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Analysis of Soft Soil Subgrade Treatment Technology in Road Construction

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Abstract: *Soft soil subgrade is a special form in highway construction. The stability and operability of soft soil subgrade are poor, which is easy to affect the road construction quality and the whole road structure. In order to effectively improve the comprehensive performance of soft soil subgrade, effective treatment methods must be adopted. At present, highway construction technology is becoming more and more mature in the process of soft soil treatment, in which there are different treatment processes, each with its advantages and disadvantages. Based on this, this paper makes an extensive analysis on some soft foundation treatment technologies in highway construction, which has certain guiding significance for the construction of similar projects. Starting from the main influence of soft soil foundation, this paper focuses on the treatment technology of soft soil foundation, and puts forward the key points of construction engineering, in order to provide reference for similar road construction projects.*

Keywords: *Highway Construction, Soft Soil Subgrade, Technical Analysis*

1. Introduction

Although many highway construction projects are facing the construction of soft soil foundation, and its construction is becoming more and more mature, the development of soft foundation treatment technology complicates the construction of soft foundation treatment. Most soft soil piles often need special mechanical equipment, and its performance and characteristics have an important impact on the construction quality. In the process of some highway soft soil foundation treatment, the selection of mechanical equipment is relatively backward, which is difficult to give full play to the advantages of equipment, which not only restricts the application of technology. But at the same time, it also brings risks to the safe disposal of soft soil layer.

2. Causes of Soft Soil and Characteristics of Soft Soil Subgrade

Soft soil is generally clay with high water content, high pressure compression and low bearing capacity, which is mainly the sediment formed by the melting of glaciers at the end of Quaternary under the scouring action of surface water. Soft soil is mainly composed of dust, peat, soft clay, peat and silt. It has the characteristics of natural aquifer, poor permeability, large porosity and large disturbance. It is mainly distributed in low-lying areas such as rivers, beaches and lakes, as well as areas with water and rain. Soft soil subgrade is easy to be damaged and has low bearing capacity, which poses a great threat to road safety. In order to improve the reliability and bearing capacity of the embankment, the embankment must be properly treated to ensure the construction quality and personal safety [1-2].

If the soft soil is unstable, there will be obvious water damage under severe weather conditions such as heavy rainfall. In addition, if the road building materials are damaged, their performance advantages will be seriously limited and it is difficult to meet the requirements of stability and durability. The pavement is closely connected with the foundation. In subgrade construction, if the treatment method is unreasonable and the filler quality is unqualified, it will not only damage the pavement structure, but also affect the pavement. However, this will also reduce the stability of the vehicle when passing through and increase the safety risk [3]. It can be seen that soft soil subgrade is a very special subgrade. If the construction quality does not meet the standard, there will be an embarrassing situation of

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"pulling one hair and moving the whole body". Therefore, in highway engineering construction, how to reasonably deal with soft soil foundation and further improve highway construction and operation conditions is an urgent problem to be solved.

3. Adverse Effects of Soft Soil Foundation on Highway Construction

Soft soil foundation includes mud and soft soil, and its bearing capacity is very low. If the soft soil foundation is not improved, it is impossible to ensure the stability of the road. At the same time, due to the large porosity and low shear strength of soft soil foundation, it is difficult to maintain the long-term stability of highway. There are often a large number of vehicles on the road, and the soft soil foundation will affect the safety of vehicles. If the settlement is too large, cracks will appear on the road. Cars driving on the highway are more prone to traffic accidents and increase the risk. With the long-term operation of the expressway, the pavement may crack due to the lack of stable pavement. In some places, traffic paralysis may occur [4].

3.1. Pavement Subsidence

Generally speaking, the core soil has large compressibility, high humidity and high porosity. Since the foundation is located at the gully point, the bridge structure often deforms (as shown in Table 1). In addition, when the foundation strength is not high, the pavement engineering is easy to deform. Compared with the normal subgrade section, the subgrade section of bridgehead section is generally controlled between 5cm and 10cm. The upper part is easy to transfer additional stress to the foundation, resulting in foundation settlement. In addition, with the increase of filling height, if the bearing capacity of soil does not change, the foundation will deform and form serious settlement (as shown in Table 2).

