APPLICATION OF NEW “STRAIGHT LINE” VACUUM PRELOADING METHOD IN SOFT SOIL FOUNDATION TREATMENT

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ABSTRACT: With the rapid development of the mass and hypervelocity reclamation projects, the new vacuum preloading technology arises at the historic moment. In this paper, based on the construction experience of the project applied new type “Straight Line” process which the writer participated in, a brief introduction and summary has been made on the new-type “Straight Line” process applied in the foundation treatment of vacuum preloading. By optimizing conventional vacuum preloading construction technology, direct vacuum preloading method is adopted to connect drainage board with filter tube directly, shorten vacuum transfer path and reduce energy consumption. The predicted effect is obtained.

Keywords: New process, straight line, vacuum preloading technology, foundation treatment, application.

INTRODUCTION

Vacuum preloading method as an effective and conventional practical Soft Soil Reinforced method, is widely used in the construction of port, highway, airport runway, power plant, petrochemical tank and other projects in recent years, especially in the port construction industry most widely used.

With the rapid development and opening of Tianjin Binhai New Area, a large-scale, ultra-high-speed land reclamation has been set off. And the land reclamation area is mostly in shallow shoals. The certain elevation of mud surface is formed when the dredging soil is used for reclamation. But the foundation is very poor, high water content and low strength and bearing capacity, which must be reinforced in order to meet the requirements of the bearing capacity for the kind of soft soil.

In the process of vacuum preloading method used for reinforcing such “super-soft soil foundation”, a new type of “Straight-Line” construction technique have emerged. As the technical engineer and management personnel, we are lucky to join the construction of new processes for the Tianjin Harbor thermoelectric soft ground treatment works in the Tianjin Harbor Industrial Zone. Based on several projects in the vacuum preloading foundation treatment works, we make a brief introduction for supporting and helping the construction of similar projects, at the same time we hope the similar process can get better promotion and application.

NEW “STRAIGHT LINE” VACUUM PRELOADING

Background for the new “straight line” vacuum preloading

With the acceleration for the project progress for the Tianjin Port Reclamation land, the foundation for dredger fill shall be reinforced after the reclamation on the soil surface elevation. But many problems have been exposed using conventional vacuum preloading technology, mainly as follows:

1) The foundation soil is of high water content, quite low strength and bearing capacity in the reclamation finished just now, on which must be laid multiple layers of geotextile as a reinforcing measure in order to ensure 30~50 cm thick yellow sand cushion smoothly be laid.

2) The capacity of ultra-soft ground formed by reclamation can not meet the sanding motor vehicle traveling requirement even if a large number of reinforcing measures are taken. The laying of yellow sand can only be done by manual trolley combined with bamboo springboard, which results in low construction efficiency that affect the duration, but also improves the project cost.

3) After the yellow sand laying is completed, back to pulp is very serious when plastic drain board is laid. It influences the sand cushion severe pollution, blocks the horizontal drainage channel, seriously impact on the

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level drainage effect of the sand cushion, and thereby affect the vacuum effect and engineering quality.

(4) The serious back to pulp and reinforcing measures not in place results in the surface rough, uneven hardness, a board machine dumping many times and even mired in the mud when the plastic drain board being set up, which brings a great security risk to the construction workers and equipments.

Above more than a few problems appear in the process of vacuum preloading treatment in beginning of the Tianjin Harbor Industrial Zone construction. It affects the duration of the project, quality, safety, and cost of project. Against the above problems for conventional vacuum pre-loading technology exposed in the ultra-soft foundation treatment, a new type of vertical-type vacuum preloading technology came into being.

New “Straight line ” vacuum preloading technology introduction

New “Straight line” vacuum preloading technology was researched and developed by a design company in Tianjin, and the engineering test of new “Straight line” vacuum preloading technology was very successful. The company already has a patent for the technology. In the Harbor Industrial Zone the technology has been gradually achieved standardization and industrialization. The technology has been widely used in the reclamation projects of the Harbor Industrial Zone. The technology is applied to most of vacuum preloading projects in the industrial zone at present.

New “Straight line” vacuum preloading is a new kind of soft soil foundation treatment technology, also known as vacuum preloading without sand cushion drainage, belongs to the static drainage consolidation method. The construction method of the technology is as follows: firstly vertical plastic drainage plate is set in the soft soil foundation, secondly Horizontal vacuum tube is directly connected to the exposed end of the plastic drainage plate(each vacuum tube is arranged between the two rows of plastic drainage plate, the usual connection method of plastic drainage plate and vacuum tube is shown in Figure 1 ~ Figure 4 ), then the exposed end of the plastic drainage plate connected with vacuum tube is set in working cushion or on surface of working cushion(working cushion is usually silty sand soil, geotextile). Finally, the vacuum tube is connected with vacuum equipment, vacuum preloading begins after sealing film laying.

