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Application of Engineering Survey in Deep Foundation Pit Construction in Forest Area

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Abstract:

In summer, the dense leaves in the forest canopy strongly weaken the solar radiation, so that the heat in the forest is less than that in the non forest. In addition, the total evaporation heat consumption of forest is large, so the temperature is naturally lower than that outside the forest. This brings great difficulty to the engineering survey in the construction of deep foundation pit. In summer, the dense leaves in the forest canopy strongly weaken the solar radiation, so that the heat in the forest is less than that in the non forest. In addition, the total evaporation heat consumption of forest is large, so the temperature is naturally lower than that outside the forest. This brings great difficulty to the engineering survey in the construction of deep foundation pit. At present, there is no mature method to calculate the deformation of soil around the foundation pit. Accurate and timely monitoring in construction can guide the excavation and support of foundation pit. This is conducive to take timely emergency measures to avoid or reduce the destructive consequences. This paper summarizes the application technology of engineering survey in deep foundation pit construction. Combined with the monitoring data of a large foundation pit, the application of horizontal displacement monitoring, building settlement monitoring, internal force monitoring of enclosure system and earth pressure monitoring in practical engineering is further studied. The experimental results show that the method can improve the efficiency and accuracy of measurement.

Keywords: *Forest Area, Engineering Survey, Deep Foundation Pit Construction, Data Fusion*

I. INTRODUCTION

In modern urban construction, there are a lot of deep foundation pit engineering in subway engineering, high-rise buildings and other projects. Deep foundation pit engineering is one of the most dangerous projects stipulated by the state [1-2]. The excavation construction process of deep foundation pit engineering often causes the changes of foundation pit support system and surrounding environment, which has great risk. A little carelessness will not only endanger the

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safety of the foundation pit itself, but also damage the surrounding buildings, roads and various underground facilities, causing serious social impact and economic losses. Foundation pit engineering monitoring is not in place often causes major safety accidents.

Because of the complex technology and frequent accidents of deep foundation pit engineering, it is necessary to monitor in the construction process [3]. During the excavation and construction of foundation pit, the foundation pit and surrounding environment shall be monitored, and the occurrence of excessive displacement, deformation and engineering accidents shall be prevented [4-5]. The monitoring of foundation pit can grasp the construction and use process of surrounding slope, understand the stress condition and deformation of foundation pit supporting structure, and provide reliable basis for optimization and modification of design, and achieve the purpose of dynamic design and information construction.

The monitoring standard of foundation pit engineering is the technical requirement and standard for the foundation pit monitoring project [6]. From the collected standards and specifications for the monitoring items, monitoring frequency, monitoring alarm values of various provisions can be seen, there are still many problems to be solved in the foundation pit monitoring project in China. Therefore, the research on the monitoring method and accuracy of foundation pit will not only enrich and broaden the research field of engineering monitoring technology, but also has important practical significance for the foundation pit monitoring project.

II. RESEARCH ON MONITORING METHOD AND PRECISION REQUIREMENT

2.1 Horizontal displacement monitoring

When measuring the horizontal displacement in a specific direction, the projection method, small angle method and collimation line method can be used. When measuring the horizontal displacement of monitoring points in any direction, the polar coordinate method, resection method and forward intersection method are adopted according to the distribution of monitoring points. When the distance between the measuring point and the reference point is too long, the GPS measurement method or the comprehensive measurement method combining the blue angle, trilateral and corner measurement with the reference line method can be used. There are many monitoring methods for horizontal displacement, but the applicable conditions of each method are different, so special attention should be paid to the selection of methods and measurement [7-8]. If the small angle method is adopted, the theodolite should be corrected for the inclination of the vertical axis before monitoring. When the collimation line method is adopted, the distance between the buried measuring points and the datum line should not be more than 2cm, and the zero position difference of the movable gauge plate should be measured.

The embedding of horizontal displacement monitoring datum points should comply with the relevant provisions of the current national standards. It is appropriate to set up observation piers

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with forced centering, and adopt precise optical centering device. The centering error should not be greater than 0.5mm. It is better to choose copper materials with rust prevention and use protective devices for protection. When the forced centering observation pier is used, it is strictly forbidden to pile up debris within 2m around the pier to avoid touching the pier, and regular inspection and maintenance are required.

2.2 Structural internal force monitoring

Structural internal force monitoring generally adopts the stress meter installed inside or on the surface of the structure for measurement, which is suitable for internal force monitoring of supports, columns and other parts. Concrete members can be measured by steel bar stress meter or concrete strain meter, and steel members can be measured by axial force meter or strain meter. The steel bar internal force meter for testing the internal force of concrete members can be welded on the main reinforcement during the fabrication of members.

The internal force monitoring value should consider the influence of temperature change and other factors. For the structure type of steel support, the influence of temperature change on its internal force can not be ignored in the season when the outdoor temperature changes greatly. Therefore, the influence of this factor should be considered in the internal force monitoring value.

