Discussion on Construction Technology and Control Measures of Drainage Pipeline Network in Municipal Engineering

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Abstract. With the continuous advancement of urbanization and the increasing number of urban residents, the ecological and water environments in cities are gradually deteriorating. In the current stage, in order to protect the ecological and water environment of the city, in addition to our joint efforts to reduce sewage discharge in daily life, it is also necessary for local governments to actively make efforts to regulate urban industrial sewage drainage through laws and regulations. Of course, there is also a top priority task, which is to build a good municipal road drainage network project. To ensure the drainage effect of underground drainage pipes in municipal road engineering, taking the municipal road reconstruction project in a certain area as an example, the design and construction plan of underground drainage pipe network are studied. Based on the original drainage network situation and geological survey results of the project, the low impact development (LID) concept is adopted for the design of the drainage network and the overall construction plan is formulated. The micro top pipe construction technology is selected to complete the underground drainage network construction of the municipal road project.

Keywords: municipal road engineering; Underground drainage; Pipeline network design; construction technique

1 Introduction

The quality of municipal road drainage pipe network engineering is closely related to people's lives. In practical terms, if the quality is too poor and problems arise in the later use process, it will not only lead to pollution of groundwater and soil, but also cause major problems, such as large-scale urban waterlogging. Therefore, from any perspective, the construction quality of municipal road drainage pipe network engineering will become one of the hotspots of social concern[1-2]. The municipal road drainage pipe network project belongs to concealed engineering, which is often located directly below the road and is difficult to maintain. It is even better in sections with fewer pedestrians and vehicles. If the maintenance site is located in a busy area with a

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lot of traffic, not only will the approved maintenance time be shorter and the pressure on workers be stronger, but the cost required will also be higher. Therefore, ensuring the construction quality of the drainage pipe project is crucial[3].

2 The Significance of Drainage Network Construction

2.1 Can optimize the Drainage Function of the City

The development of social economy can promote the development of a city. In terms of basic urban construction facilities and settings, the regeneration and sustainable development of water resources have become the focus of attention for the whole society[4]. With the continuous increase in urban water consumption, the large-scale generation of wastewater and the solution of sewage are also urgent. The proposed or ongoing construction of various public infrastructure projects closely related to urban living facilities also falls within the scope of municipal engineering, which includes the construction of drainage networks that this article aims to analyze and elaborate on. Similar to the role of ground rail transit and road operations, the success of drainage pipe network operations directly affects the circulation, regeneration, and reuse of groundwater, rainwater, and different wastewater in the entire city. Scientifically and reasonably optimizing drainage facilities such as rainwater, sewage, and farmland irrigation is also one of the main purposes of municipal drainage pipe network construction, and an important means to enhance the overall function of a city and the scientific layout of underground pipe networks[5-6].

2.2 Ensure the Soundness of Underground Pipeline Networks and Extend Their Service Life

In addition to a large number of drainage pipelines, conventional municipal surface and underground infrastructure construction also involves different types of network structures such as electricity, heat, gas, and channels. As an important part of the entire underground pipeline system, the drainage system undertakes the tasks of water supply and drainage (including rainwater, sewage, and farmland irrigation and drainage) for the entire city. Therefore, after completion, the project leader must ensure the scientificity and rationality of the preliminary operations, ensure the quality and service life of the underground pipeline network, and prevent the serious consequences of running, emitting, dripping, and leaking due to improper drainage pipeline design, which may affect road traffic conditions.

3 Case Overview

A certain residential project belongs to the civil construction project, covering an area of 1.219 million square meters, of which the construction area involving the drainage pipe network is about 402000 square meters. In addition to the above ground building project, the underground drainage pipe network operation is also extremely

challenging. Considering that the drainage operation of the pipeline network is only 5km away from the existing high-speed railway station, the technical personnel adopted a combination of multiple processes to ensure orderly construction and safe operation in the actual layout of rainwater, other wastewater, and heating pipeline network.

4 Construction Points of Drainage Pipe Network

4.1 Construction Plan and Process Flow

After completing the design of the drainage network, the pipeline construction plan will be determined. Before determining the construction plan, it is necessary to conduct a geological survey of the construction area; After on-site investigation, the overall soil layer within the construction scope is composed of silty clay with high flow plasticity and compressibility, and the foundation bearing capacity is 66.2kPa. Therefore, in order to ensure the construction effect of the drainage pipeline network, combined with the geological survey results, the micro top pipe construction technology was selected for the construction of the drainage pipeline. The overall construction process is shown in Figure 1.

