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The Effective Application and Research of Foundation Reinforcement in Civil Engineering Construction

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In this paper, the bearing capacity of the foundation is analyzed by means of numerical model tests. By changing the natural foundation of the coal gangue carrier size and position parameters obtained by the analysis are the main factors that influence the height of the strengthening effect of the conclusion. In the loading height H_1 is less than or equal to 6m, the height increments and the bearing capacity of the foundation is approximately linear relationship; by changing the physical and mechanical parameters of pile carrier, through the analysis of filler bulk density is the main factor affecting the reinforcement effect conclusion, capacity increment density and foundation approximate linear relationship. According to the research results of natural foundation, composite foundation in the existing research of heap load method, only consider the loading height and packing density of two variable factors get the surface load and pile foundation bearing capacity to enhance the approximate relation between the magnitudes. Secondly, the assumption of slip surface method is used to calculate the bearing capacity increment of natural foundation and composite foundation under the condition of load, and the results are compared with the numerical results. For the natural foundation of mining subsidence pile bearing capacity increment Δf_a foundation load may be determined with reference to "design code of building foundation", considering the effect of mining, foundation soil physical parameters adopted to reduce the dynamic value of value increment Δf_a calculation formula of bearing capacity of foundation pile load characteristics obtained after type loading height limit of H_1=6m; according to the compound two-layer foundation bearing force theory, the basic expression increment ΔP_a foundation surface under overload limit is derived, in the loading height limit of H_1=6m, the mining influence, foundation soil physical parameters to reduce the dynamic value after mining.

1. Introduction

In recent years, with the rapid development of economic construction, railway transportation efficiency needs to be improved, how to ensure the roadbed engineering meet the railway design speed requirements, especially the construction of Railway Subgrade in loess area (including the foundation and basic quality assurance body) is facing more and more problems. Compared with the traditional railway, the new railway and high-speed railway not only improve the design target speed, but also deepen and change the traditional construction technology and maintenance concept. Whether it is slag track or slag free track, Gao Pingshun and a more stable basis for the line, high-speed train, safe and stable operation of the key (Zhou et al., 2016). The design of Railway Subgrade in China, from the settlement control perspective, by twentieth Century eight, 90s 30cm~50cm to 15cm of Qinhuangdao Shenyang Railway, the Beijing Shanghai high speed deformation control within 10cm, and then to the deformation in the construction of Zhengzhou-Xi'an Passenger Dedicated Line 1.5 cm and 5 cm. Therefore, the reasonable foundation treatment measures strictly control the uneven settlement of the foundation, to prevent excessive settlement of roadbed, to ensure the quality of roadbed construction to achieve the design standards.
In the process of civil engineering construction, the schematic diagram of the foundation reinforcement is shown in Figure 1, as shown in Figure 2. When it is directly used as roadbed filler, the nature and the state of the water will change greatly, which will cause the failure of roadbed slope. Roadbed greatly falls. Although it

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can be used to change the soil structure and reduce the collapsibility of loess in the railway subgrade engineering, it is not easy to compaction due to the compaction of loess. The water stability of loess roadbed is still poor, and it is easy to soften after soaking. Under the erosion of rain, the roadbed slope is easy to be washed, which can cause serious damage to the roadbed. Therefore, in the loess area to build a high standard railway, loess cannot be directly used for filling roadbed, must be in accordance with the requirements, after improvement to meet the design requirements of railway subgrade filler, can be used. There are many ways to improve the loess. According to the different construction measures, can be divided into: engineering methods (such as compaction), physical methods (such as adding aggregates, clay particles and improve the temperature conditions) and chemical methods (such as adding additive, chemical additives, organic and inorganic binder and other polymers), heat treatment methods (such as electrochemical stabilization) etc. In recent years, with the inorganic binder, cement lime modified soil cement, lime soil, lime soil cement and two lime modified soil in road and railway engineering has been widely used in engineering, and has achieved good effect. The soil has been improved, and its scope of application has been increased. The strength and durability of the soil have been improved. At the same time, it reduces the difficulty of construction and reduces the investment cost of the project. Therefore, the improved soil material has been developed and applied in other industries. In order to further promote and use the improved soil, the railway sector is studied specially in railway soil, accumulated some practical engineering experiences, and through summing up, continues to develop and implement a series of industry standard (Gao and Feng, 2015).

