Structural Design and Monitoring Analysis of Foundation Pit Support in Yiwu Huishang Tiandi

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Abstract: Huishang Tiandi deep foundation pit in Yiwu is a two-story basement,which is located in the downtown area and adjacent to the city center main traffic trunk. The surrounding environment is too com-plex to slope. The excavation depth is large, the formation is weak and complex, and the groundwater level is high.In order to ensure the safety of the foundation wall and the surrounding environment, the deformation of the foundation pit support is strictly controlled, and the deformation and internal force of the foundation supporting structure and the surrounding building are monitored.The deformation law of the foundation pit is obtained through the analysis of the horizontal displacement , the deformation rate of the supporting struc-ture, the surrounding environment of the foundation pit and the internal force of the anchor cable. The relia-bility and rationality of the design of foundation pit support are verified. It is of reference value for the de-sign and construction of other deep foundation pit engineering in Yiwu area.

1 Introduction

Yiwu is a famous commodity wholesale and distribution center in China, and the contradiction between economic growth and urban land use is increasing. With the continuous emergence of high-rise and super high-rise buildings in urban construction, the effective use of underground space has become an inevitable choice. The foundation pit supporting technology, which is used to ensure the construction of the foundation pit and the underground pipeline of the road, has been greatly developed. In this paper, according to the specific engineering geological conditions of the site of Yiwu International Trade City, the safe and reasonable support scheme is selected to ensure the safety of the foundation pit supporting structure.

2 Project Overview

Yiwu Huishang Tiandi in Zhejiang province, a district is located in Yiwu international trade city of Yinhai, on the west side of the street Chouzhou North road. It covers an area of 7835.2 m^2, the proposed 9-storey office building 1 and 2-story basement. The total construction area of the project is 34591.8 m^2, of which the underground construction area is 11087.4m^2.

The surface elevation of the site is 68.80 ~ 70.80 m. The proposed project has a ± 0.00 elevation of 70.00 m. The elevation of the board on the second floor is -8.80m, the bottom plate and the cushion thickness is 0.70 m, and the base pit elevation is -950 (60.50) m. The depth of the foundation pit is 8.30 ~ 10.30 m, the area is about 6945.8 m2 and the circumference is about 410.4m.

According to the size and importance of the foundation pit, the safety grade of the foundation pit is determined to be one grade, the important coefficient of side wall is 1.10, and the service life of foundation pit is 2.0 years.

3 Surrounding Environment of the Foundation Pit

Land red line from the east side edges basement is 5.50 m, and the land outside the red line is the district road. On the west side, the basement side line is 5.10 m from the land red line. There is a water supply pipe in the red line with a depth of about 1.00m. The land red line (wall) is about 16.00m. There are 6 buildings, frame structure and pile foundation.

On the south side, the basement side line is 4.90 m and 7.50 m from the red line, land red line away from the wall (sidewalk edge) is 5.50m and 12.30 m. There are 1.50 m high voltage cables buried in the wall (sidewalk), and the buried depth of gas pipeline is 1.20 m. On the north side, the basement side line is 5.0 m from the red line, land red line is 2.0m away from the wall (sidewalk edge).

The main soil layers of the construction site are miscellaneous fill, silty clay, fine sand, strong weathering, medium weathered silt sandstone and other soil layers., among which miscellaneous fill and fine sand and other soil layer of soil are loose and easily to collapse.

Survey report shows a higher groundwater level (underground 2.60m), miscellaneous fill and fine sand and other soil layer has a certain permeability.

