Study on Comprehensive Disposal of Sludge Dump in the Lihewa Comprehensive Improvement Project

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Abstract: In the comprehensive improvement project, there are many methods and technologies for disposal of dump, such as rapid mud-water separation and rapid consolidation technology. All of them should be implemented according to the specific environment in application. According to the characteristics of river dredging in Lihewa, the combined technical scheme of rapid mud-water separation technology and rapid consolidation technology can greatly shorten the land acquisition time and reduce the project cost. In this case, the dump can be returned to the people for cultivation on schedule. Which plays an important role in maintaining social stability and benefiting the people

1. The necessity of disposal

The Lihewa comprehensive improvement project adopts hydraulic cutter suction method for river dredging. Hydraulic cutter suction dredging method refers to that the mud (water) soil in the river channel is cut and destroyed by cutter, and the broken soil and part of water body are transported to the preset dump along the mud discharge pipeline by the slag suction pump for storage. The amount of dredging work in Lihewa comprehensive improvement project is large, and the amount of earth waste in the dump is 27.82 million m^3[1]. According to the engineering geological data, the dredged soil within the dredged reach of Lihewa comprehensive improvement project in Hongze Lake is mainly clay soil. Based on this, it can be judged that the dredged sludge produced by this project will be characterized by high water content, large clay content, poor water permeability, slow consolidation of natural drainage, etc. The conventional technical scheme adopted in the Lihewa comprehensive improvement project will cause large land acquisition area and takes a long period, and it will be difficult to realize the agricultural land rehabilitation of the land occupied by the dump in a short time. In addition, due to the large land acquisition area and long occupation period of the dump, the land acquisition compensation cost is high, and the investment in the later stage of the project is large and difficult to control.

Main problems in dredged sludge dump of the Lihewa comprehensive improvement project;

First, the dump covers a large area, and there are potential safety hazards.

Second, some areas are swamped, and it is difficult to transfer the dump as a whole.

Third, the dump causes social conflicts, and it is difficult to raise new compensation costs.

To ensure that the land occupied by the dump in Lihewa comprehensive improvement project can be handed over in time and returned to the people on schedule, necessary engineering measures should be taken to speed up the consolidation of dredged soil in the dump, which not only meets the actual needs of the project, but also helps to control the project investment, and at the same time can eliminate potential safety hazards and avoid social conflicts, which is of great significance to the smooth development of project construction and project management.

2. Technical scheme

2.1 Rapid mud-water separation technology

Due to the hydraulic separation in the process of hydraulic filling, when dredged sludge flows away from the hydraulic filling port, coarse particles or mud blocks are rapidly deposited in the area close to the hydraulic filling port under their own weight, and fine particles are carried to the area far

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away from the hydraulic filling port by the water flow, forming a particle distribution from near to far from the hydraulic filling port. The particles gradually become smaller from coarse to fine in the whole dump. In the area of coarse particle accumulation, dredged soil is deposited faster, with lower water content and higher soil strength. In the area where fine particles are enriched, especially in the area near the water outlet, the dredged soil is slowly deposited, with high water content. As a result, the soil strength cannot be formed in a short time. At the same time, this area is also a low-lying area, and there is a large amount of surface water on the surface of dredged sludge. Therefore, this area is easy to be swamped for a long time.

The rapid mud-water separation technology is aimed at the obvious regional characteristics of particle distribution in the dump [2]. Before the dredged sludge dump is dredged and filled, the vertical drainage system and the bottom drainage system for preventing siltation are pre-arranged in the fine particle enrichment region, especially in the water outlet area, so as to form a spatial drainage system, realize rapid mud-water separation, preserve soil and filter water, improve the storage efficiency of the dump, reduce land area, speed up mud-water separation and improve the consolidation rate of dredged sludge [3].

The layout schematic diagram of quick mud-water separation technology is shown in Figure 1. This technology is implemented before the dredger fill in the dump. The bottom drainage pipes are set in the dump in advance, and then the vertical drainage system is arranged at a certain distance above them. The vertical drainage system is the plastic blind ditch with porous structure, and a layer of anti-blocking filter material is wrapped outside. The structural characteristics and pore size of the filter material are determined according to the nature of the treated sludge, so as to realize soil conservation and water filtration. The vertical drainage system and the bottom pipe are tightly connected.

