Application of Rapid Socket Pipe in Dredging Engineering

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Abstract. Aiming at the extension connection of mud discharge pipeline in dredging engineering, which usually adopts traditional methods such as stopping the work of cutter suction dredger or utilizing three-way gate valve, and there were problems such as poor continuity of construction and low efficiency of construction, this paper puts forward a rapid socket pipe structural design and its construction technology program relying on the Xiamen new airport blowing land reclamation project, and carries out on-site demonstration application. The results show that the two ends of the socket pipe are connected with the steel pipe as the optimal program, and the effect is better when the deflection angle is less than 12 °; when the pipeline deflection angle is less than 4 °, you can also choose to socket end steel pipe and socket end rubber tube connection; both ends are rubber tube connection and socket end rubber tube and socket end steel tube connection is less effective, not applicable to on-site construction use. The on-site application of the rapid socket pipe construction process provides valuable experience for the subsequent application of socket pipe.

Keywords: Rapid Socket Pipe; Dredging Engineering; Structure Design; Field Test.

1 Introduction

In traditional dredging and reclamation projects, the discharge pipeline is an important component of the dredging construction process[1-4]. In large-scale hydraulic fill and dredging projects, steel pipes and rubber pipes are usually used to lay sediment discharge pipelines, and flange and bolt connections are used. This method of laying sediment discharge pipelines has high connection strength, but during the process of pipeline connection extension, it is usually necessary to switch the pipeline with a three-way hydraulic gate valve or stop the construction of the cutter suction boat. Using a three-way hydraulic gate valve requires a period of clear water to be passed through the pipeline to complete the switch of the gate valve, and transporting clean water will increase the energy consumption of the cutter suction boat; Both methods will affect the continuity of construction and reduce construction efficiency. With the continuous improvement of engineering construction requirements, a fast socket pipe technology is needed to solve the problems of existing mud discharge pipelines. In existing research,

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socket and spigot pipe joints are mainly concentrated in the use of water supply pipelines, especially in underground pipelines and tunnels, which are widely used. Therefore, the further application of socket and spigot pipe joints in dredging and filling operations can provide new ideas for the optimization of dredging engineering[3,5,6].

Based on the Xiamen New Airport Project as shown in Fig. 1, this paper optimizes the socket pipe technology by designing the interface of the socket pipe for dredging and blow filling and by adjusting the relevant construction parameters and repeated tests in the project site, so as to provide a technical demonstration for the application of the fast socket pipe in dredging and blow filling operations.

Fig. 1. Xiamen New Airport Reclamation Project

2 Technological Design

2.1 Design of Socket Pipe Interface

The new socket pipe designed in this study mainly consists of two quick couplings, the male port and the female port, which are connected to the existing sludge discharge pipeline through the flange in advance. This study is based on the field DN850 steel sludge discharge pipeline, the design of the new socket pipe male connector as shown in Fig. 2, the male port is a flat pipe, the wall thickness is 18mm, the length of the protruding pipe is 200mm (flange thickness is not taken into account), which connects with the steel sludge discharge pipe through the flange, and the mass of a single male connector is about 178kg.

The design of the socket pipe female port is shown in Fig. 3, the shape is flared, and the angle between the flare and the horizontal line is about 14°, relying on the size match and friction between the male and female ports to reach the assembly, and the sealing effect is guaranteed by the negative pressure of sediment flow. The advantages of this female port design are simple structure, simple manufacturing process, convenient for male and female ports in the field construction of docking installation, pipe sealing and stability of the use of the field test to determine, and the formation of the optimal socket pipe construction process.

