Research on Prediction Method of Foundation Settlement

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Abstract: The prediction research of foundation settlement is an important research direction in geotechnical engineering. Considering the complexity of geological conditions, the applicability of ground settlement prediction methods is also different. This paper reviews the latest developments of foundation settlement prediction methods under different geological conditions, as well as the superiority and accuracy of various prediction methods, and improves and optimizes the prediction methods. It summarizes the current solutions of advanced prediction methods and selects them accurately. The method of predicting the settlement of foundation provides a reference and provides an idea for subsequent research.

1. Introduction

Foundation settlement refers to some deformations caused by the vertical and external stresses of the foundation. The foundation of the structure will have three parts of settlement after long-term load, ie initial settlement (or instantaneous settlement), main solid Junction settlement (referred to as consolidation settlement) and secondary consolidation settlement. Uneven settlement of foundations is endangered, and uneven settlement of foundations may not cause serious cracking of buildings on the ground. Seriously, the structure of structures will be greatly deformed, tilted or even destroyed, such as the Leaning Tower of Pisa, Italy, and caused by precipitation in foundation settlement. Settlement is an irreversible settlement, so we need to make reasonable and effective prediction of foundation settlement to prevent the damage caused by uneven settlement of foundation. Due to the complex and diverse geological conditions, the settlement of foundation settlement is complex and diverse under different geological conditions. For example, the impact of impact foundation on earth dam is complex and variable. The deformation and deformation of the expansive soil foundation on the building is repetitive and long-term. Settling of the foundation of the tank due to adverse geological conditions. It is difficult to accurately predict the actual value of foundation settlement under a variety of complex conditions. Therefore, this paper fully considers the settlement of foundation under different complicated conditions and provides specific prediction schemes.

2. Settlement analysis

Under the action of load, the foundation soil is deformed by compression, and the deformation amount is the settlement of the foundation. During the compression deformation process, the pore water in the soil is discharged, the soil particle adjustment position is rearranged, and the soil pore volume is reduced. In soil mechanics, this process is also called the consolidation process of the soil. The compression deformation law and consolidation principle of soil are the basis of settlement analysis and calculation of traditional soil mechanics. The amount of settlement of the foundation depends mainly on the cause of the deformation of the soil and the nature of the soil itself. The reason for the deformation of the soil is mainly the change of the stress state in the soil, such as: the change of the stress field in the foundation caused by the ground load, the additional stress in the foundation; the change of the groundwater level in the foundation; the influence of vibration on the foundation. Here, the soil trait mainly refers to the compressibility, or the stress-strain relationship, which refers to the effect of the soil under the action of additional stress. Taking saturated soft clay as an example, the soil will produce shear deformation under the action of additional stress.

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Consolidation deformation will occur as the soil is consolidated, and creep deformation will occur as time progresses. The stress-strain relationship of the soil is very high. Complex, often elastic, sticky, plastic, and nonlinear, anisotropic, also affected by the history of stress. Foundation soil is a product of natural history, and its inhomogeneity makes its traits more complex. The correct calculation of the additional stress in the foundation soil and the correct description of the soil properties of the foundation are two key issues to improve the accuracy of settlement calculation. The classical settlement calculation method deals with the above two problems: the additional stress field in the foundation under the load is calculated according to the semi-infinite space isotropic elastic theory, and the soil compressibility is determined according to the one-dimensional compression test. And use the stratified sum method to calculate the settlement of the building. Obviously, there are quite a few gaps between the settlement calculation model and the true traits of foundation settlement. In order to make the calculation results more reasonable, many settlement calculation methods have been developed.

3. Introduction to the method

The logarithmic curve method (three-point method) is a commonly used method for estimating the final settlement of foundations. Zeng Guoxi suggested that the degree of consolidation of foundations is calculated by the following formula:

$U_t = 1 - \alpha e\ xp(-\beta t)$

In the formula, α and β are consolidation parameters. The settlement at a certain time can be expressed as: $S_t = (S_\infty - S_d)[1 - \alpha \exp(-\beta t)] + S_d$ where: the measured settlement at the time of S t - t; Sd , S ∞-the instantaneous settlement and Final consolidation and settlement. In order to find the settlement at time t, the three-point method can be used to solve the values of S ∞, β, Sd and α respectively. By substituting the obtained Sd, S ∞, α, and β into the equation, the settlement amount at any time can be obtained.

The exponential curve method is based on the statistical results of field measurements. It is approximated that the settlement S is an exponential function of time t, which can be expressed as: S(t)=S ∞ -(S ∞-S0)et0 -tη t ≥t0

Where t is an observation time; S(t)-the settlement value at a certain time of the calculation; S0-the settlement amount corresponding to t; S ∞-the final settlement amount, which is the to-be-determined value; η-parameter, It is a pending value. After η, S is obtained, the final settlement and the settlement at any time can be obtained.