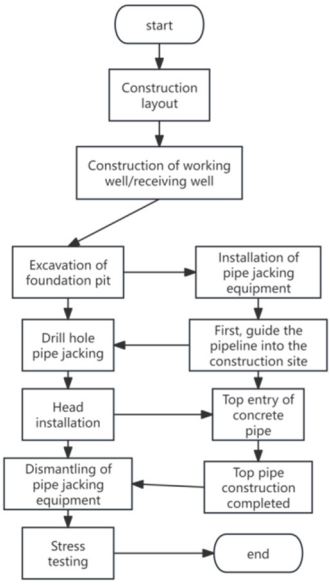

Fig. 1. Construction Process of Micro Top Pipe.

4.2 Division of Construction Sections

After determining the overall construction plan and process of the drainage network, due to the long section of the overall reconstruction project, it is necessary to divide the

construction into four sections. The details of each construction section are shown in Table 1. In the entire construction section, the L2-L3, L3-L4, and L4-L5 jacking construction sections belong to medium to long-distance pipe jacking construction. The geological changes in this section are relatively complex, so strict control of construction technical parameters is required.

4.3 Selection of Construction Equipment

After completing the division of construction sections, the selection of construction equipment is based on geological conditions and construction space. The details of equipment selection are shown in Table 2.

Table 1. Details of each construction section.

Construction section number	Top entry distance/m	Top in interval range	Geological conditions
1	160	L1~L2	Clay and soil layers do not contain groundwater
2	1145	L2~L3	Muddy silt clay
3	1450	L3-L4	Silty soil
4	1050	L4~L5	gravels

Table 2. Details of Construction Equipment.

Equipment name	details
Large scale pipe jacking machine	KDI-3000
Mixing Bowl	/
Mud mixing pump	/
Rail transport electric scooter	DQ-05
Grouting pump	SYT80-50-II
Relay oil cylinder	900kN
Relay pumping station	FA540 high voltage
gantry crane	25t

4.4 Key Construction Steps

4.4.1 Construction of working and receiving wells

The project adopts micro top pipe construction technology, and both the working well and the receiving well are constructed in the form of steel protective shafts for sinking well construction. The diameters of the steel casing are 1.89m, 2.09m, and 2.59m, all made of 0235B steel plate. The wall thickness of the casing is 20mm, and the height of each section of the casing is 2m. During the construction process, in order to reduce the friction between the steel casing and the soil during the sinking process, the soil receiving side of the lowest section of the steel casing is processed into a serrated shape with a depth of about 15em; The connection between different steel

casings needs to be welded before installation. Sinking to the design elevation after excavation, and using C30 concrete for bottom sealing construction.

4.4.2 Installation of Top Pipe Equipment

After the construction of the micro top pipe working well is completed, the top pipe equipment is installed inside the well. Based on the central axis of the top pipe, the installation of the base channel steel in the working well is completed. A 50cm space needs to be reserved between the channel steel bottom and the floor for storing a small amount of sediment. After the completion of the base channel steel, the installation of the bottom plate and the pushing platform is completed based on the pipeline axis. Then, the pushing platform is fixed by fastening bolts on the bottom plate, and connected to the well wall with a triangle iron. The fixing is done by welding to ensure the stability of the pushing platform during the construction process.

During the process of pipe jacking construction, it is necessary to strictly control the total jacking force. In combination with relevant standards for pipe jacking construction technology, the total jacking force F for pipe jacking construction is calculated using the following formula:

$$F = \pi D_1 L f_k + N_F \tag{1}$$

In the formula: D_1 ——Outer diameter of pipeline;

L ——Top insertion length;

f_k ——The average frictional resistance between the outer wall of the pipeline and the soil layer;

N_F ——Facing resistance of the pipe jacking machine.

In the process of micro pipe jacking construction, if the end face of the jacking machine used for the construction equipment is trumpet shaped and an extrusion type non dumping jacking construction is adopted, then N_F The calculation formula is:

$$N_F = 0.25\pi D_g^2 (1-e) R \tag{2}$$

In the formula: D_g ——Outer diameter of pipe jacking machine;

E——aperture ratio;

R——Squeezing resistance.

(3) Grouting control.

During the construction process of micro top pipes, in order to ensure the quality of drainage pipeline construction, grouting is used to reduce the friction between equipment and soil layers. During this process, the grouting situation needs to be controlled. Before the grouting operation, the mud is first circulated for hole cleaning, and the treatment principle is shown in Figure 2.

