Research on reinforcement effect of vacuum preloading to treatment of the soft foundation

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Abstract: vacuum preloading method is a commonly used method to reinforce soft ground at present. Monitoring during construction stage is a dynamic monitoring, which is a standard to judge the quality of construction. This paper relies on the reclamation project of Tianjin Port Industrial Zone in North China, analyzed the monitoring purposes, monitoring method and collection data. Results had shown that vacuum preloading monitoring can make an accurate evaluation of construction quality during construction. The project practice can provide reference for similar projects.

1. project overview

A reclamation area is located in Tianjin Lingang Industrial Zone, which total area is about 575 thousand square meters. The project is divided into 24 regions, and each region is reinforced by vacuum preloading method.

The whole reinforcement process of the construction area should be monitored dynamically, according to the monitoring data, the reasonable unloading time of the consolidation is determined.

2. vacuum preloading design

The main content of monitoring includes stratified settlement observation, pore water pressure observation, deep horizontal displacement and groundwater level. A group of pore water pressure gauges and a set of stratified settlement are respectively arranged at the central position of each reinforcing zone before the vacuum preloading pumping. The purpose of each monitoring project is as follows:

(1) Stratified settlement observation

By measuring the compression and settlement process of different soil layers in foundation, the comprehensive consolidation degree of soil can be calculated, which provides a basis for predicting the settlement and determining the unloading time.

(2) Through the measured data, mastering the dissipation of pore water pressure in the preloading process, which can be used to analyze the consolidation degree and the strength increase of the soil, and meanwhile, the dynamic monitoring, can guide the construction of the preloading process.

The observation of the deep horizontal displacement and groundwater level is to check the effect of reinforcement.

The vacuum preloading design load of this project is 85kPa, and the effective pumping time is about 100 days. The surface of filled layer is laid with medium coarse sand with thickness 350mm as working cushion. The vertical drain channel adopts plastic drainage plate(pvd) with a spacing of 1.0m and a square arrangement. There are short pvd between two long pvd, , bottom elevation is -6.0m of long pvd, drainage board (long board) is directly connected with the filter.

Unloading standard of vacuum preloading construction:

(1) The average consolidation of foundation soil is greater than 82% which is calculated according to the settlement curve;

(2) The average settlement rate is not more than 3.0mm/d for 5 consecutive days.

3. monitoring effect analysis

The monitoring of the whole preloading process, the changes of settlement, pore water pressure, horizontal displacement and the underground water level in the foundation can be seen, the monitoring results are analyzed as follows.

（1）Stratified settlement observation

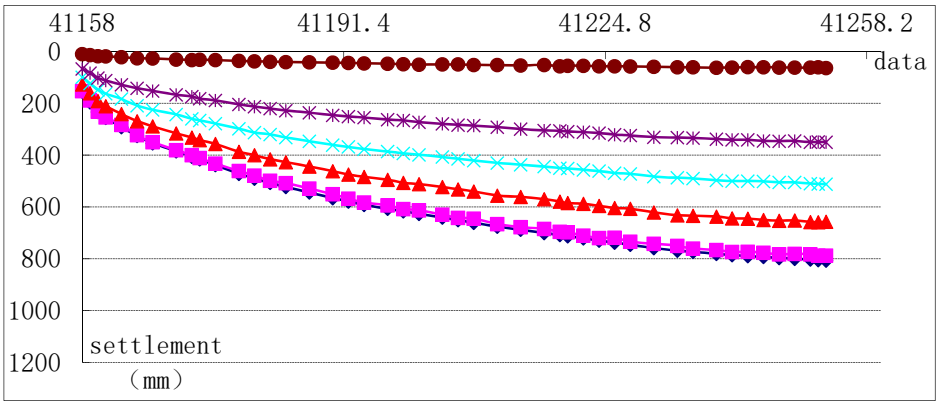

Fig. 1 the relationship between the stratified precipitation and time

After setting up the plastic drainage plate, according to the design requirements, Stratified settlement are embedded near the central point of the vacuum preloading reinforcement area so as to grasp the deformation of the soil layers in the foundation. Because of the plastic drainage plate have set, the drainage path of soil is short, and a certain amount of consolidation settlement occurs soon under the self-weight of the soil. The settlement of preloading area 1 and 24 is 619mm and 1080mm. According to the observed data, the relationship between consolidation settlement and time is plotted. According to the monitoring data to calculate the consolidation degree of the foundation soil which can reflect the reinforcement effect. The relationship between the stratified precipitation and time of preloading area 18 is shown in Fig. 1 .

When unloading, according to the observation of average settlement and layered settlement for 5 consecutive days, the consolidation degree of the foundation is more than 85%, which is meet the unloading requirements.

(2) Observation of pore water pressure

The pore water measuring heads are embedded near the central point of each vacuum preloading zone, and the embedment position is in the central position of the surrounding area of the four drainage plates, and the buried depth is the depth of the design requirement. According to the analysis of the observation results before and after of paving membrane, the pore water pressure in the foundation of measuring head position is significantly greater than the hydrostatic pressure, the excess hydrostatic pressure is in the foundation, the foundation soil is not already consolidation, and each measuring point of the pore water pressure gauge had greater dissipation in the construction period. Fig. 2 is a curve of pore water pressure in vacuum 18 zone. Table 2 is a statistical table of pore water pressure cumulative dissipation in vacuum 18 zone.

