lifelong guarantee system of quality responsibility. The project manager is fully responsible for the quality of the project ; the chief engineer of the project is responsible for organizing the preparation and implementation of quality plans and engineering excellence plans ; the project manager department has a full-time quality inspection engineer, who is responsible for the inspection of raw materials, semi-finished products and processes, and is responsible for the comprehensive inspection and approval of specific processes ; the construction team leader is responsible for the construction quality of the project team, and the full-time quality inspection engineer is responsible for the quality control and acceptance of all processes.

3.2. Organizational guarantee measures

Establish and improve the quality management organization, set up a quality management leading group, led by the project manager and the chief engineer, to ensure the realization of the quality objectives from the organization. The quality assurance organization chart is shown in Figure 2.

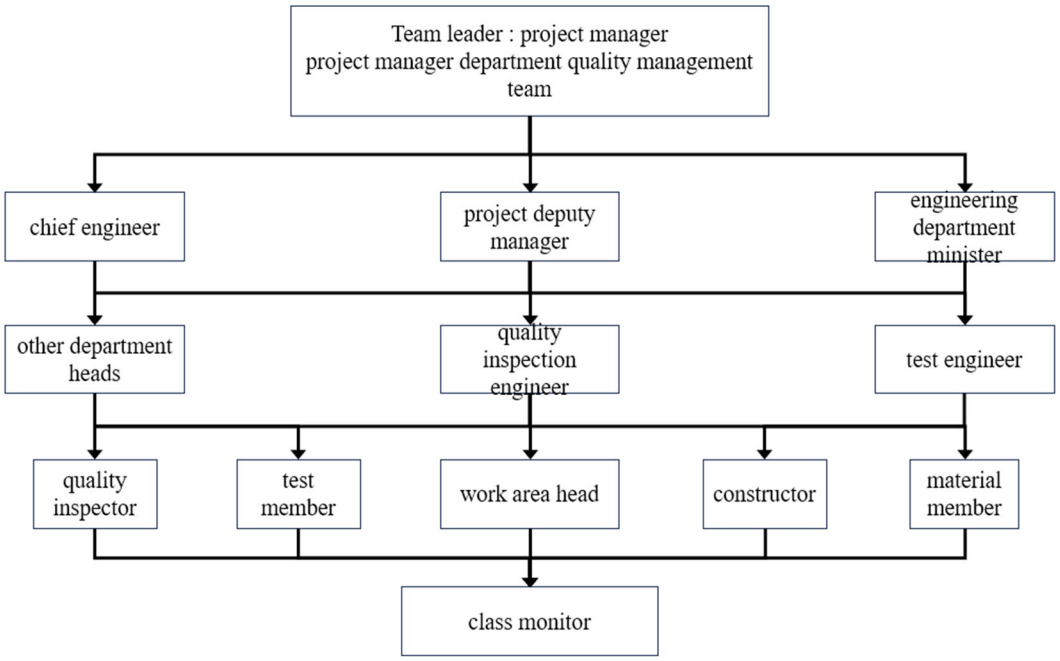

Figure 2. Quality assurance organization chart

3.3. System guarantee measures

1. regularly held quality education activities and learning, and assessment;

2. Organize engineering quality inspection and assessment at the end of each month;

3. quality assessment analysis from time to time;

4. Carry out group management activities.

3.4. Construction guarantee measures

3.4.1. Shield tunneling

1. Strengthen the training of construction personnel, improve the operation level of the roadheader driver.

2. Strengthen the construction survey, take the shield automatic measurement first, manual measurement at any time to check the measures to ensure that the tunnel line is correct and does not exceed the limit.

3. Reasonable selection of tunneling parameters to eliminate the impact of accidents such as surface subsidence and main tunnel damage on quality.

4. In strict accordance with the design, construction specifications to organize excavation, improve the quality of excavation.

5. Strengthen the level of management information, analyze and process the feedback information in time to guide the on-site construction.

3.4.2. Pipe installation

1 Segment assembly is carried out in strict accordance with the operation instruction of segment assembly process.

2.Take necessary measures to prevent the wrong platform when the pipe is assembled.

3. Improve the quality of excavation to prevent distortion

of the pipe.

4. Pay attention to adjust the shield tail gap, to prevent the pipe section from breaking out of the shield tail.

5. Ensure the quality of anti-friction grouting to prevent the sinking or floating of the pipe.

6. The position of the special segment should be checked before the pipe jacking is excavated to the reserved mouth of the construction to ensure that the position of the special reserved mouth is accurate.

3.4.3. Grouting

1. Before grouting, a detailed slurry mix ratio test is carried out to select the appropriate grouting material and slurry ratio to meet the design and construction requirements, check the sealing of the pipeline, ensure that the slurry does not leak, and ensure the smooth flow of the grouting pipeline.