Table 1: compressive data of different rocks under saturated water state unit: MPa

Rock type	Particle standard	hardness
Soft rock	< 5	Extremely soft
	5 - 15	soft
	15 - 30	Softer
Hard rock	30 - 60	Soft and hard
	> 60	hard

Table 2 acceptance criteria for bearing capacity of different ground base treatments

Foundation treatment content	Bearing capacity of foundation treatment / kPa
10 cm thick concrete	five hundred and ninety-five point eight
Surface cleaning and rolling	ten point three
40 cm thick 6% lime soil	one hundred and ten point nine

3.2. Destruction of Highway Structure

If the soft soil is unstable, the water resources will be seriously damaged under severe weather conditions such as rainstorm. In addition, if road construction materials are damaged, their benefits will be greatly limited and can not meet the requirements of stability and durability. If the treatment is unreasonable and the filling quality in pavement construction is not ideal, the gypsum is closely connected with the foundation. This will affect the highway structure [5]. At the same time, it will also reduce the driver's stability when driving and bring unnecessary safety risks. Therefore, in the process of highway construction, there is an urgent need to improve the adverse impact of soft soil foundation on highway construction, which is an urgent problem [6].

4. Treatment Method of Soft Soil Subgrade

4.1. Bedding Material

Geotextile is a kind of material widely used in earthwork. It has good traction and adhesion, and can effectively enhance the strength and stability of road structure. At the same time, it has good anti-corrosion performance and low requirements for building environment and road environment. It is widely used in all kinds of soft soil. Soft soil foundation soil itself has porosity, filtration and water absorption. Geotextile can prevent the water content and soil erosion of subsoil, ensure the stability and integrity of subsoil and prevent soil falling off [7]. The traditional materials in the geotextile coating

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technology can also be used in the grounding grid. The geotextile is mainly laid at the bottom of the subsoil by layering and overlapping. Its main function is to insulate, disperse and improve the stability of the road. The geotextile grid is mainly connected with the soil layer. The friction, bonding and resistance between Geogrid and soil layer improve the strength of the base, so as to improve the stability and bearing capacity of the embankment.

4.2. Drainage Consolidation

In soft soil treatment technology, drainage consolidation method is suitable for saturated soft soil. The treatment technology requires the installation of vertical drainage devices on saturated soft clay. Its working principle is to press the drainage pipe into the soft soil base, release the moisture in the medium, and seal the soft bottom Subgrade after sealing, so as to improve the strength of soft soil. Drainage carburization has a good treatment effect on saturated soft soil foundation and cohesive soft soil foundation. It can give full play to the role of drainage carburization and improve the strength of soft soil

4.3. Additive Method

Additive method is one of the common methods to treat soft soil foundation. It has the advantages of low requirements for mechanical equipment, low cost and convenient use. This method usually mixes cement, quicklime, hydrated lime and other additives in the soft soil to make a series of chemical reactions between the soil additives and the soil and consume the water in the soft soil, so as to create stable solid particles, change the original composition and structural characteristics of the soft bottom, and improve the stability and compressive strength of the soft bottom.

4.4. Replacement Method

The replacement method is usually used in the construction process of treating soft soil foundation. The replacement method is mainly divided into the following three kinds: the first is the method of disassembly and replacement. According to the requirements of road construction, the soft soil foundation is directly excavated on the soft soil foundation, and then the basic fillers such as gravel, gravel and high-strength dense sand with strong water permeability are used. Therefore, the composition of the dam has been comprehensively improved. If this construction method is adopted, the soft floor should be relatively thin to achieve more effective construction effect. The advantage of this method is that the exchange is carried out in a simple way, and fewer mechanisms can effectively reduce the project budget. Secondly, the waste deposition method is mainly used to increase the proportion of soft soil on the matrix and reduce the fluidity and moisture of soft soil. Dispose of stones directly at the bottom of the road and compact the soil. In this way, it must be ensured that there is sufficient rock, which is usually used as mud accumulated over the years. It can be built in some places where mechanical equipment cannot enter directly, so as to effectively improve the underground load. The last is the explosion method, which is mainly used in deep, dense, simple and short soft soil sections.

