Monitoring Analysis and Research of a Foundation Pit Engineering in Soft Soil Area

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ABSTRACT

A deep foundation pit project in soft soil area has deep depth, complex surrounding environment and close proximity to subway, so it is necessary to monitor the supporting structure and surrounding environment of the foundation pit during the construction of the deep foundation pit. According to the characteristics of the foundation pit, a reasonable monitoring scheme is formulated to monitor the deep horizontal displacement of the foundation pit, the horizontal displacement of the top of the retaining structure, the vertical displacement of the upright post and the underground water level outside the pit, and the monitoring results are analyzed. The monitoring results show that the deformation of the retaining structure and the vertical displacement of the upright post of the foundation pit gradually increase with the excavation unloading process of the foundation pit soil, and the supporting effect will restrain this deformation. After the foundation pit floor construction is completed, the deformation gradually tends to be stable. The monitoring results provide a reliable guarantee for the safety of the project during foundation pit construction, and can provide reference and basis for similar projects.1

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INTRODUCTION

Soil engineering has the characteristics of uncertainty of geological conditions, uncertainty of soil parameters and diversity of load conditions, combined with the complex and changeable construction environment on site, which makes geotechnical engineering highly unpredictable. It is difficult to predict various problems that may be encountered in actual engineering simply in theory [1]. At this time, it is necessary to carry out site engineering monitoring in a planned way under the guidance of theory. Monitoring work is an indispensable and important part of geotechnical engineering in formation construction [2]. Timely understanding of dynamic deformation during foundation pit excavation is conducive to optimizing construction scheme, shortening construction period and reducing construction cost. Previous scholars have carried out extensive research on the construction monitoring of building foundation pit and subway deep foundation pit, but less on the monitoring of building foundation pit close to subway protection area [3]. A deep foundation pit project in Tianjin has a large excavation area, complex surrounding environment and close proximity to subway [4]. Taking this foundation pit project as the research object, monitoring the supporting structure and surrounding environment of foundation pit in the process of foundation pit excavation has certain engineering practical significance for similar projects.

MONITORING PROGRAMME

The monitoring items and monitoring instruments of the foundation pit are shown in Table 1 and the distribution diagram of the monitoring points is shown in Figure 1.

<table>
<thead>
<tr>
<th>MONITORING CONTENT</th>
<th>DISTRIBUTION POINTS NUMBER</th>
<th>MONITORING INSTRUMENT</th>
<th>ACCURACY REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep horizontal displacement</td>
<td>14</td>
<td>Inclinometer TGCX-1-100B</td>
<td>System accuracy 0.25mm/m, Resolution 0.02mm/500mm</td>
</tr>
<tr>
<td>Horizontal displacement of top of enclosure structure</td>
<td>18</td>
<td>Total station TS30</td>
<td>Angle measurement accuracy 0.5°, Ranging accuracy 0.6mm+1ppm×D</td>
</tr>
<tr>
<td>Vertical displacement of column</td>
<td>9</td>
<td>Trimble Dini03</td>
<td>±0.3mm/km</td>
</tr>
<tr>
<td>Groundwater level</td>
<td>13</td>
<td>Water level gauge TGCS-2</td>
<td>±1mm</td>
</tr>
</tbody>
</table>
The proposed building in a foundation pit project site is 3 floors underground, with two high-rise residential and commercial buildings on the ground. The highest building height is nearly 200 meters, the deepest foundation pit is about -18.4 meters, and the foundation pit area is about 8856 m². The foundation pit is a first-class foundation pit with three concrete supports. The surrounding environment is complex, close to the subway, and its basement exterior wall line is close to the subway control line, and its exterior wall is about 9m away from the nearest subway structure. This paper analyzes the results of site monitoring of foundation pit engineering, combines theory with practice, summarizes the monitoring work by synthesizing its research results, and provides important reference materials for site monitoring of foundation pit.

ANALYSIS OF TEST RESULTS

The deep horizontal displacement of the retaining structure of the foundation pit is monitored by sliding inclinometer. As the foundation pit is close to the subway, this monitoring focuses on the deformation of the foundation pit close to the subway side, and the monitoring points close to the subway side need to be monitored. The monitoring results of CX8 monitoring points on the subway side are now analyzed,
and the curve of the deep horizontal displacement with time is shown in Figure 2 (in the Figure 2, the deep horizontal displacement of the retaining structure is positive toward the inside of the foundation pit).

Figure 2. Depth curves varying with time for CX8. Figure 3. Top horizontal displacement.

In order to better understand the deformation of the retaining structure of the foundation pit, it is necessary to monitor the horizontal displacement of the top of the retaining structure of the foundation pit. Since the side close to the subway is the focus of this monitoring work, the monitoring results of the horizontal displacement monitoring points JC9, JC11 and JC13 close to the subway side are now analyzed. The curve of the horizontal displacement of the top of the retaining structure with time is shown in Figure 2.

As can be seen from Figure 3, the horizontal displacement of the top of the retaining structure shows a wave-like upward trend in the process of foundation pit construction. Earthwork excavation is an unloading process, and the horizontal displacement at the top of the retaining structure gradually increases, while the construction of various supports inhibits the trend of horizontal displacement increase. After the foundation pit floor construction is completed, the horizontal displacement at the top of the retaining structure gradually tends to be stable. The maximum values of the horizontal displacement at JC9, JC11 and JC13 monitoring points are 13.9 mm, 19.0 mm and 6.5 mm respectively (toward the inside of the foundation pit), all of which do not exceed the alarm values.

**CONCLUSIONS**

Taking a deep foundation pit project as an example, this paper introduces the process of data processing and analysis of foundation pit monitoring. By analyzing the monitoring results of deep horizontal displacement of retaining structure, top
The deep horizontal displacement of the foundation pit fluctuates with the excavation of the foundation pit soil. Earthwork excavation will increase the deep horizontal displacement of the retaining structure of the foundation pit, while the support will restrain this deformation, but there will still be a small increase. While excavation and support construction, the deep horizontal displacement of the retaining structure does not exceed the alarm value.

Earthwork excavation and support construction make the horizontal displacement at the top of the foundation pit retaining structure appear a wave-like upward trend. After excavation and unloading, the horizontal displacement increases significantly. After the bottom plate is completed, this deformation tends to be stable.

In the process of earthwork excavation unloading, the soil body at the bottom of the pit rebounded to different degrees, thus making the vertical displacement of the upright post gradually increase in the process of foundation pit construction, but under the support, this deformation increase is limited and tends to be stable after the construction of the bottom plate is completed [5].

The groundwater level around the foundation pit will change with the seepage of foundation pit soil and site pumping. When site pumping, the groundwater level around the foundation pit will obviously decrease.

It can be seen from the monitoring of deep horizontal displacement of foundation pit, horizontal displacement of retaining structure, vertical settlement of upright post and underground water level that monitoring work is very necessary for foundation pit construction and provides basic means for foundation pit informatization construction to control deformation within a safe range [6]. When the situation exceeds the alarm value, alarm in time and take corresponding measures can well ensure the safety of the project.

REFERENCES