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Research on Sand Cushion Foundation Treatment Technology and Its Application in Engineering

Gaoyuan Qi[1] & Jingquan Lin[2]

[1] Central & Southem China Municipal Engineering Design and Research Institute Co., Ltd., Wuhan, China

[2] Nuclear Industry Southwest Survey & Design Institute CO., Ltd., Chengdu, China

Correspondence: Jingquan Lin, Nuclear Industry Southwest Survey & Design Institute CO., Ltd., Chengdu, China.

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Abstract

In this paper, the research on the foundation treatment technology of sand cushion is carried out, and its basic principle, design method, construction technology and quality control measures are discussed in depth. By analyzing the mechanism and application scope of sand cushion foundation treatment, the scientific design method and construction process are put forward. The research shows that the foundation treatment of sand cushion can effectively improve the bearing capacity of foundation, reduce settlement and improve drainage performance, which has a wide application prospect in engineering. In this paper, the foundation treatment measures of sand cushion are verified by practical engineering cases, which provides theoretical basis and technical guidance for related engineering practice.

Keywords: sand cushion, foundation treatment, affordability, control settlement

1. Introduction

Foundation treatment technology is becoming more and more important in modern engineering construction, with the acceleration of urbanization and the continuous development of construction projects. As a traditional and effective foundation treatment method, sand cushion foundation treatment has been widely used in various engineering construction due to its simple construction, low cost and remarkable effect. However, the sand cushion foundation treatment technology has a large scale in the project. In the case of complex geological conditions, new challenges are faced.

The purpose of this study is to systematically analyze the mechanism, design method and construction technology of sand cushion, and to explore the theoretical basis and practical application of sand cushion foundation treatment technology, so as to provide scientific guidance for engineering practice. At the same time, the actual effect of sand cushion foundation treatment will also be evaluated, combined with specific engineering cases, for research and practice in related fields. The significance of this study is to promote the innovation and development of sand cushion foundation treatment technology, improve the quality and efficiency of foundation treatment engineering, and contribute to the sustainable development of the project.

2. The Basic Principle and Application Scope of Sand Cushion Foundation Treatment

Sand cushion foundation treatment is a technical method to improve the performance of foundation by laying a certain thickness of sand layer on the surface of foundation. The basic principle is to improve the bearing capacity of the foundation, reduce the settlement and improve the stability of the foundation by using the high permeability[1], good drainage performance and high shear strength of the sand layer. The sand cushion can effectively improve the engineering performance of weak foundation by dispersing the upper load, accelerating the drainage consolidation of foundation soil and preventing the liquefaction of foundation soil.

The sand cushion foundation treatment method is suitable for many geological and engineering types. First, it is suitable for geological conditions with low bearing capacity, such as weak foundations such as sediment and soft clay. Under these conditions, the sand cushion can significantly improve the bearing capacity of the substrate and reduce the uneven settlement[2]. Second, in the area with high groundwater level, the high permeability of sand cushion is helpful to speed up drainage and reduce the adverse effects of underground water on the foundation. In addition, for temporary roads, yards, light workshops and other projects that require rapid construction, sand cushion foundation treatment is also applicable.

3. Design Method of Sand Cushion Foundation Treatment

The design of sand cushion foundation treatment is the key link to ensure the treatment effect. First of all, the determination of the thickness of the sand cushion needs to consider the bearing capacity of the foundation soil, the upper load size and the settlement control requirements. Usually, the thickness of the sand cushion is between 0.5 and 2.0 meters, and the specific value needs to be determined by calculation and test. Elastic theory or finite element analysis method can be used in the design, considering the compressibility of foundation soil and the stress diffusion of sand cushion.

The particle size has an important influence on the performance of sand cushion. The ideal material of sand cushion has the following characteristics: uniform particle size (0.25 ~ 2.0mm), low mud content (less than 5 %) and continuous gradation. Due to the good permeability and shear strength of medium-coarse sand, medium-coarse sand is the most commonly used material in engineering. In some special cases, in order to improve the performance of the sand cushion, consider the use of graded gravel or mixed with a small amount of cement or other additives.

Because the sand is loose, unformed and not easy to be compacted under the condition of low water content, according to its road characteristics[3], the sand cushion should be set up with the bank-grade material and the protective layer to increase the stability and bearing capacity of the roadbed.

Drainage system design is also an important part of sand cushion foundation treatment. In order to speed up the drainage consolidation of foundation soil, it is generally required to set drainage blindgut or drainage pipe at the bottom or side of sand cushion. Gravel to fill the drainage blindgut, and outsourcing geotextiles. At the same time, the design of the drainage system should ensure the smooth drainage, and also consider the permeability of the foundation soil, the groundwater level and the engineering requirements.

4. Construction Technology of Sand Cushion Foundation Treatment

The construction process of sand cushion foundation treatment is the key to directly affect the foundation treatment effect and engineering quality. The preparation work before construction includes field cleaning, measurement and data preparation. Cleaning requires the complete removal of surface debris and soft soil layers. The measurement and setting out need to accurately determine the range and thickness of the sand cushion, and the material preparation should ensure that the quality of the sand material meets the design requirements.

