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Settlement prediction research on the gravel pile in soft soil subgrade

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Abstract
Settlement prediction methods of soft subgrade based on the soil mechanical theories and mathematical statistics emerges in endlessly, but together with its limitations; the single theoretical calculation method maybe sometimes good, sometimes bad without the capacity to consider the change of the load; however the study of the theory of the combined forecast method is far from perfect. Under this situation, in view of the engineering practice in soft soil subgrade deformation law research in order to put forward a reasonable settlement prediction method, which is a problem urgently to be solved at present. Relying on gravel pile in soft soil subgrade construction in the highway K9+420-K9+550 section, and analyzing the data measured according to the soft soil foundation in the loading and constant loading period, taking classification of embankment load into account, and based on the related parameters of soil at the same time using the numerical analysis of saturated soft soil subgrade deformation-seepage coupling calculation, comparing the measured data with the finite element results and checking the fit, based on detailed sedimentation data by using curve-fitting method for calculating ultimate settlement value and compared with the finite element method settlement value for several years under broaden embankment. The two values differ by 1.5cm, which is in a controllable range for soft soil. Then thus the results are true and reliable in order to have implications for similar projects.

Key words: soft soil subgrade; large deformation; numerical analysis; curve fitting; sedimentation prediction

I. Introduction

There are Many soft-soil roadbed settlement prediction methods at home and abroad, sums up the main has two kinds: the first kind is to use the physical and mechanical properties of soft soil based on the constitutive model of soil, such as: using finite element analysis method, based on the Biot consolidation theory of e-lnp relationship of empirical formula method, based on geotechnical plastic mechanics and seepage consolidation theory of comprehensive method, based on laboratory test and field monitoring information of parameter back analysis method, etc. The second type is based on the measured settlement data, the use of a variety of statistical and mathematical analysis method to calculate subsidence and time relations, such as: Asaoka method, grey model, curve fitting, experience coefficient correction method, etc. Although the theoretical calculation and mathematical statistic method has its unique advantages, but has its limitations, not considering the influence of load variation; In addition, because of the complexity of the gravel pile soil reinforcement, must want to have the argument, at the same time, combined with finite element analysis and mathematical statistics method, provide the basis for predicting soft soil foundation.

This article in to the suining to great section of a highway K9+ 20-K9+550 fill-embankment in soft soil foundation, on the basis of the analysis of the field data processing of the embankment filling and solidification process by finite element method (fem) simulation, based on the accurate field observation data of using curve fitting method to get final settlement prediction, finite element calculation subsidence value is five years later, this experience method and theory combining the final settlement value, enhanced the reliability of the soft soil roadbed settlement forecast, the verification results accord with the engineering practice, the settlement calculation of similar geological conditions has a certain reference value.

II. The analysis of the field data processing

According to the settlement observation data to draw the s-t diagram, as shown in figure 1.By figure 1 selecting inflection point position (t_0, s_0) = (61,37.8) began to observation data as a basis to predict data, through data processing and linear fitting in figure 2.

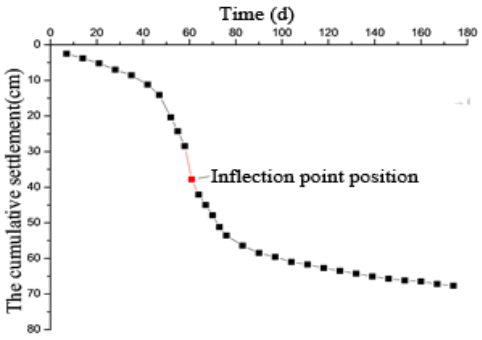

Fig.1 Relationship of between cumulative settlement and time

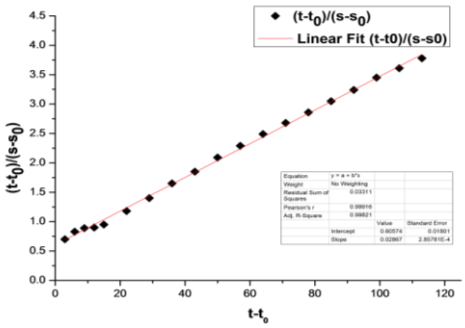

Fig.2 Line fitting plot of between $(t-t_0)/(S_t-S_0)$ and $(t-t_0)$

Through the diagram of (t - t0)/(St - S0) and (t - t0), coefficient are obtained by formula (1), alpha = 0.60574, beta = 0.02867.

