Field test research on the long-term stability improvement of the base structure of the road storage yard in the port area

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Abstract. Relying on a road project in a certain port of Zhuhai, through field tests, the effect of the semi-rigid base rolling process on the degree of compaction, 7-day water immersion compressive strength and CBR was researched; proposed a pavement structure layer with geogrid and sand cushion added to the soil foundation and graded gravel cushion, and evaluated the roads in the port area after adding geogrid and sand cushion at different parts by field test and inspection. And the deformation capacity of the storage yard can provide technical support for the optimal design of the road storage in the port area.

Keywords: port area; road and storage yard; pavement structure layer; long-term stability; geogrid

1 Introduction

In recent years, with the rapid scale and quantity increase of port construction, the service life of roads and pavement structures in port areas has attracted more and more attention. Our country spends hundreds of millions every year due to the cracking and subsidence of the pavement structure of the road yard in the port area, which seriously affects the normal operation of the port [1-2].

The main reasons for the damage of the pavement structure of the road yard in the port area include [3-7]: improper selection of semi-rigid base material or design of mixture ratio, low base modulus and strength, prone to insufficient crack resistance and insufficient erosion resistance etc.; without waterproof and drainage measures, the water in the surface layer of the pavement seeps into the base layer through the cracks, and the strength of the surface layer is greatly reduced under the action of cyclic traffic load, resulting in erosion and mud pumping, which affects the quality and life of the road; affected by soft soil Influenced by the uneven settlement of the foundation, the overall deformation coordination of the semi-rigid base is insufficient, and the base is damaged by tension and cracks appear.

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For this reason, based on a port road stacking project in Zhuhai, a systematic study was carried out on the long-term stability of the basic structure of the road stockpile in the port area, in order to prolong the service life of the pavement structure of the road and stockpile in the port area, and provide reference for similar projects.

2 Research on field construction process parameters

Select 20m×20m as the test area, and formulate the test method as follows: (1) Stir and mix the gravel according to the design mix ratio and transport it to the test area, and at the same time sprinkle water with a sprinkler on site to ensure the water content of the graded gravel every time it is rolled 5.5%. (2) After paving and levelling the graded gravel, use a road roller to carry out vibratory rolling, and the controlled rolling times are 2 times, 3 times, 4 times, 5 times, 6 times, 7 times, and 8 times. (3) After each vibratory rolling, two sets of compaction detection and CBR penetration test are carried out in the test area at the same time. According to the field test, the test results of the number of rolling passes, compaction degree and CBR value are obtained, as shown in Fig.1 and Fig.2. It can be seen from Fig.1 that the greater the number of rolling passes, the greater the degree of compaction, but when the number of passes reaches 6 times, the increase in the degree of compaction decreases accordingly. Therefore, it is more reasonable to choose 6 times of vibratory rolling for the crushed stone layer.

The relationship between the rolling times and the water content, the rolling times and the loose laying coefficient, and the rolling times and the compaction are shown in Fig.3-4. It can be seen from the figure that as the number of rolling times increases, the moisture content of the mixture decreases. When the number of rolling times reaches 8 times, the moisture content drops to 5.7%. With the evaporation of temperature, on the other hand, the moisture in the mixture participates in the hydration reaction of early cement, which promotes the reduction of moisture. With the increase of the rolling times, the loose laying coefficient increased from 1.159 to 1.277, and when the rolling times reached 8 times, the loose laying coefficient changed little. When rolling reaches 8 times, the degree of compaction is 98.9%, and then increasing the number of times of rolling, the degree of compaction of the water-stabilized layer increases slowly. Based on the above analysis, when the number of rolling passes is 8, the construction cost is relatively economical.