In the construction, the laying is the core of the sand cushion. Generally, the method of layered pavement is adopted, and the thickness of each layer is controlled at 30 ~ 50cm. When laying, it is paved from low to high to ensure that the sand layer is smooth and uniform. After each layer, in order to ensure that the density of the sand cushion meets the design requirements, it is necessary to use a flat vibrator or a roller for compaction. In the process of compaction, attention should be paid to the control of vibration frequency and the control of rolling times to avoid sand crushing due to excessive compaction.

The drainage facilities are constructed simultaneously with the laying of sand cushion. According to the design requirements, the drainage blindgut or drainage pipe is arranged to ensure the smooth drainage. Between the sand cushion and the foundation soil, in order to prevent the sand cushion and the foundation soil from mixing together, an isolation layer is paved with geotextiles or geogrids. At the top of the sand cushion, a layer of gravel can be added to disperse the upper part.

5. Quality Control and Detection of Sand Cushion Foundation Treatment

The quality of materials is an important aspect of quality control. Before the sand enters the field, it is necessary to go through strict inspection, so as to meet the quality requirements of the designed particle size, mud content and gradation. At the same time, in order to prevent the fluctuation of material quality, the corresponding sampling inspection should be carried out during the construction period.

Construction process monitoring is another important aspect of quality control. It includes real-time monitoring of the thickness, compaction and flatness of the sand cushion. On-site detection can use nuclear density instrument, plate load test and other methods to ensure that various indexes meet the design requirements. At the same time, the influence of temperature and humidity on the performance of sand cushion is also monitored.

Quality inspection and acceptance is the final guarantee of engineering quality. It mainly includes the thickness detection, compactness detection, bearing capacity test and settlement observation of sand cushion. Borehole sampling method can be used for thickness detection, and ring knife method or nuclear densitometer can be used for compactness detection. The bearing capacity test usually adopts the plate load test, and the settlement

observation needs to set the settlement observation point for long-term monitoring. All test results should meet the design requirements and relevant specifications before engineering acceptance.

6. Analysis of Engineering Application Cases of Sand Cushion Foundation Treatment

This study takes a sand-filled roadbed in the coast as an example. The sand-filled roadbed material comes from the coastal sand-blowing field. According to the classification of dredger fill in the Technical code for ground treatment of hydraulic fill[4], the dredger fill sand is medium sand. The water content and CBR values meet the requirements of the specification. According to the requirements of the specification, the dredger fill sand subgrade should determine the appropriate drainage path; the slope should be protected by bank-grade material. And set the protective layer on the top of the roadbed. (Figure 1)

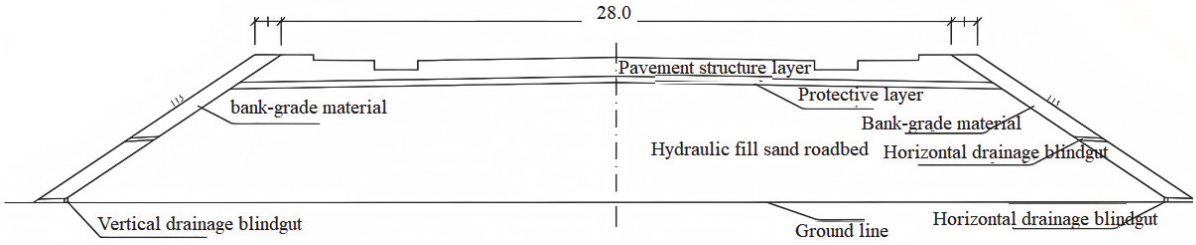

Figure 1. Cross section of sand filled roadbed

Embankment filling is composed of two parts: bank-grade material filling and dredger sand filling[5]. After the soil base is cleared, the embankment is filled. The embankment is filled with sand in two layers, each layer is 40 cm thick, and the next layer of construction can be carried out after one layer is compacted. Then the outer bank-grade material is filled, and the bank-grade material is clay. Vertical and horizontal drainage blindgut are set at the bottom of the soil before filling, and drainage ditches are excavated at the foot of the slope to exclude surface runoff water in the catchment area. Then, two layers of dredger sand are filled, and then the second layer of bank-grade material is filled. A row of transverse drainage blind ditches are set up at an interval of 1 m. A layer of cohesive soil with a thickness of 50 cm is added to the top of the subgrade as the protective layer. Finally, the surcharge preloading is carried out. After the preloading period expires and the settlement stability meets the design requirements, the construction of the upper pavement structure layer is carried out.

7. Conclusions

In this paper, the scientific design method and construction process are put forward by analyzing the mechanism and application scope of sand cushion foundation treatment. The foundation treatment measures of sand cushion are verified by practical engineering cases, which provides theoretical basis and technical guidance for related engineering practice.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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