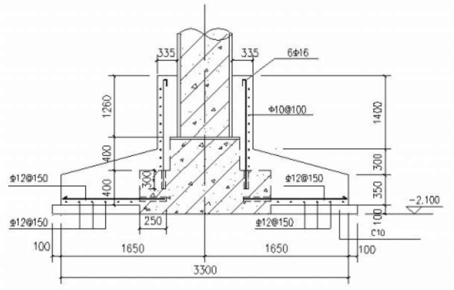

Figure 1: Schematic diagram of foundation reinforcement structure

With the development of the western economy, a large number of high-speed railway constructions in the western region, promote a lot of relevant departments and professional personnel to carry out a lot of researches on the Loess and loess roadbed filler, and made a lot of achievements. This paper puts forward the control standards for high speed railway subgrade to meet the requirements of strength (Rooshdi et al., 2017), water stability, compressibility and post construction settlement. In this paper, the composite foundation with horizontal and vertical reinforcements is used in order to ensure that the pile foundation can bear the load, adjust the pile-soil stress ratio, and reduce the stress concentration of the pile top. Mr. Huang Xiling proposed, based on the set-up cushion to improve the bearing capacity of soil cement pile composite foundation, so as to achieve better technical and economic results. It makes up for the shortcomings of the two types, so that the load on the composite foundation piles and soil between piles are well distributed between each other, the bearing capacity of the pile and soil have been fully played.

Figure 2: Schematic drawing of foundation settlement reinforcement

2. Experimental study on basic engineering properties of Loess

2.1 Experimental research program

In order to study on engineering properties of loess, loess tests were taken from the Zhengzhou-Xi'an

Passenger Dedicated Line from Zhengzhou to Mianchi in ZXZQ01 section of the two area, WA Yao Po Cun Chengguan Township Manager Department of the Xingyang Municipal Railway seven bureau third project area as the first manager of the Department of loess, Xingyang City Shi Yuan Cun seven Bureau of China railway project area is second loess. A large number of laboratory tests were carried out for two kinds of Loess respectively. The contents of the experiment include the specific gravity of the loess, the limit water content, the particle analysis, the compaction test, the consolidation test, the loess collapsibility test and the strength characteristic test. Compaction test is used for compaction test. Firstly, five kinds of soil samples with different moisture content were prepared, and each soil sample was divided into three layers. According to the relationship between the water content and the dry density, the curves were drawn to obtain the maximum dry density and the optimum moisture content. The experimental results show that the compaction curves of two kinds of loess are shown in figure 3. In the same compaction, dry density difference between two kinds of loess under different water content corresponding to the larger, the water content is smaller, because the soil particles between water film is very thin, relatively difficult to move, the soil dry density is smaller; with the increase of water content, soil particles between the water film thickening, drag force, relatively easy move, arranged more closely, with the increase of dry density. When the water content continues to increase, more than the optimal water content, the soil particles are filled with free water. Although the particles are easy to move, but the excess water is not easy to discharge, the soil is not dense, but its dry density is smaller. Two kinds of loess in cement or lime, maximum dry density and optimum moisture content with mixed variation ratio is not consistent, so the Loess of different, should be based on the compaction test of the soil maximum dry density and optimum moisture content with blending ratio variation. Standard consolidation test method for consolidation test. Pressure rating of 50, 100, 200, 300K Pa, the level of stability for each level of pressure of the sample deformation is not greater than 0.005mm. The experimental results show that the pore ratio e is the ordinate and the pressure P is the abscissa. At the same age, the compression coefficient of the same kind of improved loess decreases with the increase of compaction coefficient. The compaction coefficient is the main factor that affects the strength of loess. In practical engineering, the compaction coefficient can be controlled to ensure the roadbed has enough strength to prevent the excessive deformation. Under the same compaction coefficient, for the same kind of improved loess, the bigger the age, the smaller the compression coefficient, thus significantly improving the compressive properties of the improved loess. It can be seen that strengthening the maintenance and ensuring a certain curing age can improve the compressive deformation characteristics of the Improved Loess and enhance the stability of the improved loess. The above analysis shows that the compressibility of loess has been greatly reduced and the strength of the soil has been enhanced after the loess has been improved. Loess is different from other cohesive soil, because of its special material composition and unique porous structure, it is particularly sensitive to the change of water content in loess, and thus has collapsibility. In the gravity stress and additional stress under the combined effect of significant additional damage the structure of the soil water sinking.