4.5. Dynamic Compaction Method

Strong compaction method is a relatively mature construction method for treating soft soil foundation at present. The specific working principle of this technology is to make rational use of physical gravity, use high self destruction to form gravity, and effectively reduce compressibility through repeated and continuous foundation sealing. This increases the density of the soil. The application of heavy stamping construction technology has the advantages of simple equipment, high efficiency, fast construction speed and wide application range. It can effectively improve the bearing capacity of soft foundation dam. The reinforcement depth can reach 5.5-10.5m, the settlement deformation is small, the compression time can be shortened by about 2-8 times, and the base strength can be increased by 3-4 times. However, there are some defects in the treatment of soft foundation, which will cause large vibration and noise in the construction process. Therefore, appropriate depreciation measures should be taken in the application stage, such as the establishment of seismic areas or sound barriers.

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4.6. Perfusion Technique

In order to determine the thickness of soft soil layer, it is necessary to study the base conditions of soft soil foundation and various conditions related to threshold thickness and gravel ratio. The thickness of the sand layer shall increase or decrease with the different environment. At the same time, the composition and content of the soil shall be determined in the load test to ensure the adsorption and drainage speed of the soil and shorten the settlement time. The pouring process is mainly to stack cement and other solidified materials in the soft soil base, and the cement and soft soil are completely mixed. At the end of the air drying and solidification stage, the soft soil stabilizes the layered structure of the soft soil. The main technical parameters of filling technology are filling time, filling depth and filling amount [8].

4.7. Optimize Trial Mix Proportion

In the process of optimizing the trial mix proportion, the adjustment of mix degree, sand rate and water utilization rate shall be ensured according to the parameters of the sand quarry. In the specific working process, when the water cement ratio, steel fiber volume ratio and cement dosage remain unchanged, the concrete is combined, and the trial mixing ratio can be determined if it meets the requirements of performance, strength and durability. It is also verified by field verification method. Once the internal mixing ratio is determined, the trial mixing test must be carried out for the large mixing room to ensure the quality control of subsequent road construction, because the mixer used in the indoor environmental test is small and the volume can not meet the requirements of the large mixer. In addition, the laboratory test adopts the single shaft horizontal mixer, and the large mixer mainly adopts the double chamber mixer. If there is no mixing, the mixing time will increase. After trial mixing, the laboratory must be started within a period of time after the stacker is ready. After the adjustment of the pavement performance and the supplementary water ratio, determine whether the pavement performance can meet the design requirements [9].

5. Construction Quality Control Measures of Soft Soil Subgrade

The construction of soft soil subgrade needs to be comprehensively considered according to the specific conditions of soft soil and the surrounding environment of subgrade. Due to the different roads and their surrounding environment, different construction technologies must be adopted to ensure the stability of the pavement. At the same time, increase the embankment load and reduce the possibility of settlement and landslide. During the construction process, strengthen the construction management, improve the comprehensive quality of construction personnel and effectively ensure the quality of various operations. During construction, quality documents shall be created to clarify the preparation, collection, distribution, identification and archiving of recorded data. The quality control level of nonconforming items the reports and suggestions of nonconforming items must be submitted to the regulatory authority for review before the implementation of the plan. Reduce unsatisfactory work quality and duplication, solve problems in time, and fully implement scientific and effective management measures. Reasonably apply the soft bottom construction technology to ensure the construction quality of soft soil end.