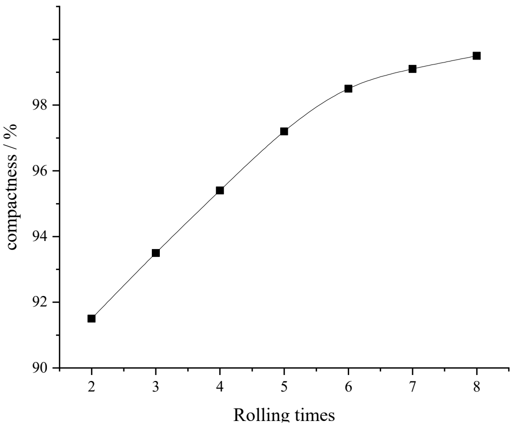

Fig. 1. rolling times Vs compaction

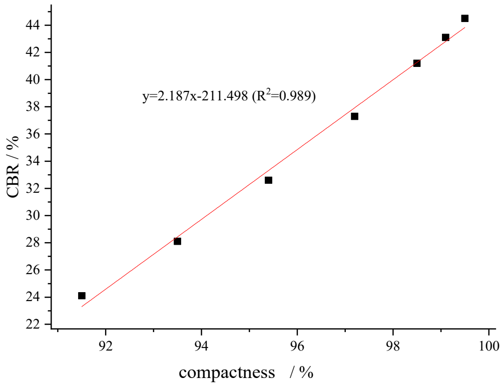

Fig. 2. CBR vs compaction

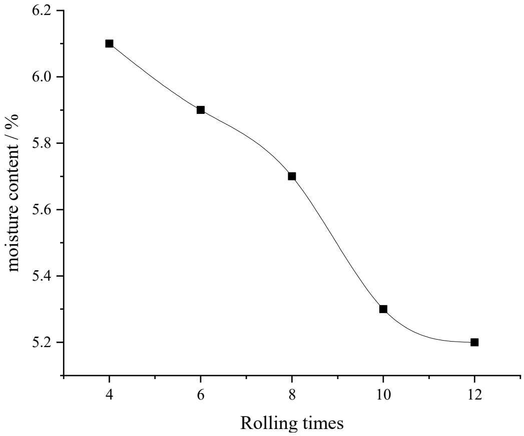

Fig. 3. rolling times vs moisture content

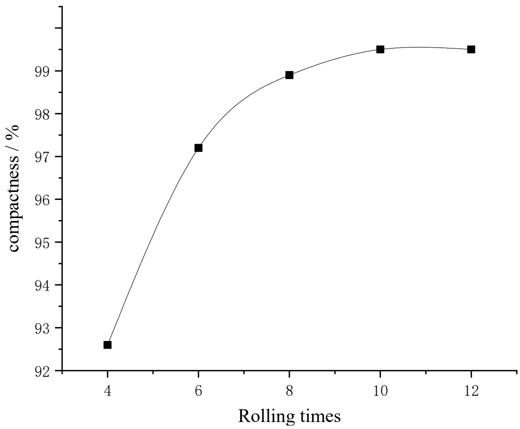

Fig. 4. rolling times vs compaction

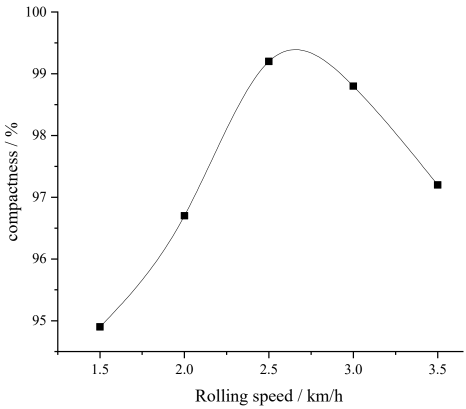

Fig. 5. rolling speed vs compaction

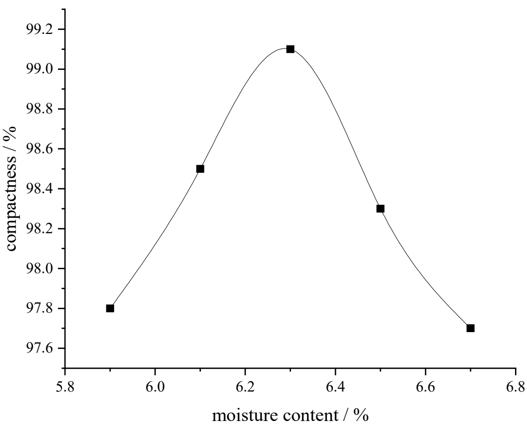

Fig. 6. moisture content vs compaction

In the case of the same rolling process, adjust the rolling speed of the 22T road roller, and test the compactness of the gravel layer at different speeds. The test results are shown in Fig.5. It can be seen from the soil that when the speed is 2.5km/ After h, the compaction is optimal.