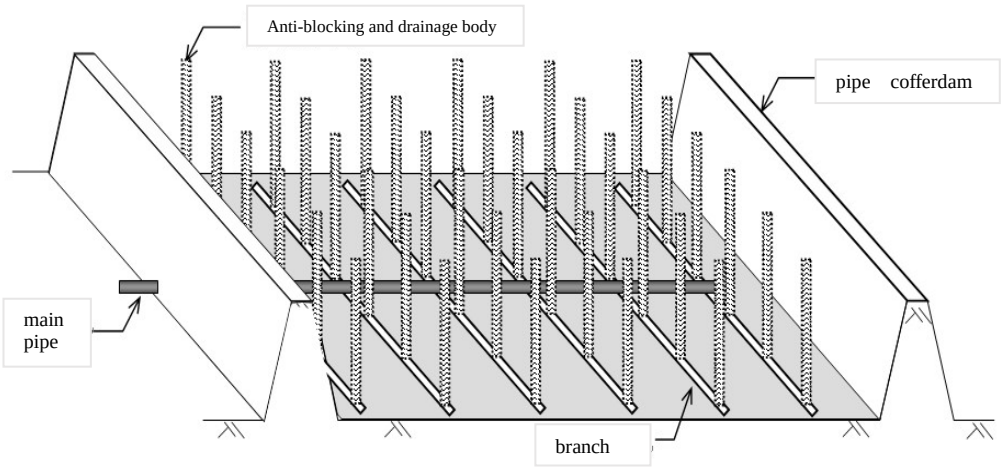


Figure 1 Schematic diagram of rapid mud-water separation technology

2.2 Rapid consolidation technology

Rapid consolidation technology is developed on the basis of traditional vacuum preloading technology, which is mainly used to deal with areas that are difficult to consolidate for a long time in the dump under the condition of natural drying and air drying after hydraulic filling [4]. In view of the problem that traditional vacuum preloading technology often causes siltation and poor reinforcement effect when dealing with dredged soil in the dump, anti-blocking measures are adopted. The initial optimal vacuum degree is set by the control device, and loading is carried out in stages according to the optimal vacuum loading ratio, so as to solve the problem of siltation and realize the rapid consolidation of dredged sludge, the rapid reclamation of the dump and the cyclic utilization of land [5].

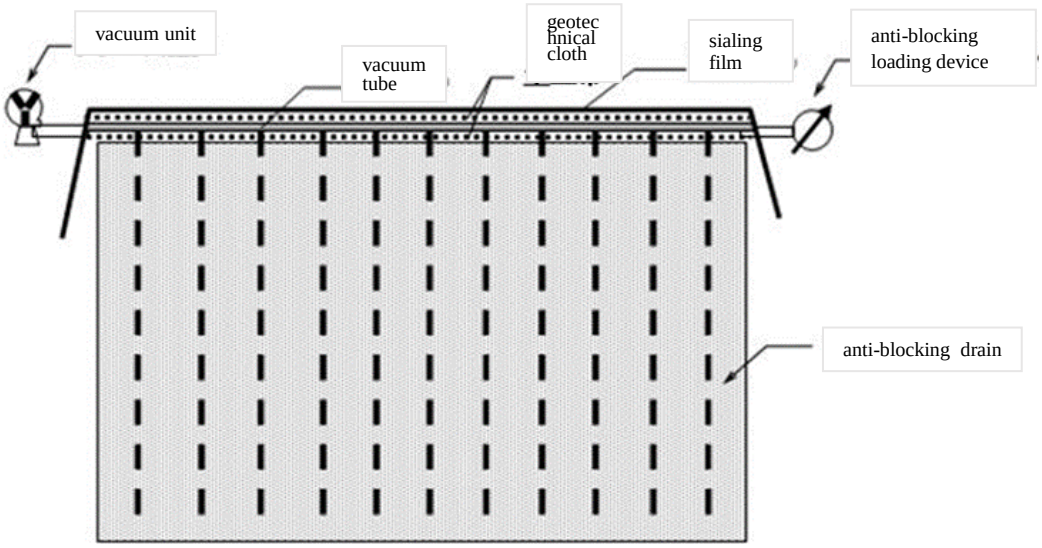


Figure 2 Schematic diagram of rapid consolidation technology

3. Implementation plan

3.1 Rapid mud-water separation

The rapid mud-water separation technology is implemented in advance before the dredger fill of the dump [6]. It is used to treat the fine particle enrichment region near the water outlet, which accounts for about 8% of the total area of the dump.