The original soil layer is often the soil layer that can be planted. In this planting layer, excavate unnecessary sundries and clean the soil (select 14T roller). Make the structural layer "10cm thick C20 concrete, 40cm thick 6% lime" paved on the road, as shown in the figure. After repair, a 1% transverse drainage slope must be built according to the projected area of the beam, and the actual processing width of the base course on each side shall be increased by 150cm.

Figure 1 foundation treatment within the projection range of box girder in green belt

Bearing capacity is an important index for the quality evaluation of soft soil foundation treatment, which must be tested by professionals according to the requirements of the code. For each layer of syringe, it is usually used by professionals, preferably on the surface. Determine the soil load according to the obtained data, and compare the calculation results with the design requirements to objectively determine the quality of foundation engineering and ensure that the load of each layer exceeds the design cost. Otherwise, it needs further treatment [10].

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6. Engineering Example of Soft Soil Subgrade

Case 1: on the standard four lane with a total length of 28.5km. The designed vehicle speed is 80km / h. In the process of road construction, the soft soil foundation is liquid with low bearing capacity, which can not meet the construction conditions. During the construction, the soft soil foundation must be treated according to the construction practice of the highway construction site and combined with the soft soil foundation. Finally, the compression method is adopted. Compaction control determines the interrelated test compaction time. Make sure their match is appropriate. The last two rammers must meet the following requirements: if the energy of the rammer is less than 4000kn • m, the rammer must be set to 50mm; If the sealing energy is less than 4000-6000kn • m, it is set to 100 mm. If the sealing energy exceeds 6000 kn • m, the setting number must be 200 mm. Check within the above range. According to the previous design experience, after 2-3 times of tamping, 2 times of low-energy tamping, compress and control the descent distance, and compact the base material again. Each press must be inserted into each other to control the setting around the sealing pit within the specified range, so as to improve the flatness and prevent lifting. According to the water pressure value of soil static pore layer, the pressure dissipation trend is analyzed and the pressure dissipation time is calculated. The degree of underground permeability can be analyzed and the soft soil subgrade can be tamped continuously to achieve the purpose of continuously closing the high ground permeability [11].

Case 2: on the highway with a total length of 3400m, the length of soft soil foundation is 2140m, accounting for 63% of the total driving length. In the construction of the project, the water content of the soil foundation is high, which is dark brown plastic powder water. The longitudinal silt of the road is 3-12m, and the horizontal bearing layer under the horizontal silt tilts from the right side (mountain) of the subgrade to the left (SEA), that is, the transverse slope of the bearing layer is large. Considering these factors, the construction of soft soil subgrade will lead to the instability of the project, especially the "landslide", which will affect the stability of the pavement. According to the structural drawing, the replacement area is determined by coordinate method. At the same time, station instruments are installed to measure the line axis and slope. After determining the replacement range, determine the appropriate underground width according to the actual situation of the construction site, make scientific planning, and determine the specific operation sequence of the site, landfill and sediment. During concrete pavement maintenance construction, 1% drainage cross slope shall be set to ensure effective drainage and avoid ponding on site [12]. Rolling measures shall be taken for lime construction. 14T roller shall be used as the main equipment, and the principle of "layered construction" shall be followed. The thickness of single layer shall not be greater than 30cm, and the thickness of each layer shall be as uniform as possible. At the same time, preparations shall be made before rolling construction, that is, the soil, tree roots, weeds and other sundries on the ground shall be completely removed, and comprehensive rolling shall be carried out on this basis.

7. Conclusion

In the highway subgrade construction, in order to improve the subgrade construction quality, the construction unit and construction personnel must have a specific construction scheme. According to the characteristics of early construction, this paper summarizes the problems existing in the construction process, and obtains effective solutions through the study of these factors. Ensure the stability of road traffic. For the construction of expressway, in the subgrade construction of expressway, the filler shall be selected, the filler method shall be determined, and the subgrade topsoil construction shall be carried out. Stability during construction is achieved through foundation leveling and subgrade crushing. Improve the professional level of construction workers and provide guidance for the sustainable development of the construction industry.

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