The relationships between water content and compaction degree, water content and loose laying coefficient of cement-stabilized macadam base on site are shown in Fig.6. It can be seen from the soil that the optimal moisture content is 6.3%, which is slightly higher than the 5.9% of the laboratory experiments. For stable coarse-grained soil and medium-grained soil, it should be 0.5%-1.0% greater than the optimum water content, so choose 5.9%-6.4% as the control moisture content in practice.

3 Typical test sections

Six sections of 50m-long road were selected as the test section in a road area of a port area in Zhuhai. The test section and scheme design are shown in Fig.7.

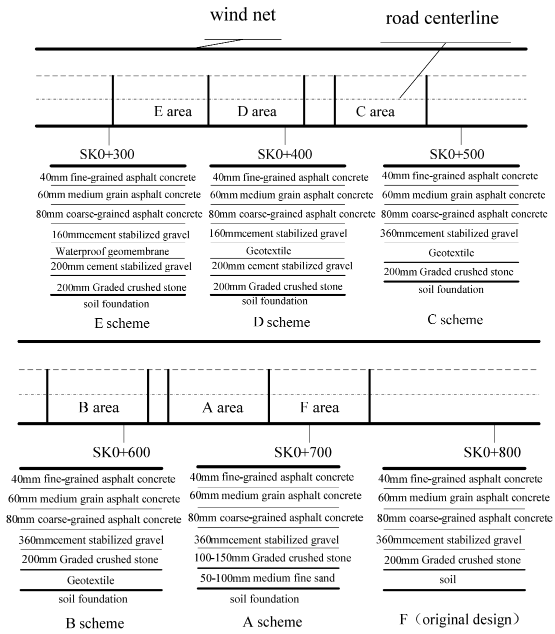

Fig. 7. Schematic diagram of the test section

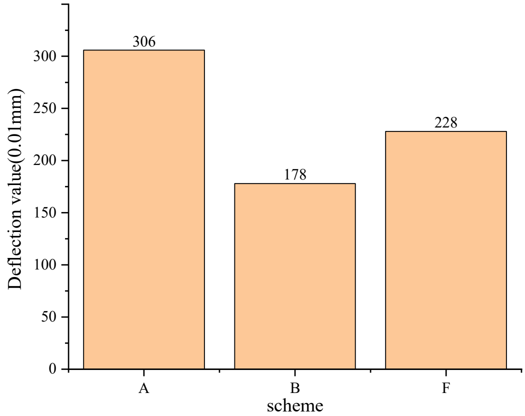

Fig. 8. Deflection detection of crushed stone layer

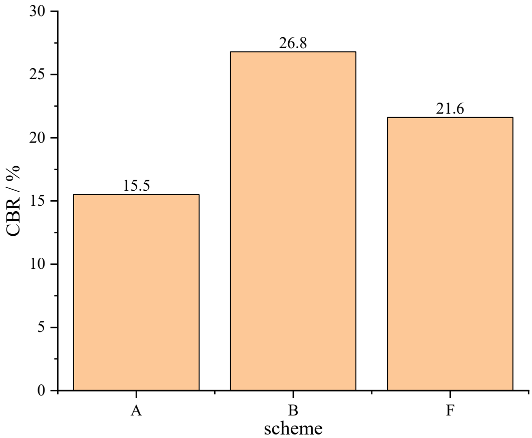

Fig. 9. CBR detection of gravel layer

It can be seen from Fig.8-9 that when the subgrade has only graded crushed stones, the measured deflection value is about 22 less than that without geogrid after the geogrid is installed in the subgrade. %, indicating that its overall stiffness has been significantly improved.