$$\frac{t-t_0}{S-S_0}=\alpha+\beta t \qquad (1)$$

Again get final settlement by formula (2), S_∞ = 72.7 cm.

$$S_\infty = S_0+\frac{1}{\beta} \qquad (2)$$

III. The finite element analysis

According to K9+500 subgrade cross-section, making the use of finite element software to calculate the embankment from filling to preloading settlement value after five years. the analysis results show that the maximum settlement value of 74.1cm. The central settlement value is greater than the foundation on both sides in the first stage filling in the middle. Adopted the gravel pile treatment due to the segment MianRuan soil, filled soil surface contour to deep foundation, and gravel pile reinforcement effect is obvious. Deformation of soft soil foundation is under control. There are hump phenomenon on both sides of soil embankment, which reason is the role of stress.

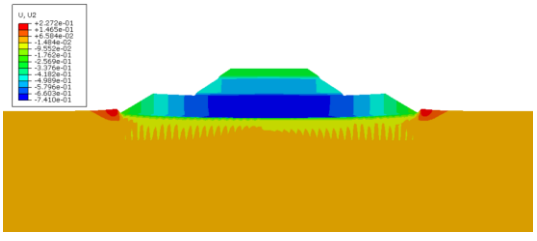

Fig.3 Vertical settlement contours

IV. Final settlement prediction

Figure 4 is finite element calculation subsidence value of K9+500 section. The comparison between results of measured values and curve fitting can be seen from the diagram,which the finite element calculation subsidence curves and the measured settlement value curve fits. Finite element calculation

result was slightly larger than the measured values, calculation process has considered drainage function of the sand drain, and the seepage consolidation effect of soft soil, the results may be due to the difference of the complexity of the actual situation and monitoring error, cause the simulation parameters selection has certain deviation;Utilization of prediction based data fitting curve fit finite element calculation of subsidence curve and measured curve, the final settlement prediction is 72.7 cm, from embankment filling preloading after five years of finite element calculation value of 74.1 cm, the difference between the two is 1.4 cm, that is based on the field observation data using curve fitting method to make accurate subsidence prediction is the reliability, the calculation method is applied to the K9+500 section of settlement calculation is feasible, field monitoring data is relatively accurate, the finite element constitutive relationship and calculation parameter Settings are reasonable, actual situation can be more reliable reaction.

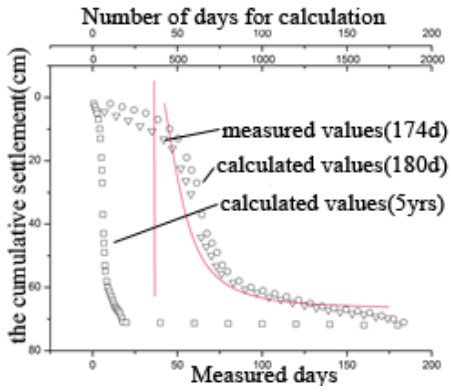

Fig.4 Comparison of between calculation results and measured values

V. Conclusions

This paper analyzes the characteristics of soft-soil roadbed settlement, the subsidence through comparison between measured values and the finite element calculation value verified that the finite element model and the parameter selection meet high fit in two cases, and based on the accurate field observation data of using curve fitting method to get final settlement prediction. This empirical method combined with theoretical method final settlement values enhanced the reliability of the soft-soil roadbed settlement forecast. The verification results accord with the engineering practice, draw the following conclusion:

(1)Settlement through comparison between measured values and the finite element calculation value verified that the finite element model and the parameter selection. In situations where they are fit, based on the accurate field observation data of using curve fitting method to get final settlement prediction, compared several years after the finite element calculation subsidence, such experience method and theory combining the final settlement value, enhanced the reliability of the soft soil roadbed settlement forecast, which at the same time improves the accuracy of the soft soil roadbed settlement forecast, and provides theoretical basis for engineering practice.

(2)Try from finite element contour map (figure 3), you can see that test section of soft-soil subgrade using gravel pile reinforcement subgrade can effectively improve the soft soil's shear capacity and better control the lateral deformation of soft clay, which effectively shorten the slow subsidence during the late stage of development,and reduce the post-construction settlement.

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