According to the above description, horizontal drainage and vertical drainage without sand cushion drainage form a complete drainage system, it reduces the vacuum transfer and the pore water flow path resistance in the sand cushion drainage. The new technology can improve vacuum transfer efficiency, save power and sand resources, shorten the construction period, reduce
construction cost etc. The new technology applies to soft soil foundation treatment projects of port, highway, railway, water conservancy, and airport construction projects, especially ultra-soft ground of dredger fill and recently silt accumulation.

Fig. 4 Drainage plate and filter tubes usually connected Detailing (2)

APPLICATION FOR NEW “STRAIGHT LINE” VACUUM PRELOADING TECHNOLOGY

Several Cases for applying to vertical-type vacuum preloading technology

The new “straight line” vacuum preloading technology is mainly applied in the following types of vacuum preloading works:

One is to deal the ultra-soft foundation that just reclaimed. For this kind of foundation, we should reinforce the surface by vacuum preloading until the surface foundation has a certain bearing capacity that can meet the work conditions of the following procedures: the laying of sand cushion, the driving of prefabricated drains, etc. And then deal the foundation with the traditional vacuum preloading process. In this case, the “straight line” vacuum preloading technology usually used in the first vacuum preloading that reinforcement treatment of surface foundation.

Another is almost same with the former; the difference is that after the first vacuum preloading, the second deep vacuum preloading use the new “straight line” directly without laying sand cushion. The “straight line” technology is both applied in two cases for vacuum preloading(Ground Layer and Deep Layer).

The third, the better foundation of geological, which can meet to insert the board or do after laying reinforced materials(Generally laying waven cloth, Jingba, bamboo and black sand reclamation), can be applied in “straight line” for deep vacuum preloading.

This kind of foundation is same with the previous two cases, which is applied little. It reserves some depth water and meet the overwater light flapper flow after the soil surface meeting the design elevation. Meanwhile, a layer of geotextile is laid on the soil surface below water in order to insulate the board head inserted into soil from soil surface. And the light board device is used to settle drain plate which exposes long enough board head. The vacuum filter tube is settled in order to connect it to drain plate. A layer of geotextile and sealing film is laid on the soil surface and the vacuum tube is connected to the vacuum pump. So the “straight line” vacuum preloading technology can be done.

It is worth that in the first and second case, the geotextile and geonet laid on the drain pipe and filter tube after which is connected in order to reinforce the discharge capacity for the horizontal drain pass in the shallow “straight line” vacuum preloading technology; in the second and third cases above, the drain plate is laid in the silty sand after which is connected to the filter tube in the deep “straight line” vacuum preloading technology, which is proved better preloading effect in the practice.

Construction process flow chat

The first kind construction process flow chat is shown on figure 5, 6, the second is shown on figure 8, and the third is shown on figure 7.

Fig. 5 Construction process for shallow vacuum preloading
CONCLUSION

We can see one kind of “straight-line” process applied for soil surface treatment and another of which done for the deep vacuum preloading. There are respective advantages and disadvantages in the application process, as follows:

(1) It is not necessary for “straight line” process to lay horizontal drainage sand cushion. On the one hand, the sand materials can be saved and the coarse sand resources can be reduced slowly; on the other hand, the construction schedule can be significantly speed up, so long as workers who tie the plate head are added, a few days can be saved.

(2) The process of omitting to lay sand cushion can be suitable for super soft foundation treatment. The foundation soil is of high water content, quite low strength and bearing capacity in the reclamation finished just now. The soft topsoil can meet some strength by surface treatment. And the deep vacuum preloading treatment can be done when the topsoil meets the construction condition for vacuum preloading.

(3) The bearing capacity of super soft foundation can be greatly strengthened after the topsoil applying in “straight line” process with a layer of no less than 50cm silt cushion reclamation together. So the hidden danger for construction for workers and board equipment can be reduced.

(4) By connecting drain board to vacuum filter tube directly and no setting draining sand cushion, the horizontal and vertical draining system can become a an organic whole, the resistance resulted by sand cushion...
can be reduced in the pore water seepage path, the transmission efficiency for vacuum can be increased, the construction period can be shortened, and the price can be reduced. It is applied to the foundation treatment for vacuum preloading for port, road, railway, water conservancy and airport projects, especially suitable for super soft soil reinforcement for dredger fill and new mud accumulated.

(5) For the “straight-line” deep vacuum preloading process, the drain board is buried in black sand cushion after connecting to filter tube. Because of the fine particles for black sand, if the quality of filter cloth for vacuum tube and three or four direct links is poor or the broken filter cloth, bad connecting three or four direct link to filter tube, the black sand can be easily taken into filter tube. On the one hand, diaphragm seal shall be broken because of sand running-down. On the other hand, when black sand flows into draining system, the normal work for jet pump and draining capacity for vacuum filter tube will be under the influence and thus the vacuumized quality for will be poor.

REFERENCES
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