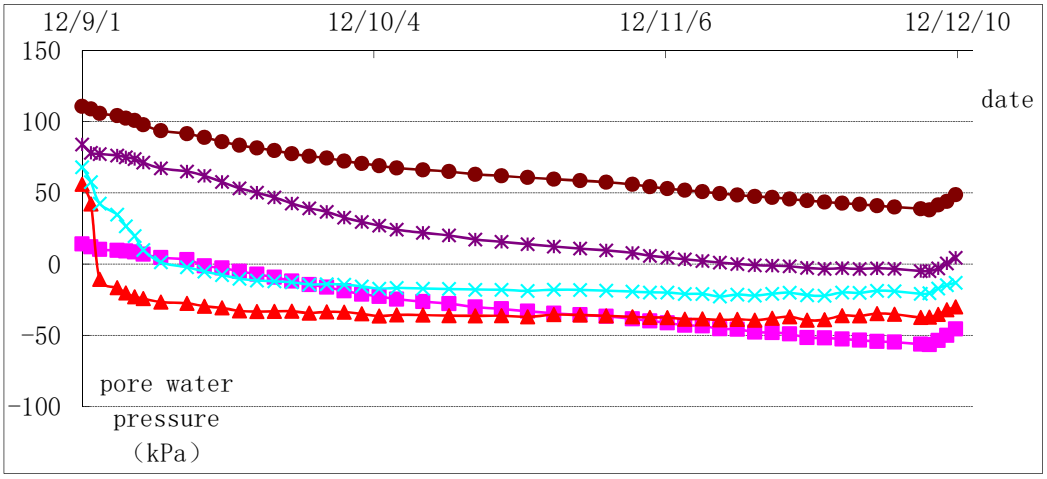

Fig. 2 The curve of pore water pressure in vacuum 18 zone.

(3) Observation of horizontal deep displacement

Inclinometer is buried outside of the reinforcement area to observe the displacement of reinforced soil surrounding area before beginning of the vacuum preloading period. The observation results show that horizontal displacement is from outside of the reinforcement area to the inside of reinforcement area during the preloading process, the maximum horizontal displacement is 306.7mm, horizontal displacement mainly occurred in the upper part soil of foundation.

(4) Observation of groundwater table

Before the beginning of pumping, the pore water in the foundation will discharge from the drainage channel under the load condition, which leads to the decline of water level in the foundation. A water level pipe has arranged at the outside of the construction area so as to observe the change of the groundwater level o.

The results show that the water level is lower with vacuum preloading process, the water level of the outside of reinforced area is obvious decline, a decrease of 2.14m ~ 3.18m. The relation between water level and time on the north side of A-1 district is shown in figure 3.

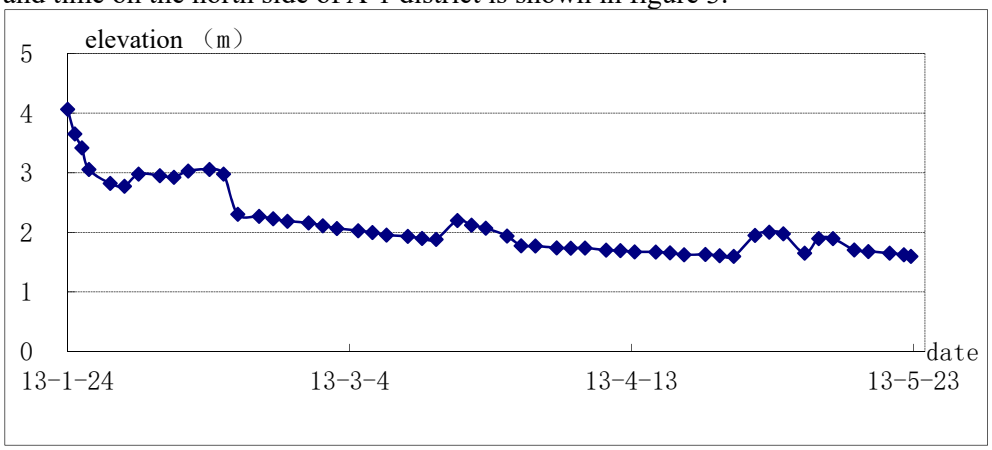

Fig. 3 The relation between water level and time on the north side of A-1 district

4. Conclusions

(1) according to the data of the stratified settlement, during vacuum preloading period, the stratified settlement is 619mm ~ 1080mm, there were more significant settlement in each reinforced area , reinforcement effect of vacuum preloading of soft soil foundation is very good;

(2) the degree of consolidation is from 82.2% to 85.7%, average sedimentation rate is 1.2mm/d ~ 2.0mm/d of 5 consecutive days, the construction qualification of the vacuum preloading is good.

(3) The analysis results shows that the pore water pressure dissipation of each soil layer is significantly, pressure rebound phenomenon did not occur in the construction of vacuum preloading process, the pore water pressure can reflect to the effect of vacuum preloading construction;

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