It can be seen from Fig.10-13 that as the curing time increases, the deflection value of the road base increases. When the subgrade is composed of cement-stabilized crushed stone aggregate layer and graded crushed stone layer, after the geogrid is set, its deflection value increases slightly compared with that without setting, and when the geogrid is set on the cement-stabilized gravel When the aggregate layer and the graded gravel layer are in the deflection value, the deflection value is the smallest, indicating that the overall stiffness of the roadbed. when the geogrid is in this position optimal. When the pavement structure is equipped with a base layer, its modulus of resilience increases by about 2 times compared with that of the soil foundation, indicating that the anti-deformation ability of the pavement structure is significantly improved after the base layer is set. When the pavement structure has a base layer, and the base layer is composed of a cement stabilized crushed stone layer and a graded crushed stone layer, after the geogrid is set, when it is set between the soil foundation and the base layer, the rebound The modulus is the largest, which is about 11.7% higher than when it is not set, indicating that the overall deformation resistance of the pavement structure has been improved.

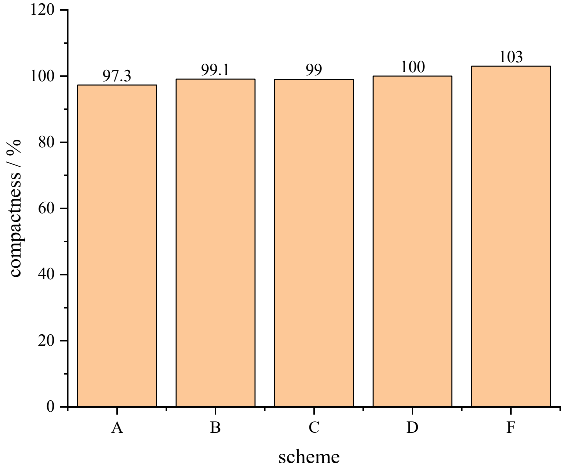

Fig. 10. Compaction degree of gravel layer

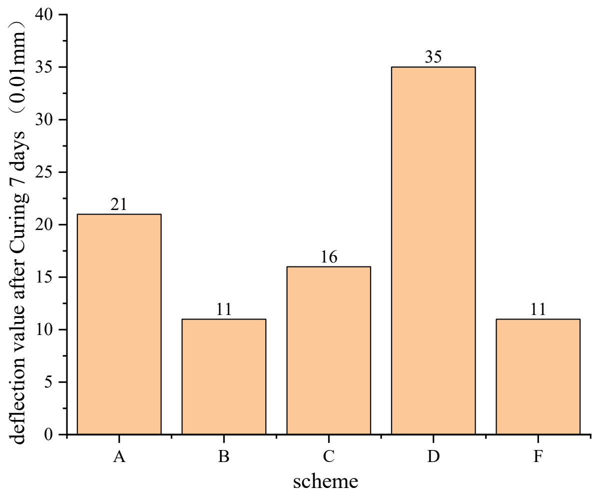

Fig. 11. Deflection detection of gravel layer (7d)

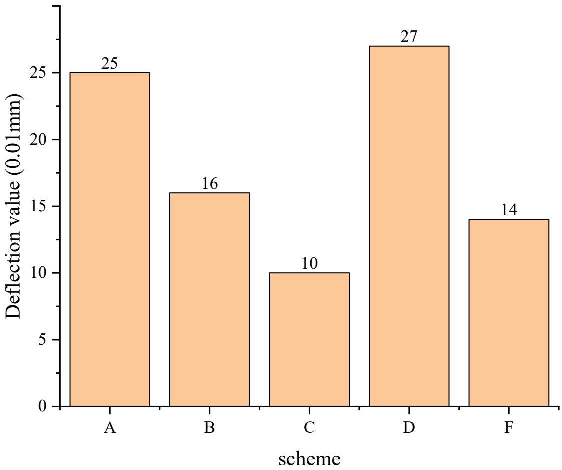

Fig. 12. Deflection of gravel layer (32d)

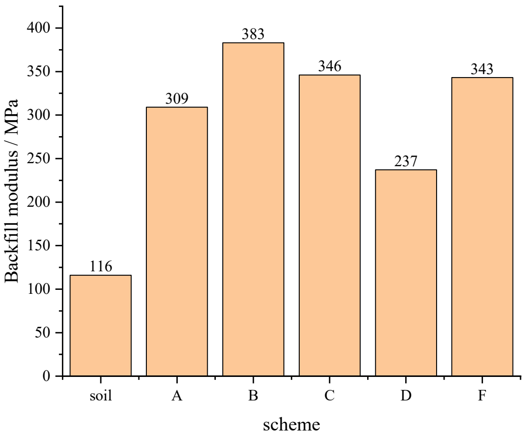

Fig. 13. modulus of crushed stone layer (32d)

4 Detection and analysis during operation

Relying on the completion of the project delivery, deflection, rebound and water seepage tests were carried out in the test comparison area within 3 years to evaluate the long-term stability of the basic structure of the road yard in this area.