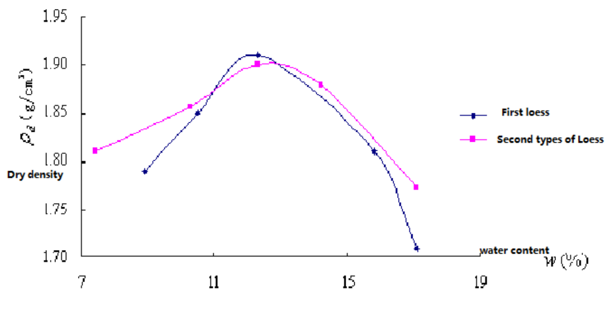

Figure 3: The test results of two kinds of loess compaction curve

2.2 Loess Strength Test

Two kinds of test methods were used to study the strength, that is, the three axial compression test and unconfined compressive strength test. Three axis test using strain control type of three axis, respectively, under different constant pressure, the gradual increase of axial pressure, so that the sample shear stress until the sample failure. Due to the special structure of loess, the failure characteristics and deformation characteristics of loess are slightly different from those of other soils. The stress and strain curves of loess can be used to reflect the failure characteristics of loess. According to the existing research results, it is shown that the stress-strain curves of loess are mainly three types: brittle failure, plastic failure and approximate ideal plastic failure (Zhang et al., 2014). There are two types of brittle failure, including strong softening and weak softening. The so-called strong softening refers to the stress-strain curve reached the maximum stress before nearly linear in strain value is small, damage to the highest value of stress, when the stress exceeds the damage peak with the increase of the strain intensity drops suddenly, the sample begins to fracture; weak softening type refers to the stress-strain curve with increase the maximum strain value of the stress is not obvious, when the stress exceeds the damage after the peak value with the increase of the strain intensity drops suddenly, specimens of brittle failure (Xue et al., 2006). The plastic damage type in the form of strong hardening and hardening type, the stress-strain curve of stress peak hardening, with the increase of the strain stress curve is nearly linear; gradually increased, the weak hardening is to increase the stress-strain curve with the strain, began its steep curve no, there is a peak value when the strain increases to a certain value curve becomes stable; the approximate ideal plastic damage type, with the increase of strain began to refer to the stress-strain curve is a straight line, when the strain exceeds a certain value curve becomes smooth, and with the increase of strain in stress continues to grow. The stress strain curve of loess is shown in figure 4. From the two aspects of water stability index and strength index, the two kinds of loess cannot be directly used for roadbed filling. At the same time, to build reasonable measures for drainage, to prevent water from roadbed, slope and near the slope toe into the embankment and foundation, reduce the performance of subgrade engineering.