3.1.1 Layout of dump site

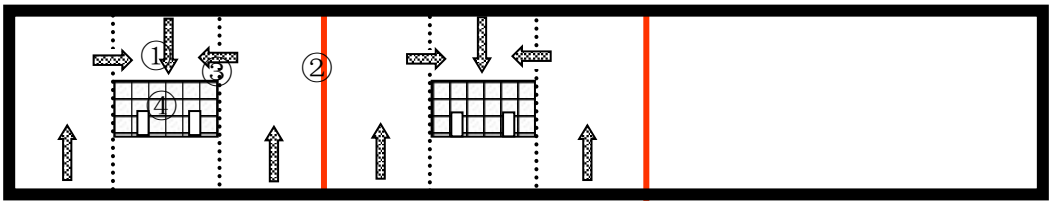
The 13 sludge dumps in this project are all large in area. To ensure that the fine particle enrichment region is concentrated near the water outlet to facilitate the overall treatment, first, the large-area sludge dump is divided into several treatment units with the first-stage weir, and the area of each treatment unit is controlled at about 450 mu; each treatment unit is divided into three areas with the secondary weir. Each of them is about 150 mu. The second-stage weir is provided with an overflow port to control the position of the hydraulic filling port and the hydraulic filling construction process. The hydraulic filling construction is carried out from both sides to the middle area. First, the two sides are dredged, and then the middle area is dredged, so that fine particles gather in the middle area for centralized disposal. The layout of the dump can be appropriately adjusted according to the actual situation of each dump [7].

3.1.2 Setting of special water outlet for mud-water separation

The middle area of each treatment unit is provided with a special water outlet for mud-water separation (see Figure 3). According to calculation, for every 10m2 -15,000 m2 of mud-water separation system, it is necessary to set a centralized water outlet to ensure the smoothness of the whole drainage system. The layout area of the mud-water separation system of each treatment unit in this project is 36 mu (450 mu× 8%), which is about 24,000 m2. Two special water outlets for mud-water separation should be set in the middle area of each treatment unit.

3.1.3 Layout of rapid mud-water separation system

A rapid sludge-water separation and drainage system is pre-arranged in the fine particle enrichment region near the special sludge-water separation water outlet. The rapid sludge-water separation system of each treatment unit adopts a rectangular layout of 240m×100m , covering an area of about 36 mu (450 mu× 8%). The layout area of the rapid mud-water separation system can be appropriately adjusted according to the actual conditions of each dump.



① First-stage weir ② Second-stage weir ③ Layout area of mud-water separation system ④ Hydraulic filling construction sequence

Figure 3 Schematic diagram of mud-water separation system layout

3.1.4 Vertical drainage body

The vertical drainage body adopts plastic blind ditch+anti-blocking filter. Among it, the blind ditch has a diameter of 20cm. The blind ditch height = hydraulic filling height+digging thickness of cultivated soil+rich height = 3.0 m+0.3 m+0.2 m = 3.5 m. The vertical drainage bodies are arranged in a square with row spacing and line spacing of 3m.

3.1.5 Bottom drainage pipe

According to the calculation, the horizontal branch pipes at the bottom of the mud-water separation system have a diameter of 110mm, and the main pipes have a diameter of 325 mm. The diameter of the drain pipe can be adjusted according to the change of actual conditions on site.

The construction process flow chart of rapid mud-water separation technology is as Figure4:

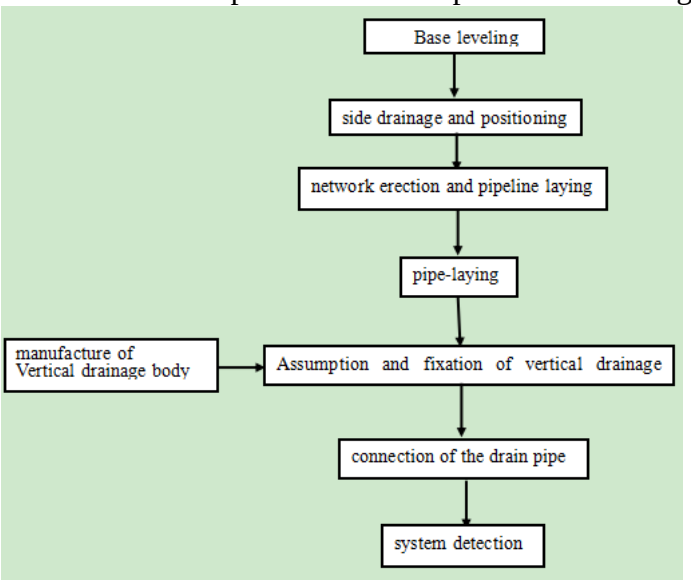


Figure 4 Flow chart of rapid mud-water separation construction process

3.2 Implementation of rapid consolidation technical scheme

The rapid consolidation technology is used for the fine particle enrichment region with high water content except the mud-water separation area after the completion of hydraulic fill, which generally accounts for about 3% of the total area of the dump.

