

Research on simulation of soft foundation treatment

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Abstract: Engineering field is in a closed area, big surcharge ratio of precipitation preloading method is the first time be proposed to apply to soft foundation treatment, and successfully applied in the artificial island foundation treatment, its advantages of efficient and fast were fully played in practice. This paper discusses process of the overload preloading method to apply to soft foundation treatment, include all key technologies of designing, monitoring and evaluated the reinforcement effect. this project can provide reference for future similar engineering construction or modification of the value of limited of specification.

1. Project overview

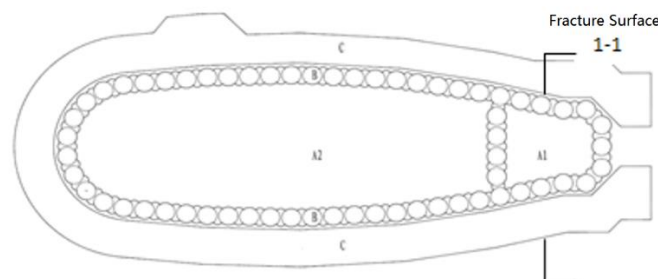


Figure 1. West Island District Map

Artificial island is made of diameter 22m steel cylinder deep into the impermeable layer, between the steel cylinder, use of sub-grid connected to the enclosed area. Island wall structure was formed by the steel cylinder; The island area is subject to a soft soil foundation treatment before construction. According to the time limit for a project requirements, artificial island construction will be divided into large island area and small island area. Partition diagram as shown in figure 1. This article selects the island as shown section 1-1 for the control section are studied. Artificial island foundation is distributed with very deep sediments of the whole new marine sediments, silt clay, which characteristic is the moisture content, high compressibility, low strength, poor permeability, long consolidation time, it is the main soil foundation treatment.

2. Key technology of preloading



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2.1 Construction

The area of soft ground treatment is about 72000 m^2 . After the excavation of the base trough, percussing the cylinder and the sub-grid are applied and the mortise grouting, forming a sealed dam, to provide conditions for future precipitation preload; Construct the wells after throwing in the coarse sand, to complete the construction of the drainage wells and start precipitation, as well as the formation of land on the board of the construction conditions; The use of modified hydraulic press board percuss plastic drainage board; The use of modified hydraulic press board to apply plastic drainage board; At the same time backfill surcharge and construction, the use of belt dump ship filled the coarse sand on the artificial sand, and then use bulldozers, loaders to push flat, after leveling the coarse sand, continue backfilling the coarse sand. For the process of backfilling while improving the dewatering well level, and pay attention to the protection of the drainage wells; After stack of coarse sand and precipitation to 16.0 m, with precipitation residual joint stack preloading silt, silt soil and compressible viscous soil layer; According to the monitoring data to analyze the reinforcement effect to meet the design requirements, stop pumping, unloading.

2.2 Analysis methods

The load of the site is 20 kPa, after the preloading is completed, the upper stack of coarse sand excavated to -12m between the island and the immersed tunnel. The upper part of the construction period is about 170kPa.

For the top surface of the reinforcement soil, preloading load for backfill of coarse sand, load about 378 kPa, depending on the upper structure and foundation pit excavation depth is different, the foundation of using different load. For the absence of the superstructure, an excavated area, according to the use of load 20kPa considerations, for the reinforcement of the top surface of the soil, the use of load is about 238kPa, overload ratio of about 1.6; For the island head excavation deepest, which is the Pipe end position, the reinforcement of the top surface of the use of the load is about 152kPa, overload ratio of about 2.5.

3. Analysis

3.1 Typical section of numerical analysis

According to the selection of the construction area shown in Fig. 1, a finite element analysis model similar to the structure is established in the ANSYS interface. The model size is equivalent to the actual size. The model contains the specific grid division of the key construction, according to the specific construction steps to simulate calculation.

For the sake of symmetry, from the centerline south cut out half of the modeling calculation, a typical cross-section model shown was build, The model width is 11m and the slope is 46m long, extending the slope from the slope to 220m, in order that eliminate the boundary effects. The formation is selected base on the actual drilling, Calculate the formation to the third largest layer, 1-1 section to ③2 silty clay sand layer at the bottom, Elevation -45.4m, The bottom of the section is in the sand or gravel sand, calculated when the settlement is not considered.