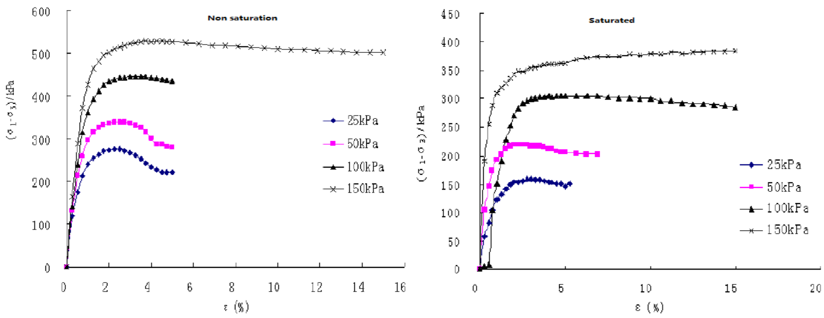

Figure 4: Schematic diagram of stress strain curve of Loess

2.3 Experimental study on Improved Loess

The hardening mechanism of cement improved loess is different from that of concrete. The strength of Cement Improved Loess growth process is much slower than the concrete, much more complex. Under the same conditions, the stress-strain curve is roughly the same as the same kind of cement improved loess; in the initial stages of loading curve is approximate to a straight line; with the increase curve of strain increased slowly and the stress gradually increases when the strain value reaches a certain value, the stress reaches the maximum with the increase of strain value; then began to curve the steep fall stress decreases rapidly, and the emergence of the inflection point, the phase of the sample starts to break. With the increase of strain, the stress changes little; there are residual stress and residual strain. The first kind of Cement Improved Loess failure stress value between 0.5 ~ 2.0MPa, the failure strain of Cement Improved Loess in 0.5 ~2.5%; second kinds of destruction of Cement Improved Loess stress value between 0.62.0MPa, the failure strain in 0.8%~2%. The failure stress of cement loess increases with the increase of W_a. The stress and strain curves of the cement loess with different mixing ratios in the initial stage of the stress are approximately close to the straight line, and the slope of the straight line increases with the increase of confining pressure. And the failure stress of cement loess increases with the increase of confining pressure. failure types of cement loess is brittle, which increased with strain, the failure stress gradually increases and increases to the maximum peak after stress sample decreased rapidly, then with the increase of the strain, the strength of the sample remains unchanged. The strength of cement soil increases with the increase of age. Because there is no coarse aggregate in cement soil, the strength growth law is different from that of concrete. Therefore, more than a month old, with the growth of the age of the intensity of growth, but the growth rate has weakened. Schematic diagram of the change curve of the strength characteristics of cement loess at different ages is shown in figure With the increase of age, two kinds of cement loess cohesion c without increasing the compressive strength of Qu confined 7d ~ 28d, the strength of loess cement is the biggest growth rate can reach more than 30%; and the law is different from the concrete strength increase, the age of more than 28d, with the age increasing its strength continues to grow. But the growth rate gradually decreases. In addition, the strength increase of cement loess is related to water content. Under the same condition, the strength index of cement loess is less than that of unsaturated loess. The visible age and water content have an important influence on the strength characteristics of cement loess, so it can improve the strength characteristics of loess cement and improve the water stability of cement loess (Hu et al., 2014).

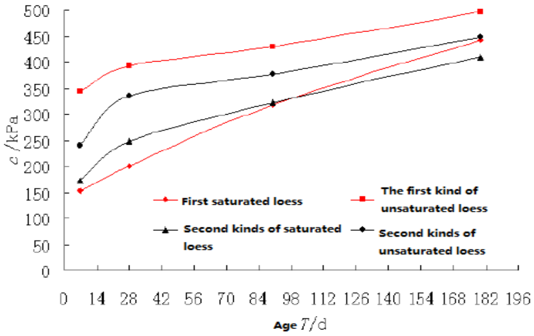

Figure 5: Schematic diagram of the variation of strength characteristics of cement loess at different ages