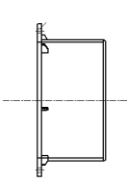

Fig. 2. structural design of male port

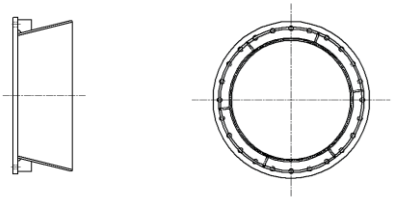

Fig. 3. structural design of female port

2.2 Rapid Socket Pipe Technology Solution

The main construction process flow of rapid socket pipe site is shown in Fig 4. The whole process is mainly divided into two parts, construction preparation and construction process. Specific construction process shown in Fig 5. Use an excavator to lift and transport the socket pipe to the corresponding position, place the socket pipe that needs to be extended at one end of the pipe mouth, and install two 350 excavators on the other end of the pipe mouth. Then use an excavator to align the female mouth with the male mouth of the main pipeline, and use a double excavator to lift and hold the socket pipe. During its insertion process, the male port is the fixed end and the female port is the active insertion end; After the excavator is lifted, the female head is diagonally fastened into the male head through the excavator swing arm; Adjust the pipeline angle through the male port excavator. After the socket connection is completed, the excavator near the socket will detach from the pipe and move to the new male port. The excavator far away from the socket remain stationary for the time being to ensure smooth flow of slurry inside the newly connected socket and avoid being washed away, which may cause takeover failure; Then excavate and retreat away from the socket, and connect the next section of the socket pipe to achieve pipeline extension during the construction process.

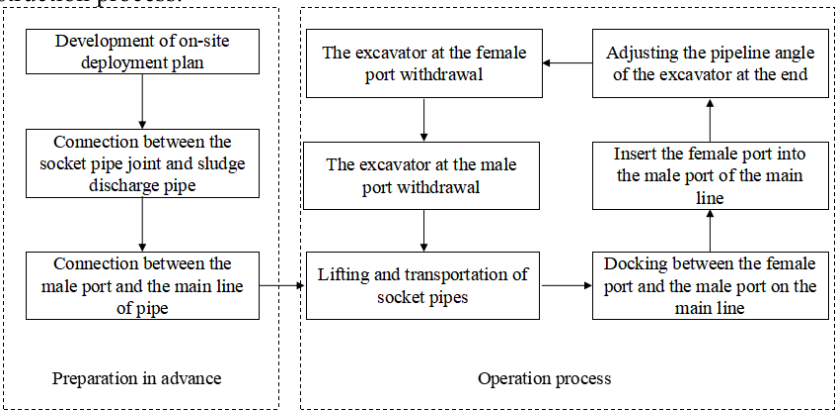

Fig. 4. Rapid socket pipe operation flowchart

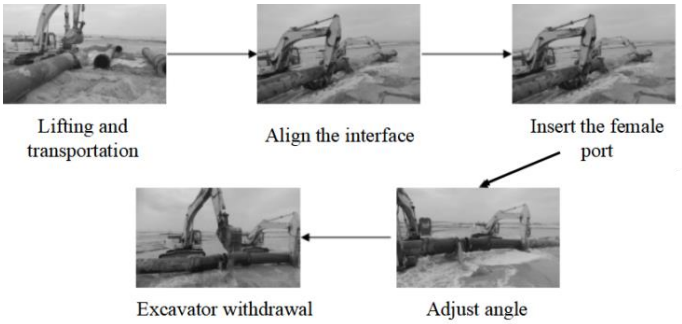

Fig. 5. Schematic diagram of rapid socket pipe operation

3 Result and Analysis

3.1 Field Test Conditions

In order to analyze the leakage and stability at the interface of the socket pipes under different pipeline combinations, a total of four combination methods were designed on site, the male and female ports of the socket pipes were connected to steel pipes, the male and female ports of the socket pipes were connected to rubber pipes, the male port was connected to rubber pipes, the female port is connected to steel pipes, and the male port was connected to steel pipes, and the female port was connected to rubber pipes. Due to the low accuracy of on-site pipeline dismantling and the influence of terrain, it was not possible to accurately determine the deflection angle; Mainly based on the actual deployment situation on site, different angles are selected to analyze the impact of deflection angle on the leakage and transportation stability of the socket pipe. The specific working conditions are shown in Table 1.

