Exploration of Key Technologies for Dredging Construction of Drainage Pipelines

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Abstract. With the acceleration of urbanization, dredging construction of drainage pipelines has become an important part of urban infrastructure maintenance. This article first analyzes the causes of sedimentation in drainage pipelines and their impact on urban drainage systems. Then, it focuses on exploring key technologies for dredging construction of drainage pipelines, including high-pressure water jet cleaning, mechanical dredging. By comparing and analyzing the advantages and disadvantages of different technologies, combined with engineering examples, this article provides technical choices and construction suggestions for the dredging construction of drainage pipelines.

Keywords: drainage pipes; Dredging construction; High pressure water jet; Mechanical dredging;

1 INTRODUCTION

With the acceleration of urbanization, drainage pipelines, as an important component of urban infrastructure, their normal operation is crucial for ensuring the order of urban life and production. However, in actual operation, due to pipeline aging, water flow erosion, sediment accumulation, and other reasons, drainage pipelines often experience sedimentation, seriously affecting their drainage capacity, and may even cause problems such as pipeline blockage and sewage flooding. Therefore, dredging construction of drainage pipelines has become an important task for the maintenance of urban drainage systems.

2 REASONS AND IMPACTS OF SEDIMENTATION IN DRAINAGE PIPELINES

The impact of sedimentation in drainage pipelines on urban drainage systems is multifaceted, specifically manifested in the following aspects:

Reduce drainage capacity. Sediments occupy the internal space of the pipeline, reducing its effective cross-sectional area and thus reducing its drainage capacity. During

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the rainy season or peak season, drainage pipes are prone to overflow or overflow, leading to serious urban waterlogging problems. Increase the resistance of sewage discharge. The presence of sediment increases the flow resistance of sewage in pipelines, making sewage discharge more difficult[1]. In order to ensure the normal operation of urban drainage systems and the quality of life of residents, it is necessary to pay attention to the problem of sedimentation in drainage pipelines and take effective measures for prevention and treatment.

3 DRAINAGE PIPELINE DREDGING CONSTRUCTION PIPELINE SEALING AND DIVERSION KEY TECHNOLOGIES

3.1 High Pressure Water Jet Cleaning Technology

Principle: High pressure water jet cleaning technology uses the high-pressure water flow generated by the high-pressure water pump to form a high-speed jet through a specially designed nozzle, and uses the scouring effect of the water flow to clean the inside of the pipeline. High pressure water flow can effectively remove and flush sediment on the inner wall of pipelines, restoring their smoothness.

3.2 Mechanical Dredging Technology

Principle: Mechanical dredging technology is the use of professional dredging equipment, such as suction trucks, grab dredging machines, etc., to excavate, grab, and remove sediment inside pipelines. These devices use mechanical force to extract sediment from the inside of the pipeline and transport it to a designated location for processing through transport vehicles.

3.3 Pipeline Sealing and Diversion

In the process of dredging and repairing the current sewage pipeline, based on the requirements of blocking water, blocking gas, and preventing harmful gases from entering the operating pipeline, pipeline sealing is required. Considering transportation and construction period factors, airbag sealing is adopted on site.To ensure the safety of air pressure and the normal discharge of upstream water during airbag sealing, temporary diversion operations of the pipeline are required during dredging and pipeline repair processes.Specific measures:

(1) Sealing construction:Choose three inspection well sections as one construction section (approximately 120m in length, and the construction section should not be too long, otherwise it cannot be completed on the same day, which poses significant safety hazards and is not conducive to the discharge of toxic and harmful gases). First, block the upstream section, and then block the downstream section after the water discharge is completed.The end of the pipeline is sealed with a dedicated airbag[2]. Before the sealing operation, check whether the airbag is intact and whether the sealing pipe

mouth is polished flat without burrs.After passing the inspection, the electric air compressor airbag will be used for gas filling[3]. Three professional technicians will carry out airbag sealing construction on site, including one person for airbag sealing in the well, one person for safety observation at the wellhead, and one person for pressurizing the blower on the well.After the completion of airbag sealing, observe for 15 minutes without deformation before proceeding to the next process;During the process of pipeline dredging and repair construction, a dedicated person is arranged to observe the pressure gauge, monitor the pressure, and form a written record. The pressure value is controlled within the required range to ensure the safety of operators (see Figure 1).