3. Brief introduction of numerical analysis software and establishment of calculation model

In the numerical analysis mainly include two categories: the first category is the method of continuum methods including finite element method, finite difference method, boundary element method and meshless method; second kinds of non-continuum methods including discrete element method, particle element method, popular element method etc. With the improvement of computer performance, the numerical analysis method has been developed rapidly. From linear to nonlinear development so as to promote the finite element method (FEM) development, provides a powerful tool for rock mechanics and geotechnical engineering problem solving complex, by continuous mechanical development to non-continuum mechanics has discrete element and manifold element method for numerical simulation method to solve the discontinuous media problem thus, the simulation provided a new way for geotechnical engineering numerical. In recent years, as for the new FLAC3D, the boundary element method for numerical simulation of geotechnical engineering, so as to overcome the shortcomings of the finite element for large deformation or finite deformation analysis provides a new method of numerical calculation. The finite element method (FEM) has been widely used today. This method is based on the theory of mechanics, mathematics, and computer, put a whole into several discrete units, in the analysis of detailed and accurate to different units, relationship between unit displacement and strain. Then, the relationship between the nodal force, displacement and strain of all elements is integrated. The approximate solution of the system of differential equations or integral equations is given. Then, by increasing the number of the number of regions, the approximate solution is improved. The popular finite element method (MM) is a numerical method based on the finite cover technique, which is based on the finite cover of mathematics. Based on the interpolation approximate function of each unit in the establishment of the global epidemic, and then from the optimization of the discrete approximation formula to compute the approximate solution. Can be used to solve the boundary value problem of polygon domain. The boundary element method (BEM), also known as the integral equation method, is a numerical method developed after the finite element method. The biggest advantage of this method is that the dimension of the problem is low, and the precision is high. And the error is small. Thus, the unknown quantity in the study area can be solved by the boundary value (Huang et al., 2014). The error introduced by the boundary integral method is only from the discretization, and the accuracy of the infinite domain problem is higher. Element free method (EFM) is a new method for numerical simulation of geotechnical engineering, because of its function in the construction of approximate calculation, node can be arranged free, do not need to connect the processing node, overcome the limit unit of the computational domain, only geometric boundaries and nodes. It can be used to solve boundary value problems with complex boundary conditions. Different constitutive models of rock and soil are established in the software to meet the needs of engineering analysis. Mainly used in geotechnical engineering and mining engineering also can simulate the initial excavation stress and displacement field generated, the stability of the slope, excavation of underground engineering, fluid solid coupling analysis of surrounding rock in tunnel engineering, analysis of retaining wall structure of groundwater flow and soil consolidation and pile foundation bearing and settlement characteristics etc.. The difference between FLAC3D and the commonly used numerical calculation software is that it uses the command driven mode. In order to establish the FLAC3D model, the constitutive model must be determined firstly, and then the unit and grid are generated. Finally, the boundary conditions and initial conditions are defined. After a series of calculation steps, the solution of the problem is obtained. In the solving process, through three-dimensional fast Lagrange method can simulate different geotechnical materials accurately yielding, plastic flow, softening and deformation, especially with its unique advantages in the field of processing geometric nonlinear and large deformation problems. The cement soil pile composite foundation reinforcement of loess foundation, the upper structure load of single pile composite foundation and the settlement of the basic research contents include pile stress distribution, pile-soil stress ratio, pile and soil between piles and the composite foundation settlement of substratum settlement. Pile and pile soil bear the upper load. The geometric model is shown in Figure 6.

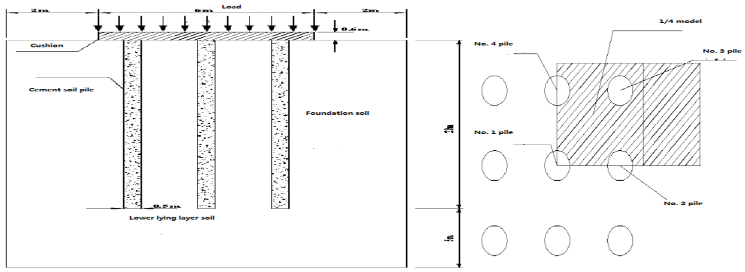

Figure 6: Schematic diagram of geometric model

4. Conclusions

In this paper, the theoretical study on the bearing capacity and settlement of loess foundation treated by cement soil pile composite foundation is presented. On this basis, the basic engineering characteristics of loess and the strength characteristics of loess under different conditions were studied. After extensive reading of relevant reference books and literatures at home and abroad, the FLAC3D software is used to simulate and analyze the loess foundation treated by cement soil pile composite foundation. For the construction of Subgrade in loess area, there are two main reasons for the settlement of loess subgrade: the internal cause is the collapse of its own. Due to the effect of the water, the Loess Subgrade softening, the strength decreased, resulting in serious deformation and subsidence of the roadbed. The degree of compaction and water content has a direct impact on the strength characteristics of loess, for different loess roadbed, due to the different height of the filling, different soil; the amount of subsidence is also different. The incorporation of cement and lime into loess can improve the engineering properties. The effect was related to the ratio of blending, age, and water content and compaction coefficient. It is very important to strengthen the maintenance and ensure the strength of the cement loess. There is an optimum blending ratio for different lime modified loess. Under the same conditions, the water stability of lime improved loess is better than that of cement improved loess. The effects of different load and cushion parameters on the bearing capacity and settlement of composite foundation with cement soil piles are different. Generally speaking, the load has a great influence on the settlement of the composite foundation, and the settlement increases with the increase of the load. The influence of cushion modulus and cushion thickness on the settlement characteristics of composite foundation has a reasonable range. When the cushion modulus exceeds a certain value, the increase of cushion modulus has no effect on the settlement of composite foundation. With the increase of the thickness of the cushion, the deformation of the shallow foundation in the length of the 1/2 pile body is affected. There is a reasonable cushion thickness.

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