On the basis of the specific model of the key construction step, each construction step required for backfilling, installation, excavation to separate a series of unit cell material properties, preparing to simulate the construction process in detail for the next step. Set the contact surface unit, in the dam and the surface contact with the surface, and simulation of the cofferdams and stratigraphic contact coordination deformation characteristics. According to the construction sequence, activate the cell materials that needed to be backfilled in the working condition of construction simulation. According to the actual construction procedure, simulation analysis of each construction step, At the same time introducing time parameter, adopt the fluid-structure interaction method to simulate the soil in the process of consolidation settlement in construction process, and adopt a series of hydraulic boundary conditions change in simulating the construction process of precipitation preloading effect on surface settlement.

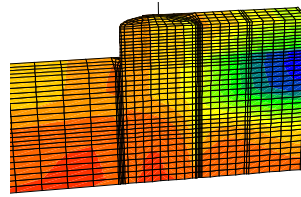


Figure 2. Section 1-1 precipitation after completion of preloading settlement

After the precipitation is completed in the construction area, the maximum settlement occurs at the central axis, and the maximum settlement is about 2.87m in the 1-1 section. Since the maximum settlement in the cloud contains the partial sedimentation of the bed, the cloud shows the maximum, the settlement is slightly larger than the foundation settlement. Regardless of the sand itself, the compression settlement, the maximum settlement of the 1-1 section foundation is 2.75m (including the compressive settlement of the foundation 270mm caused by -16m ~ -5m backfill sand).

Construction area which was covered by backfill, after a long time standing consolidation to completion, the deformation of the foundation settlement of developments as shown in figure 3. 1-1 section that the total settlement of the model is about 2.78 m, and the total settlement of the original mud surface is 2.73 m.

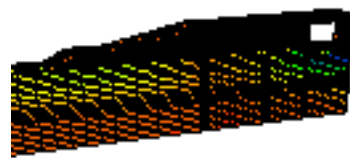


Figure 3 Section 1-1 cover backfill settlement cloud band

3.2 Prediction of final Settlement

Figure 4 shows the development curve of the foundation settlement at the center line of the 1-1 section island. According to the monitoring data the curve is simulated by the numerical simulation, the settlement curve of the whole process is obtained to predict the final settlement of the section. The figure shows that the island's foundation shows a trend of continuous sinking preloading process after backfilling into island and precipitation, and after completion of precipitation happened due to the small island excavation unloading is a certain amount of rebound, then after a period of tunnel structure construction of the island, immersed tube and cover again after backfill, immersed tube tunnel total subsidence is expected to about 2.74 m.

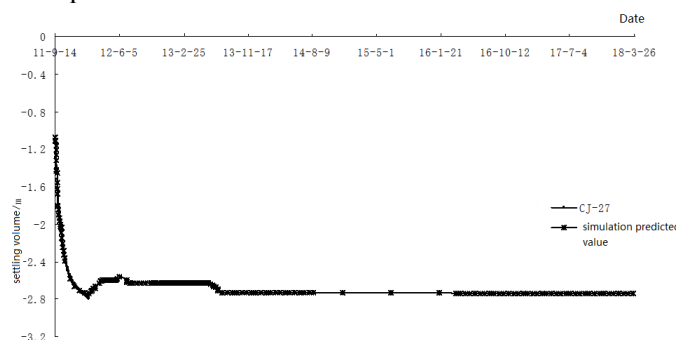


Figure 4. Section 1-1 the center line of the island of foundation settlement curve of the whole process of development

4. Conclusion

Big surcharge ratio of precipitation preloading method for the first time applied in the artificial island soft foundation treatment, artificial island sealing dam for this method to provide conditions for soft

ground treatment. In this project, the foundation of the soft foundation reinforcement is improved by the plastic drainage board plus precipitation combined with the preloading scheme, and the overall stability of the foundation is satisfied.

(1) According to the measured data during the preloading of precipitation and the finite element simulation, the foundation settlement occurred in the course of construction. The surface subsidence was 2053mm ~ 2497mm, with an average of 2234mm, But at the time of unloading, the consolidation degree of the foundation under the current preloading load is 87.3% according to the settlement of the land, which satisfies the design requirement.

(2) In the future similar to this project with cofferdam constraints of soft soil foundation design, the settlement control standard should break through the specification limits.

Based on the above analysis results, the soil strength index of the soft foundation is up to the design requirement, and due to the overload for stack preloading load is bigger, shortens the time needed for soft ground treatment.

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