Table 1. Field test condition table

	male port	female port	Deflection angle(°)
1	steel pipe	steel pipe	12.3, 2.1, < 2
2	rubber pipe	rubber pipe	2.2
3	rubber pipe	steel pipe	11.7
4	steel pipe	rubber pipe	12.1，4.3，3.3，2.9

3.2 Analysis of Test Results

There are three sets of interfaces for steel mud discharge pipes at both ends of the socket pipe joint, as shown in Fig 6, with corresponding deflection angles of (a) 12.3 °, (b) 2.1 °, and (c) less than 2 °. From Fig 6, it can be seen that in the case where both ends of the socket pipe joint are steel pipes, the sealing effect at the interface is rela-

tively good. During the transportation of mud, only small leaks appear at the bottom of the interface. When the deflection angle of the joint reaches 12 °, the sealing at the connection of the socket and spigot pipe is still good, and there is no mud gushing around the interface of the socket and spigot pipe; And the entire pipeline is relatively stable, without any severe vibration phenomenon.

(a) (b) (c)

Fig. 6. Both ends of the socket pipe joint are steel pipes

Fig 7 showed the test results when the male port of the pipeline was connected by a rubber short pipe and the female port was connected by a steel pipe. It could be found that during the construction process, the deviation angle of the interface would change to 11.7 ° due to the impact of mud inside the pipeline, and a large amount of leakage would occur in a gushing shape. This was because the rubber pipe at the male port had a softer texture and bears less load. The rubber pipe would deform to a certain extent and cannot fit tightly. In addition, the pipeline at the end will generate certain vibrations, which may pose certain safety risks, this method was not suitable for on-site construction.

Fig. 7. Connecting rubber pipe at the male port and connecting steel pipe at the female port

Fig 8 showed the test results when the female port was connected to a steel pipe and the male port was connected to a rubber short pipe. There were a total of 4 alignment deflection angles, which were (a) 12.1°, (b)4.3°, (c)3.3°, and (d)2.9°, respectively. It could be found that the sealing effect and alignment deviation angle of the socket pipe were highly required. As shown in Fig. 8 (a) and (b), when the deflection angle of the joint exceeded 4°, serious leakage would occur at the connection of the socket pipe, and mud will continue to gush out from the bottom of the interface. As shown in Fig. 8 (c) and (d), when the deflection angle of the joint was less than 4 °, the initial sealing effect

of the socket pipe connection is poor, and there would be relatively large mud leakage at the bottom of the interface. After a period of mud transportation in the pipeline, due to the sediment deposition at the bottom of the socket pipe, the sealing at the interface is improved, and the mud leakage was small, which could ensure normal mud transportation in the pipeline. During the initial stage of connection, there may be some vibration in the pipeline, but as transportation progresses, the vibration decreases and becomes relatively stable.

(a) (b) (c) (d)

Fig. 8. Connecting rubber pipe at the female port and connecting steel pipe at the male port

Fig. 9 shows that when both ends of the socket pipes were connected by rubber short pipes, due to the poor load-bearing capacity of the pipeline material, the socket and spigot pipes could not be tightly connected after docking. Even when the alignment deviation angle was only 2°, there was still a large amount of mud leakage around the socket and spigot pipe interface, resulting in mud spraying phenomenon; The pipeline is vibrating and not suitable for on-site construction

Fig. 9. Both ends of the socket pipe joint are rubber pipes

4 Conclusion

This study proposed a structural design for a fast socket pipe suitable for dredging pipelines. After on-site testing, it had been proven that this socket pipe structure can replace traditional flange connected steel pipes, extend pipelines without stopping work.

This study proposes four different connection methods for socket and sludge pipes. After on-site testing, it was found that the connection between the two ends and the steel pipe is the best, with the least leakage and vibration. The leakage is still small at

large deflection angles (12.3 °); When the deflection angle is less than 4 °, the male end can also be connected to the steel pipe and the female end can be connected to the rubber pipe.

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