The measuring range of the stress gauge or strain gauge should be twice the design value, the accuracy should not be lower than 0.5%F*S, and the resolution should not be lower than 0.2% F*S [9]. Sensors with strong anti-interference ability, good water resistance, no influence of wire length, good stability and durability shall be selected according to the nature of the project. Different types of strain gauges and stress gauges have different formulas for calculating the axial force of supports, which should be paid special attention to.

2.3 Earth pressure monitoring

Earth pressure should be measured by earth pressure gauge. This method is mainly used to measure the earth pressure inside and outside the foundation pit. The measuring range of the earth pressure gauge should meet the requirements of the measured repulsion force. The upper limit of the earth pressure gauge should be 2 times of the design pressure. The accuracy should not be less than 0.5% F*S, and the resolution should not be less than 0.2% F*S. The range of the upper pressure gauge should meet the requirements of the pressure range to be measured, and a little reserve should be reserved to meet the requirements of earth pressure test under abnormal conditions. The earth pressure gauge can be buried in person or in boundary. When burying, the pressure direction should be perpendicular to the stress surface of the earth pressure gauge [10]. During burying, the earth pressure membrane protection measures should be taken. When backfilling, the backfill material should be dense and consistent with the surrounding soil, and complete burying records should be made.

Due to the different structure and location of the earth pressure gauge, there are many ways to bury the earth pressure gauge, such as hanging method, jacking method, springing method,

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drilling method and so on. The earth pressure gauge can be embedded during or after the construction of retaining wall. If it is carried out after the completion of the retaining wall, because the earth pressure gauge can not be embedded close to the retaining wall, there is a certain difference between the locking data and the actual upward pressure on the maintenance wall. If the installation of earth pressure gauge is carried out simultaneously with the construction of maintenance wall, the installation of earth pressure gauge on the earth facing surface of retaining wall must be solved.

After the earth pressure gauge is embedded, it should be checked and tested immediately, and the stable initial value should be obtained before the foundation pit excavation. When the earth pressure gauge is embedded, it may cause local stress concentration. At least one week in advance is conducive to the stress balance between the sensor and the surrounding soil, and the initial value obtained is closer to the real situation.

III. RESEARCH ON DEFORMATION MEASUREMENT METHOD

3.1 Horizontal displacement monitoring

As shown in fig. 1, a and b are the only directions, p is the monitoring point, and they are observed on a and b. And p angle, so that the coordinates of p point can be calculated. This method of knowing two control points, observing the horizontal angle of a fixed point, and calculating the coordinates of a fixed point according to the coordinates of a known point and the observed angle value is called the forward intersection method. According to the coordinate difference of monitoring points in later periods, the coordinate displacement of P point can be obtained.

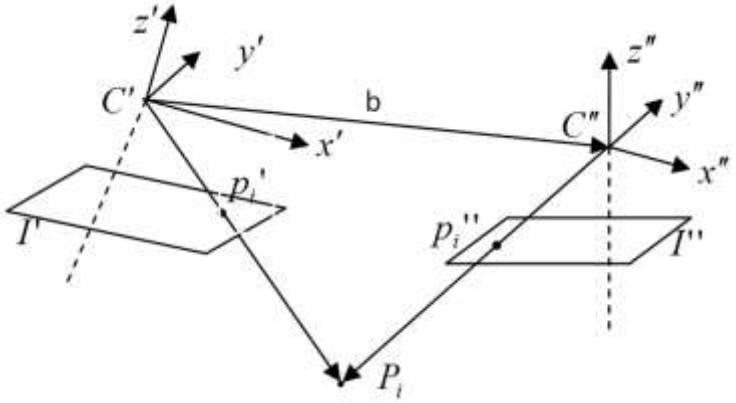

Fig 1: Forward intersection method diagram

There are three kinds of forward intersection methods: corner forward intersection, side forward intersection and angle measurement forward intersection. The observation values and instruments are shown in Table 1.

TABLE I. Types of forward intersection

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TYPE	ANGULAR INTERSECTION METHOD	INTERSECTION METHOD OF SURVEYING AND MEASURING SIDES	INTERSECTION OF EDGES AND CORNERS
OBSERVATIONS	β1,β2	D1,D2	β1,β2:D1,D2
OBSERVATION INSTRUMENT	Precision theodolite	Photoelectric rangefinder	Precision total station

The error sources of forward intersection method are as follows:

(1) Angle measurement error

(2) The influence of intersection angle y and figure

(3) Influence of intersection datum line measurement accuracy

(4) Influence of external conditions

Monitoring considerations:

(1) The initial value of monitoring items shall be measured before the relevant construction process, and the stable average value of at least three consecutive times shall be taken.

(2) The monitoring methods and accuracy of the surrounding environment of subway, tunnel lamp and other foundation pits should meet the requirements of relevant standards and the competent authorities.

(3) Independent coordinate system should be adopted for horizontal displacement monitoring datum network, and it can be combined with national coordinate system if necessary. The main axis or its parallel lines of long and narrow buildings should be included in the network. The accuracy, reliability and sensitivity of the network should be taken into full consideration when the large-scale project is deployed.