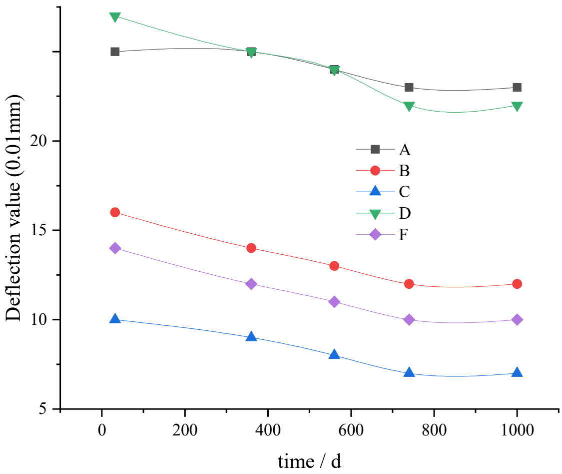

Fig. 14. deflection value changing with time

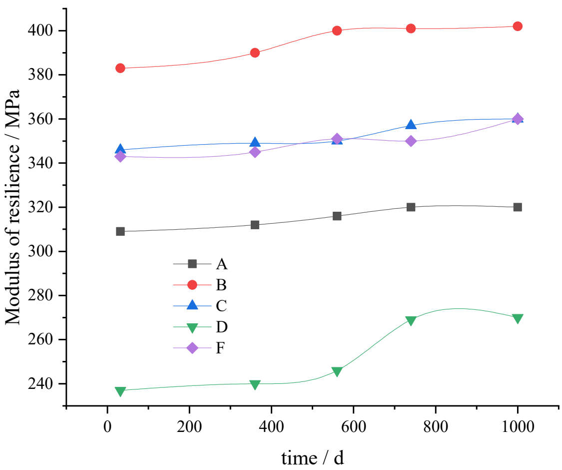

Fig. 15. the modulus of resilience changing with time

It can be seen from Fig. 14 that the deflection values of the comparison areas of the five sections have all decreased. The reason for the analysis is that at this stage, due to the repeated rolling of the vehicle load, the gradual compaction, and the semi-rigid base material The aging strength increases, which leads to a decrease in the deflection of the pavement surface and an increase in its modulus of resilience (as shown in Fig. 15). However, the subsequent reduction was not large. The water seepage test found that the permeability coefficient of the 1000d surface layer decreased by about 10%, which also shows that the construction quality of the road section is good, there are no obvious cracks, and the waterproof performance of the structure can still be maintained.

5 Conclusion

The influence of factors such as gravel gradation, cement content and water immersion time on the unconfined compressive strength of cement-stabilized gravel layers were researched through experiments, and the changes in the compactness and CBR of water-stabilized layers under different rolling processes were analyzed, obtained the following technical parameters: the cement content of cement-stabilized gravel is between 4.5 and 5.5%, and the gravel gradation of the water-stabilized layer is 30:35:35 (coarse-grained gravel: fine-grained gravel: stone chips) as Excellent, the gravel grading of the subbase is 15:75:10; the number of vibratory rolling passes is 6 passes, and the cement-stabilized crushed stone layer is 8 passes; for a 22T road roller, the optimal rolling speed is 2.5km/h, and the optimum moisture content is 6.3%.

The degree of compaction of the graded crushed stone base has a linear relationship with the CBR value: Y=2.187x-211.498, and the strength of CBR increases with the increase of the degree of compaction.

Field tests and inspections during the operation period show that setting geogrids in the cement-stabilized gravel layer and graded gravel layer can effectively improve the overall bearing capacity, and the waterproof geomembrane can effectively reduce the impact of infiltration on the long-term stability of the base structure. sexual influence. The test during the operation period also shows that the joint action of waterproof geomembrane and geogrid can improve the long-term stability of the base structure of the road yard in the port area.

6 References

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