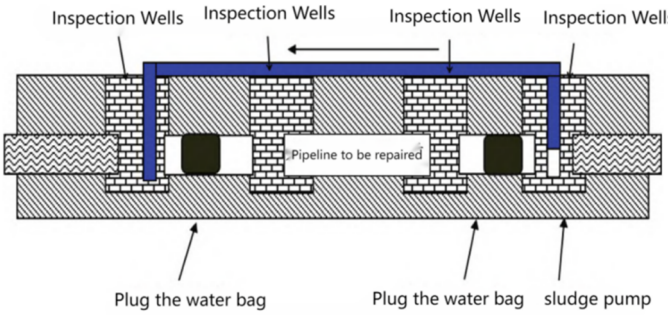

Fig. 1. Schematic diagram of sealing repair and temporary drainage

(2) Pipeline diversion: To ensure the normal use of sewage pipelines and prevent excessive upstream water pressure, it is necessary to guide the water from upstream inspection wells into downstream inspection wells to ensure the overall normal operation of sewage pipelines.On site, a sewage pump with an outlet diameter of 100-300mm is used for pumping water. A drainage hose with a diameter of 100-300mm is used for temporary bridging of the drainage pipeline, and the discharge distance is the construction section distance (three inspection wells with a length of about 120m). A membrane filtration device is installed at the end of the sewage pumping pump, and the drainage hose and inspection well are temporarily fixed with brackets.

In practical engineering, when dredging and repairing the existing sewage pipeline, it is necessary to consider the requirements of water blocking, gas blocking and preventing harmful gases from entering the operating pipeline. In this case, sealing and temporary shunting operations become crucial. To help understand, we can provide two engineering examples to illustrate how these measures are applied in practical projects.

Project example 1: urban sewage pipeline restoration project

The sewage pipeline in a city has been seriously blocked and partially damaged, which needs urgent repair and dredging. In this project, engineers adopted airbag sealing and temporary shunt technology to ensure the construction safety and normal operation of the pipeline.

For the sealing construction of the pipeline, engineers chose three inspection wells as a construction section, with a length of about 120 meters[4]. This design of construction section length aims to ensure the construction efficiency and safety. In the process of sealing construction, they first blocked the upstream section, then blocked

the downstream section after the water discharge was completed, and sealed the end of the pipeline with a special airbag. Before the sealing operation, they carefully checked the status of the airbag and the sealing nozzle, and inflated the airbag through an electric air compressor[5]. Professional and technical personnel carry out sealing construction on site, and strictly monitor the state of airbags to ensure safety. During the whole dredging and repairing process, a special person is also arranged to observe the pressure gauge, monitor the pressure and form a written record to ensure the safety of the operators.

For the temporary diversion operation of the pipeline, engineers used 100-300 mm sewage pump and drainage hose to introduce the water from the upstream inspection well into the downstream inspection well to ensure the normal operation of the whole sewage pipeline. They installed a membrane filtration device to purify the drainage, and temporarily fixed the drainage hose and inspection well with brackets to ensure the stability of the temporary diversion operation[6]. Through this project example, we can clearly see the application of sealing and temporary diversion operation in sewage pipeline repair project, and how these measures ensure the construction safety and normal operation of the pipeline.

Project Example 2: Sewage Pipe Dredging in Industrial Plant Area

The sewage pipeline in an industrial plant has been seriously blocked and leaked due to long-term use. In order to solve this problem, engineers adopted airbag sealing and temporary shunt technology to dredge and repair it.

In the aspect of sealing construction, engineers also chose the construction section with appropriate length, and adopted strict operation flow and safety monitoring measures to ensure the smooth sealing operation. At the same time, they set up special monitoring points at the scene to observe the state and pressure value of airbags in real time, so as to find and solve possible safety hazards in time[7]. In the temporary diversion operation, engineers used drainage hoses and brackets to temporarily bridge the drainage pipes, and installed appropriate filtering devices to ensure that the discharged water quality meets the environmental protection requirements. They also firmly fixed the drainage hose and bracket to cope with possible external influences and challenges during construction.

Through the description of the above two engineering examples, we can clearly see how the sealing and temporary diversion operations are implemented according to the specific needs of sewage pipeline dredging and repair projects. These measures not only ensure the construction safety, but also ensure the normal operation of the pipeline, which provides a strong guarantee for the smooth progress of the project.