3.2.1 Selection of processing area

After the hydraulic fill, due to the influence of the size of the dump area, the layout of the hydraulic fill port and the properties of the soil layer, there will be a fine particle rich area with high water content in a certain range outside the water outlet area, which generally accounts for about 3% of the total area of the dump area. This area will be treated by rapid consolidation technology.

3.2.2 Layout of rapid consolidation system

① Drain board

According to the characteristics of dredged sludge in the dump of Lihewa comprehensive improvement project in Lihewa of Hongze Lake, on the basis of considering both feasibility and effectiveness, drainage boards are arranged in a three-dimensional way (see Figure 5). The three-dimensional drainage boards can effectively reinforce dredged sludge at different depths in the dump, and at the same time, can make full use of the vacuum energy to save energy and protect the environment.

The control area of each vacuum pump is determined according to 50m×20m=1000m2. The spacing of drainage boards is 1.0m, and the row spacing is 1.0m.

② Site sealing: after the drainage boards are laid, first cover a layer of 300g/m2 non-woven geotechnical cloth, and cover it with three layers of 0.12 mm-0.15 mm plastic film. The sealing film around the site should be pressed into the soil by not less than 0.5m, and the site should be kept completely closed.

③ Site cleaning: after the rapid consolidation construction is completed, the residual pipelines, geotechnical cloths, plastic films and other sundries in the site should be cleaned up.

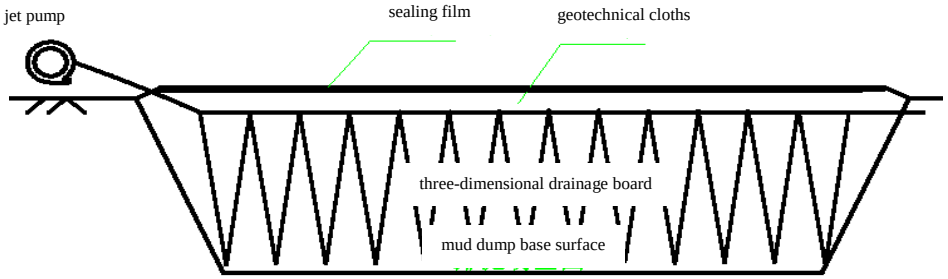


Figure 5 Schematic diagram of three-dimensional drainage board

4. Comprehensive benefit analysis

If the Lihewa comprehensive improvement project in Hongze Lake basin adopts the combined technical scheme of rapid mud-water separation technology and rapid consolidation technology, it is expected that the dump can meet the conditions of agricultural land rehabilitation about one year after hydraulic filling, and realize the overall transfer of the dump.

Among it, the rapid mud-water separation technology is implemented in advance before the dredger fill of the dump to treat the fine particle enrichment regions near the water outlet, which account for about 8% of the total area of the dump. The rapid consolidation technology is used to quickly reinforce other fine particle enrichment regions which account for about 3% of the total area of the dump after the dredger fill is completed.

The dredged soil within the reach of the Lihewa comprehensive improvement project is mainly clay soil, and the dredged sludge produced by dredging has the characteristics of high water content, large clay content and slow natural consolidation. It is estimated that the consolidation period of the dump will take 5 years to 8 years or even longer. After the dump is treated by the combined scheme of rapid mud-water separation technology and rapid consolidation technology, it is estimated that the land acquisition time can be shortened by 4 years to 7 years, and the engineering investment saved by the technology is as high as several hundred million yuan, with remarkable economic benefits.

In addition to the direct economic benefits, the application of the key technologies for comprehensive disposal of dredged sludge dump (rapid mud-water separation technology and rapid consolidation technology) in the Lihewa comprehensive improvement project in Hongze Lake basin can also bring into play huge social benefits and safety benefits.

The 13 dump sites of the Lihewa comprehensive improvement project in Hongze Lake basin have a large area, of which the largest area is close to 3,000 mu and the smallest area exceeds 900 mu. The dredged soil in the dump site is difficult to consolidate as soon as possible, and it has been in a state

of swamping for a long time. If there are residents or children drowned, livestock falling or dams breaking after heavy rain, there will definitely be adverse social impact and loss of life and property of local people. This kind of potential safety hazard can be eliminated if technical treatment is adopted to realize the agricultural land rehabilitation of the dump as soon as possible.

In addition, if the dump can't be returned to the people for cultivation on schedule, it will often lead to mass incidents such as people's petitions, social conflicts and increase the difficulty of project construction and management. At the same time, more compensation funds are needed to properly handle the above problems [8]. Using technical treatment to realize agricultural land rehabilitation as soon as possible can avoid social contradictions and is conducive to social harmony and stability.

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