2. Do a good job in the maintenance of grouting equipment and the supply of grouting materials to ensure that the grouting work is carried out smoothly and continuously. The fullness of grouting is controlled by both grouting pressure and grouting volume.

3.4.4. Anti-leakage

The waterproof grade of the tunnel project is grade two. The tunnel adopts high-precision steel mold for the production of high-precision segments. The fundamental quality control is the self-waterproofing of the segment structure, and the key is the joint waterproof. The main measures are as follows :

1. Organizational management. The process operation quality responsibility system is adopted to link the waterproof operation quality of each construction process with the construction benefit, so as to improve the waterproof responsibility consciousness of all participating employees. In view of the special operation procedures such as tunnel excavation, pipe installation and anti-friction grouting, the fixed operation of special personnel is carried out to ensure the quality of the process. Formulate strict waterproof quality reward and punishment regulations, reward the good and punish the bad, and the operators operate according to the operation procedures.

2. Pipe production. Optimize the mix design of pipe concrete to improve the impermeability of the segment. Strengthen the use management and maintenance of the pipe section mold to ensure the accuracy requirements of the segment mold. Strengthen the protection of steel bars and finished steel cages to prevent steel corrosion. Strengthen the use management, maintenance and repair of the pipe section mold vibrator, and improve the quality of concrete vibration. Strictly control the temperature of concrete steam curing to ensure the quality of pipe maintenance. Demoulding is carried out in strict accordance with the designed concrete demoulding strength to avoid damage to the segment due to too low demoulding strength.

3. Pipe assembly. Do a good job in tunneling linear control, to avoid the tunneling process is too urgent, affecting the quality of segment installation. The pipe section can be transported to the construction site after meeting the age, reaching the design strength and passing the factory inspection. Before installation, the integrity of the segment and the bonding of the waterproof material must be checked. Strengthen the protection of the finished products of the pipe section to avoid the damage of the pipe section during hoisting, transportation and construction. Strengthen the process control of the pipe section water stop and cushioning pad bonding to ensure its quality and reliability.

4. On-site Monitoring

4.1. Monitoring Projects and Scope

This project sets the following monitoring contents:

1. tunnel structure monitoring (settlement, convergence).
2. Surface subsidence monitoring.
3. Pipeline settlement monitoring.
4. Settlement monitoring of surrounding buildings : The monitoring range is 50 m on both sides of the tunnel segment of the contact channel, and within 20 m outside the ground projection directly above the contact channel.

4.2. Burying of measuring points

4.2.1. Surface subsidence

With the contact channel as the center, four settlement sections are arranged within 20 m on both sides of the ground projection above, the section spacing is 6m (5 rings), and the measuring point spacing is 2.4m, 4.8m, 6m, 7.2m (2 rings, 4 rings, 5 rings, 6 rings). The number is compiled according to XD (SD) + ring number + measuring point number.

4.2.2. Monitoring points in tunnel structure

1. Intensive settlement monitoring is carried out in the local area of the tunnel, that is, 25 monitoring points are arranged in the range of 50 m on both sides of the contact channel, and one arch bottom settlement monitoring point is arranged every 6m. The monitoring points of arch bottom settlement are encrypted every 3m in 10 rings on both sides of the center of the contact channel, and the point number is compiled according to GDL / GDR + ring number.

2. Set 11 horizontal convergence monitoring sections within 50 m on both sides of the contact channel, set a monitoring section every 12 meters, and set the point number according to SL + ring number. After the completion of the connection channel structure pump station structure, a set of convergence monitoring sections are arranged in the middle, and the point number is Lo1.

3. After the completion of the interval liaison channel and pumping station structure, a set of settlement monitoring sections are arranged in the liaison channel, a total of three points, the point number is Ltt1 ~ Ltt3, in order to understand the settlement of the interval liaison channel and pumping station structure and the differential settlement between the interval liaison channel and pumping station structure and the interval tunnel.

4.3. Monitoring frequency

In order to meet the needs of the project, the following monitoring frequency can be adjusted according to the monitoring data. The monitoring frequency is shown in the following table:

Table 1. Field monitoring frequency table

Stage	monitoring frequency	note
during the excavation	the surface is twice a day once a day in the tunnel	the frequency is adjusted according to the size of the settlement
during the grouting period	once every three days	
after the end	once a week	① the frequency is appropriately adjusted according to the amount of change (when the amount of change is small, it is adjusted to once every two weeks) ②and the final rate reaches a stable standard to stop monitoring

If the on-site monitoring results are analyzed, the monitoring results of the project are normal, indicating that the application of the above key construction technologies meets the requirements of the project.

5. Summary

1. Compared with the traditional mining method, the mechanical method has the characteristics of short construction period and small impact on the surrounding environment, which provides a new technical means for the construction of the connecting passage.

2. This paper expounds the construction scheme of the mechanical connection channel, and establishes a perfect quality management system according to the characteristics of the project. At the same time, the project site monitoring is carried out to ensure the construction quality.

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