The Asaoka method was proposed by Japanese scholar Asaoka. (1978), also known as the graphic method. It is based on the vertical unidirectional consolidation theory, and a method for estimating post-construction settlement and final settlement based on the measured settlement. He pointed out that the consolidation partial differential equation expressed by Mikasa with vertical volumetric strain can be approximated by a common differential equation in the form of a series:

S + α1dSdt + α2d2Sd x+... + αndnSd Tn =b

Where: S ---consolidation settlement; α1 , α2 ... αn ---consolidation coefficient; b---constant depending on the consolidation coefficient Cv and the boundary conditions of the soil layer. Equation (4) can be simplified in most cases as follows: S + α1dSdt = b (5) where the first-order consolidation coefficient α1 = 5h212Cv. The solution of the above formula under the consolidation boundary condition is: S(t)=S ∞-(S ∞ -S0)ex p -tα1where: S0, S ∞---the initial settlement of the soil layer Quantity and final settlement;

Zha Jinmian and Mei Guoxiong found that the relationship between settlement and time of the whole process contains two aspects: one is that the initial settlement is not zero; the other is that the settlement time curve shows “S“. Shape. The Logistic model, also known as the growth curve model, has the following general form in the time series:

S(t)=b11+b2 ex p(-b3 t)

Where b1, b2, b3 are to be determined parameter. There are many methods for determining the parameters b1, b2, and b3, such as the three-segment calculation method and the gray theory method. As long as the calculation method and parameters are reasonable, the Logistic model curve can fit the “S“, “convex“ or even “concave“ curves in the geometry well, so it is more applicable.

4. Project examples and analysis

The section of K24 +579 to K34 +816 of the Quangang section of the coastal channel of Fujian Provincial Highway No. 201 passes through Kuibi, Haisha and Shanyao Salt Field to Hui'an Luanchuan. The total length of the section is 11.316km. The road section is a soft land section. Poor engineering geological properties. Taking the observation data of K36+440 section as an example, the above prediction methods are used to simulate and predict and compare. According to the measured data of the K26 +440 section, the predicted settlement amount of the logarithmic curve method, the exponential curve method, the Asaoka curve method and the Log isitic growth model is compared with the measured settlement amount.

Since the method used in this paper does not consider the influence of the grading loading on the settlement, the prediction and the actual measurement error are large in the initial stage of the prediction, but as the time increases, the error between the prediction and the actual measurement after the loading is basically completed small. The logarithmic curve method, the exponential curve method, and the Asao ka curve method are basically the same, so the prediction results are relatively close. For such a long loading time and a large amount of observation data, it shows that the error of the previous prediction result is large and the later error is gradually reduced. However, in terms of overall error, the prediction of the exponential curve is better. The Lo gistic curve is a highly adaptable curve, but it is not as applicable when the loading time is long. From the figure we can see that the error between the initial predicted value and the measured value is not large, because the initial stage of the soft soil roadbed can be reflected in the occurrence stage of the Lo gistic curve. All of these common curves are a good predictor of final settling and settlement after loading is substantially complete.

Logarithmic curve method, exponential curve method, Asao ka curve method and Logistic curve For the final settlement of soft soil foundation and settlement prediction after the completion of loading, the prediction accuracy can meet the actual needs of the project. The logistic curve can not reflect the change of settlement during loading in the process of loading and grading, and the prediction accuracy in the later stage of loading is lower than that of logarithmic curve method, exponential curve method and Asao ka curve method. Logarithmic curve method, exponential curve method, Asao ka curve method and Logistic curve, etc. Due to some limitations of the method itself, the difference between post-construction settlement and settlement during construction is not reflected, even the method itself does not consider the time. The factor of consolidation settlement. It is suggested to establish a certain theoretical basis for the analysis of settlement mechanism and mathematical methods to improve existing methods or to establish new prediction models considering secondary consolidation so as to better predict settlement, especially post-construction settlement.

5. Conclusion

Because natural soils have a series of complex physical and mechanical properties, and are easily affected by changes in environmental conditions (temperature, humidity, groundwater, etc.), the settlement of soft soil foundation becomes a complex dynamic system with nonlinear and multi-parameter influences. Consolidation theory, due to its own assumptions and the authenticity of the calculation index, makes the theoretical calculation of the settlement-time change compared with the measured results, it is difficult to be consistent. The hyperbolic and logarithmic curve empirical formulas have the disadvantages and defects that require typical sample distribution and many information parameters, and artificially assume the settlement-time curve of the soft soil foundation as a mathematical model, thereby making the settlement calculation valu. There is a certain distance between the actual values. Although the gray model is dynamic, the premise of modeling is that the original time series implies the exponential change law. The neural network method has strong nonlinear mapping ability, but the hidden layer number, hidden node number and learning parameters of the network are difficult to determine. The number of samples can only be determined by experience. With the increase of sample data, it can be more complete. The system can further improve the accuracy of the prediction and thus has practical application value.

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References

[1] Xu Xinyue. Discussion on prediction method of settlement of soft soil foundation [J]. Building Structure. 2003, 33(3): 9 ~ 16.

[2] Zhou Huanyun, Huang Xiaoming. Overview of settlement prediction method for soft soil foundation of expressway [J]. Journal of Transportation Engineering, 2002, 2(4):7 ~ 10.

[3] Li Jingpei, He Changgen. Prediction method of foundation settlement [J]. Shanghai Highway, 2001, 22(3): 2 ~ 6.

[4] Zhai Jinmian, Mei Guoxiong. Application of growth curve in prediction of foundation settlement [J]. Journal of Nanjing Institute of Civil Engineering and Architecture, 2000, 23(2): 8~ 13.

[5] Ren Guoxu, Chen Xinyan. Error Analysis in Settlement Prediction of Expressway Soft Foundation [J]. China and Foreign Highway, 2001, 21(5): 21~ 23.