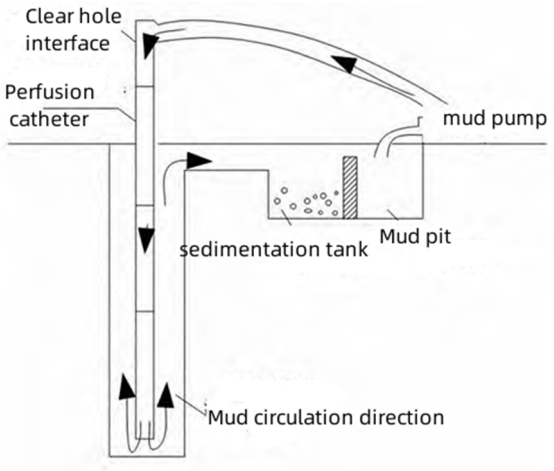

Fig. 2. Principle of secondary cleaning with positive circulation.

Strictly control the key construction technical parameters of micro jacking pipes, and complete the underground drainage pipe network jacking construction of municipal road engineering according to the overall construction process. The error control standards for jacking construction are shown in Table 3.

Table 3. Control Error of Top Entry Construction.

Parameter	Lateral penetration deviation	Elevation breakthrough deviation	Maximum uplift on the ground	Maximum subsidence of mantle
Standard result/mm	±100	±50	30	-30

Verify the construction effect of the drainage pipeline according to the standards in Table 4. If the construction result exceeds the allowable deviation range, timely construction correction and adjustment should be carried out to ensure that the deviation of the jacking construction is within the allowable range. After the monitoring is completed, the pipeline pressure is mainly tested by adding water and pressure. When the pressure reaches the standard, the pressure is stopped, and the pressure inside the pipeline is judged to ensure that the drainage pipeline is in good operating condition. Then, the overall construction of the underground drainage pipe network for municipal road engineering is completed.

5 Analysis of the Qualification Rate of Drainage Pipeline Work

The first drainage pipeline inspection in this area covered a total length of 26558m, with 75.50% of the pipes passing the inspection. The qualified length of the rainwater pipeline was 15150m, the qualified length of the sewage pipeline was 4661m, and the

qualified length of the combined water pipeline was 240m. The statistical results show that the pipeline rectification and repair rate is 24.50%. The analysis results show that the highest qualification rate for rainwater pipelines is 86.70%, the lowest qualification rate for combined water pipelines is 43.32%, the highest rectification and repair rate for combined water pipelines is 56.68%, and the lowest rectification and repair rate for rainwater pipelines is 13.30%. The specific situation is shown in Table 4.

Table 4. Statistics of First Pipeline Qualification

Pipeline type	Detecting length(m)	Qualified length(m)	Need to rectify and repair the length(m)	Pass rate	Rectification and repair rate required
rain	17475	15150	2325	86.70%	13.30%
sewage	8529	4661	3868	54.65%	45.35%
river water	554	240	314	43.32%	56.68%
amount to	26558	20051	6507	75.50%	24.50%

6 Summary

A certain residential project belongs to the civil construction project, covering an area of 1.219 million square meters, of which the construction area involving the drainage pipe network is about 402000 square meters. In addition to the above ground building project, the underground drainage pipe network operation is also extremely challenging. Considering that the drainage operation of the pipeline network is only 5km away from the existing high-speed railway station, the technical personnel adopted a combination of multiple processes to ensure orderly construction and safe operation in the actual layout of rainwater, other wastewater, and heating pipeline network.

References

1. Liu L , Zhao L .Discussion on the Application of Pipe Jacking Construction Technology in Municipal Road Drainage Projects[J].Journal of Architectural Research and Development, 2023, 7(6):29-35.
2. Huang H.Discussion on the Application of Geothermal Recovery Technology in Municipal Road Construction[J].Engineering Advances, 2023.DOI:10.26855/ea.2023.04.006.
3. Ding C .Analysis on Construction Technology of Expansion Joints in Municipal Road Construction[J].OA Journal of Engineering & Technology, 2023, 1.DOI:10.26855/oajet.2022.07.003.
4. Zhang S , Liu W , Li Q .Research on TBM Construction Technology of Small Clearance Crossing of Existing Track Lines at Soft and Hard Rock Interfaces[C]//International Conference on Civil Architecture and Structural Engineering.Springer, Cham, 2024.DOI:10.1007/978-3-031-76102-7_22.

5. Gao H , Song Z , Mao Y ,et al.Tight coupling of oxygen vacancies and acidity on α-MnO2 through cerium doping engineering for efficient removal of multi-component VOCs[J].Applied Catalysis B: Environment and Energy, 2025, 362.DOI:10.1016/j.apcatb.2024.124745.
6. Pramanik S , Mazumder D .Characterization of Construction and Demolition Waste Aiming to Recycle as Coarse and Fine Aggregate in Kolkata Municipal Corporation Area[C]//International Conference on Sustainable Advanced Technologies for Environmental Management.Springer, Cham, 2024.DOI:10.1007/978-3-031-64006-3_36.