3.2 Deep horizontal displacement monitoring

Inclinometer (as shown in the figure) according to its working principle has a variety of service acceleration type, resistance strain gauge, etc., more commonly used for the service acceleration type. The structure of inclinometer is shown in Figure 2.

Fig 2:Structural diagram of inclinometer

There are two kinds of inclinometer pipes, round and square, which are usually made of PVC plastic pipes. During installation, the inclinometer pipe shall be bound on the

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reinforcement cage and put into the pile hole together with the reinforcement cage. The top and bottom of the inclinometer pipe shall be sealed with covers to prevent mud and mortar from entering the hole.

When measuring the lateral displacement of Tsuen Keng with inclinometer, the following requirements shall be met:

(1) The inclinometer should adopt the instrument which can measure continuously at many points;

(2) The inclinometer pipe shall be laid in the middle and key parts of each side of the foundation pit, and shall be set in the soil inside or outside the pile wall of the retaining structure, and its buried depth shall be consistent with that of the retaining structure;

(3) For the inclinometer pipe embedded in the retaining structure of foundation pit, the inclinometer pipe shall be bound on the reinforcement cage, put into the hole synchronously, and fixed in the pile wall after pouring concrete

(4) The inclinometer pipe buried in soil should be drilled with geological drilling machine first, and then the segmented inclinometer pipe should be connected and put into the hole. The buried depth of inclinometer pipe should be consistent with that of retaining structure;

(5) After the inclinometer pipe is buried, it should stay for a period of time to make the inclinometer pipe firmly connected with the soil or structure;

(6) During the observation, it can be measured every 0.5m from the bottom of the pipe upward along the whole length of the guide groove, and the probe can be rotated 180 to measure again.

IV. EARTH PRESSURE MONITORING

4.1 The purpose of soil pressure monitoring

In general, the soil pressure should be measured by soil pressure measurement, which is mainly for the following purposes:

(1) The theoretical analysis value and distribution law of earth pressure of hydrochloric acid support structure;

(2) Monitoring the instability factors of the supporting structure under various construction conditions, so as to take corresponding measures to ensure the construction safety in time;

(3) The law of soil pressure change in different distance and depth caused by underground engineering construction is found to ensure the safety of surrounding environment;

(4) The static, active and passive earth pressure laws under various conditions were explored to accumulate data for improving the theoretical analysis level.

4.2 Arrangement of earth pressure measuring points

The layout of lateral earth pressure monitoring points of retaining wall should be selected at the positions with great changes in stress and drawing conditions or other representative new

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positions. On the plane, it should be matched with the positions of deep horizontal displacement monitoring points and internal force monitoring points of retaining wall, so that the monitoring data can be verified with each other, which is convenient for comprehensive analysis of monitoring items. In the vertical direction (monitoring section), the calculation figure of earth pressure, the distribution of soil layer and the matching of internal force monitoring points of retaining wall should be considered. In order to monitor the earth pressure on the contact surface of retaining structure, the earth pressure box should be arranged in different soil layers, and it can be selected at the middle point of the support girth, the second girth and the maximum horizontal displacement.

(1) The monitoring points should be arranged on the side of the enclosure with large bending moment and complex stress;

(2) The monitoring points are on the plane, and there are at least 2 monitoring points on each side of the foundation pit;

(3) The vertical distance between monitoring points should be 2-5M, and the lower part should be densified. In general, at least one measuring point should be arranged in each layer, and the middle part of the soil layer should be arranged, which can be preset on the side of the retaining wall of the soil facing surface and the soil entering section of the pit facing surface. When the depth exceeds 5-10m of the retaining wall, it should be buried at a fixed point as far as possible, and the deformation at the bottom of the retaining wall can be monitored at the same time.

4.3 Monitoring methods

Earth pressure should be measured by earth pressure meter, also known as earth pressure box, which is divided into resistance strain type and vibrating wire type. One is divided into vibrating wire type and resistance strain type. The receiver is frequency meter and resistance strain meter respectively. The structure and working principle are basically the same as the steel bar meter. The interface is highly sensitive and can sense small changes of earth pressure. The frequency of earth pressure gauge can be measured and recorded by digital frequency meter.

There are many forms of earth pressure box, which can be divided into vertical and horizontal according to shape, single mode for measuring earth pressure on contact surface and double mode for measuring earth pressure in soil according to use.

The measuring range of the earth pressure gauge should meet the requirements of the measured pressure. The upper limit of the earth pressure gauge should be 2 times of the design pressure. The accuracy should not be less than 0.5% F*S and the resolution should not be less than 0.2% F*S.

V. CONCLUSION

When monitoring the building foundation pit, the eyes in the construction of foundation pit

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engineering, only do a good job in monitoring, can we see the construction direction. The focus of monitoring is the change of surrounding environment and the deformation dynamic of foundation pit supporting structure itself. Monitor according to the construction schedule, and provide dynamic data to the construction team in time to control the construction schedule. When the monitoring alarm value appears, the monitoring frequency should be increased to adjust the construction process beat, and finally ensure the smooth implementation of the project construction.

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