The dredging and restoration of sewage pipelines plays a vital role in the construction of urban infrastructure. In the urban sewage pipeline restoration project mentioned in project example 1, engineers carefully designed the sealing construction scheme, selected the appropriate construction section length, and used professional airbag sealing technology to achieve sealing operation. In actual operation, they strictly monitor the state and pressure value of the airbag to ensure the reliable sealing effect and find and solve potential safety hazards in time. In addition, they also set up monitoring points to monitor and record the sealing construction process in real time to ensure that the operation process meets the specification requirements. These measures

not only improve the construction efficiency, but also ensure the safety of operators, which lays the foundation for the smooth progress of subsequent processes.

In the sewage pipe dredging project in the industrial plant mentioned in the second engineering example, engineers skillfully used drainage hoses and brackets to realize temporary diversion operation. They installed filtering devices and firmly fixed drainage hoses to ensure that the discharged water quality meets environmental protection standards, and to ensure the stability and continuity of temporary diversion operation. Through these operations, engineers successfully solved the problem of pipeline blockage and leakage, which provided strong support for the normal production and operation of industrial plants.

Generally speaking, sealing and temporary diversion operation play an indispensable role in sewage pipeline dredging and repair projects. They are not only necessary means to ensure construction safety and normal operation of pipelines, but also an important part of urban infrastructure construction. By strictly observing the operating rules, carefully designing the construction scheme and monitoring the construction process in real time, engineers can effectively cope with various challenges and risks and ensure the reliability and sustainability of the sewage pipeline system.

Each of the above three technologies has some advantages and disadvantages, which need to be compared and selected according to the specific situation.

High-pressure water jet cleaning technology has attracted much attention for its efficient cleaning effect and environmental protection characteristics. The dirt and blockage on the inner wall of the pipeline can be effectively removed by high-pressure water jet, and the cleaning effect is good, and chemical agents are not needed to avoid environmental pollution. At the same time, high-pressure water jet can also recycle water resources and save water. However, the operation of high-pressure water jet equipment requires professional operators, and it may not be suitable for some pipes with special materials or structures.

Mechanical dredging technology is also one of the commonly used dredging technologies, which has the advantage of wide application range and can be applied to various types of pipeline dredging operations. The relatively simple operation makes the threshold lower, and the internal situation of the pipeline can be clearly observed through mechanical equipment. However, the mechanical dredging technology also has some shortcomings, such as great destructiveness, which may damage the inner wall of the pipeline and have a certain impact on the pipeline. At the same time, the cleaning effect is slightly inferior to that of the high-pressure water jet cleaning technology.

Pipeline sealing and diversion technology is mainly aimed at the preventive maintenance of pipelines, which can effectively prevent the blockage and leakage of pipelines, improve the safety of pipeline operation and increase the stability of pipelines. However, this technology also has some shortcomings, such as high cost, more technical equipment and material costs, and difficult implementation, which requires professionals to design and construct.

On the whole, different technologies have their own advantages and disadvantages, so it is necessary to choose the appropriate technology combination according to the specific situation and needs. In actual construction, we can comprehensively consider

the material, blocking degree and environmental factors of the pipeline, and comprehensively use different technical means to achieve the best dredging effect.

4 ENGINEERING CASE ANALYSIS

4.1 Engineering Examples of High-Pressure Water Jet Cleaning Technology

4.1.1 Project Overview.

This project is located in an old residential area of Wuhan City City, and a drainage pipeline with a total length of about 2 kilometers needs to be dredged. These pipes were built in the 1980s and are mainly made of cast iron and concrete. Due to long-term erosion and sedimentation by domestic sewage, serious sedimentation occurs inside the pipeline, which affects drainage efficiency. The project overview is shown in Table 1.

Table 1. Project Overview

project	details
Project Name	Drainage pipeline dredging project in old residential areas of Wuhan City City
Project location	An old residential area in Wuhan City City
Total length of pipeline	2 kilometers
Pipeline material	Cast iron, concrete
Cause of sedimentation	Long term domestic sewage erosion and sedimentation

4.1.2 Construction Process.

Use high-pressure water jet cleaning equipment, with a working pressure set at 150-200 MPa and a water flow rate of 50-60 L/min. During the cleaning process, the first step is to conduct a comprehensive inspection of the pipeline to determine the degree of sedimentation and the condition of the pipeline. Subsequently, high-pressure water jet cleaning was carried out in sections, with each section measuring approximately 100 meters in length. The entire cleaning process lasted for 5 days. The specific construction process is shown in Table 2.

Table 2. Construction Process

Construction steps	details
The first step	Conduct a comprehensive inspection of the pipeline to determine the degree of sedimentation and the condition of the pipeline
Step 2	Perform high-pressure water jet cleaning in sections, with each section approximately 100 meters long
Equipment parameters	Working pressure: 150-200 MPa, water flow rate: 50-60 L/min
Construction duration	The entire cleaning process lasted for 5 days

4.1.3 Construction Effect.

The data before and after pipe cleaning can be seen from Table 3. After cleaning, the sediment inside the pipeline was effectively removed. According to the actual measured flow data, the average flow rate of the pipeline before cleaning is 0.6 m ³/ s. After cleaning, it increased to 0.9 m ³/ s. Increased by approximately 50%. In addition, the roughness of the inner wall of the pipeline has been reduced from the original 0.5 mm to 0.3 mm. The effect after the construction is shown in Table 4.

Table 3. Comparison of data before and after cleaning

project	Before cleaning	After cleaning	Lifting range
Average flow (m/s)	0.6	0.9	50%
Roughness of inner wall of pipeline (mm)	0.5	0.3	40%
Thickness of sediment in the pipeline (cm)	2.5	0.5	80%
Drainage efficiency (%)	60	85	41.67%

Table 4. Construction Effect

index	before cleaning	after cleaning	Change rate
Average traffic	0.6 m³/s	0.9 m³/s	+50%
Inner wall roughness	0.5 mm	0.3 mm	-40%

4.1.4 Existing Problems.

Due to the aging of the pipeline, there are cracks and rust in some areas. During the high-pressure water jet cleaning process, cracks in some areas have expanded and require subsequent repair work. During the high-pressure water jet cleaning process, cracks in some areas have expanded. Through the implementation of this high-pressure water jet cleaning technology engineering example, we have successfully removed sediment inside the pipeline and improved drainage efficiency. In my future work, I will continue to explore more effective dredging technologies and methods to provide more reliable and efficient solutions for urban drainage systems.

4.2 Engineering Examples of Mechanical Dredging Technology

4.2.1 Project Overview.

The project is located in an industrial park in Zhijiang City, where there are a large number of production-oriented enterprises. The drainage pipes are often washed and deposited by industrial wastewater. The drainage pipeline with a total length of about 3 kilometers needs to be dredged, and the main materials of the pipeline are PVC and HDPE.

4.2.2 Construction Process.

Use suction trucks and grab dredging machines for mechanical dredging. Firstly, use a suction truck to perform a preliminary cleaning of the pipeline, removing any ac-

cumulated water and most of the sediment inside. Then, use a grab dredging machine to excavate and grab the stubborn sediment inside the pipeline. The entire construction process lasted for 7 days.

4.2.3 Construction Effect.

After mechanical dredging, the sediment inside the pipeline was completely removed. The data effects after construction are listed in Table 5. According to the actual measured flow data, the average flow rate of the pipeline before cleaning is 0.8 m ³/ s. After cleaning, it increased to 1.3 meters ³/ s. Increased by approximately 62.5%. At the same time, timely repair and reinforcement were carried out on some damaged pipeline areas.

Table 5. Construction Effect

index	before cleaning	after cleaning	Change rate
Average traffic	0.8 m³/s	1.3 m³/s	+62.5%
Pipeline condition	There is sedimentation and damage	The sedimentation has been completely removed, and the damaged parts have been repaired	

4.2.4 Existing Problems.

During the mechanical dredging process, due to the hard and tight sediment in some areas, the grab dredging machine encountered significant resistance during excavation, resulting in a decrease in construction efficiency. In addition, the noise and dust generated during the mechanical dredging process have a certain impact on the surrounding environment.

5 CONCLUSION AND RECOMMENDATIONS

Through a detailed analysis of two different types of engineering examples, it can be seen that in practical applications, high-pressure water jet cleaning technology and mechanical dredging technology each have their own advantages and limitations. When choosing dredging technology, full consideration should be given to the specific situation and needs of the project, including factors such as pipeline materials, settlement degree, and construction conditions. We should strengthen the daily maintenance and management of drainage pipelines, regularly carry out dredging construction, and ensure the normal operation of urban drainage systems. In future research, the combination and use of different dredging techniques can be further explored to fully utilize the advantages of various technologies and improve the effectiveness and efficiency of dredging construction.

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