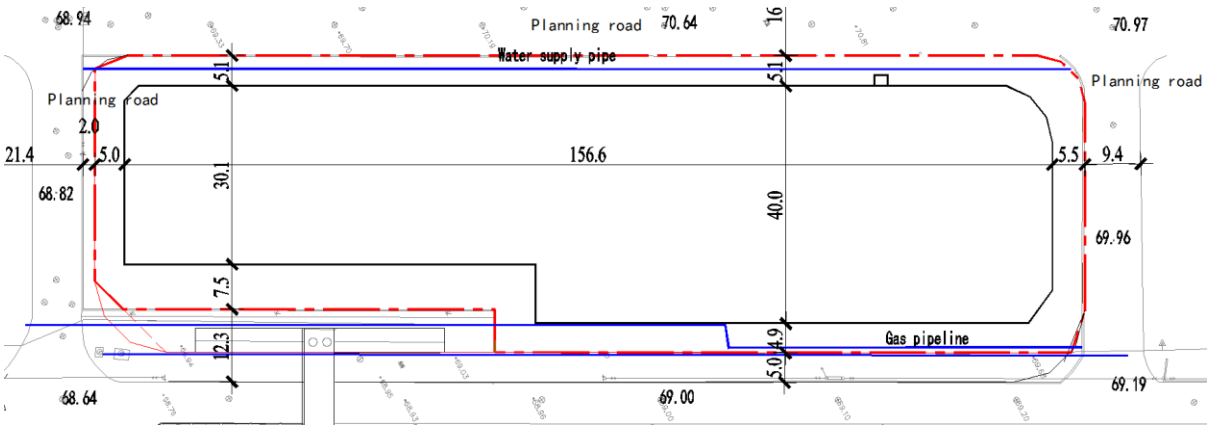

Figure 1. Pit surrounding environment map

4 Hydrological and Engineering Geological Conditions of the Site

The main soil layers in the site are the artificial filling of the Quaternary Holocene and the alluvial deposits of the upper Pleistocene, and the underlying bedrock is the upper Cretaceous Jinhua formation. According to the classification of formation age, lithology and group classification, it is divided into 3 engineering geological layers, and the 5 engineering geological layers. Described as follows:

The 1 layer of the miscellaneous fill （Q_4^{ml}）

The distribution of the soil is on the whole site, originated from the Quaternary Holocene artificial fill. The accumulation period is about10 years, layer thickness is 2.50~6.80m, and the top elevation is 69.34~71.82m, the soil is mainly composed of cohesive soil, sandy soil, broken stone, construction waste and so on, the hard content is about 20-50%.

The 2-1 layer of the silty clay （Q_3^{apl}）

The soil is partial loss, originated from the alluvial flood in the Quaternary, the layer thickness is 0.30~4.60 mm, and the depth of the top of the layer is from 3 to 5.50 m, and the height of the top layer is from 65.37 to 67.08. Gray, grayish yellow, hard plastic, local iron manganese nodule, soil were slightly glossy, dry strength test medium, toughness test medium, without shaking reaction.

The 2-2 layer of fine sand （Q_3^{apl}）

The soil is partial loss, originated from the alluvial flood in the Quaternary, the thickness of 0.80 ~ m m, the top of the buried depth of 4.60 ~ 6.70 m, the top elevation of 62.93 ~ 65.27. Yellow, brown, grey local, loose, wet-saturated, which is easy to collapse, cylindrical particles to sub circular, mainly

composed of quartz, volcano clastic rock, with argillaceous cement, high local clay content, mixed with coarse gravel in the bottom.

The 3-1 layer of the weathered siltstone (K_2^j)

The soil is distributed in the whole layer, the thickness is 0.40~1.5m, the top of the layer is buried depth of 2.50 ~8.1mm, the top of the layer is from 61.74 to 68.35m, the depth of the bottom of the layer is from 3.50 to 8.70m, and the elevation of the bottom of the layer is from 60.83 to 67.35. Purplish red, gray white, silty sand structure, rock weathering strong, dense degree is not uniform, the core is mud and debris.

The 3-2 layer of the weathered siltstone (K_2^j)

The soil is distributed in the whole field, and the thickness of the layer is 6~10.70 m, and the depth of the top of the layer is from 3.50 to 8.70 m, and the height of the top layer is from 60.83 to 67.35 m. Purplish red, grayish white, silty sand texture, thin medium thick bedded structure. Soft and hard rock weathering and joint fissures, the frequency of 2-4 / m, the crack surface coated black or grayish yellow iron manganese oxide film.

5 **Structural Design of Foundation Pit Supporting**

The groundwater level around the foundation pit is high, and the soil, such as miscellaneous fill, fine sand and strong weathered rock, has a certain permeability. Drainage holes are arranged on the side wall of the foundation pit. Drainage ditches and water retaining walls are arranged around the foundation pit, and the drainage and drainage measures such as drainage ditches and collecting wells are arranged at the bottom of the foundation pit, which can meet the requirements of safe production.

The excavation depth and excavation area is very large, the surrounding environment is complex, it is necessary to strictly control the deformation of the foundation pit, and reasonable layout of the anchor position is necessary, the foundation pit support design has brought some difficulties. According to the technical regulations of the building foundation pit support, the safety level of most side walls of the foundation pit is determined to be the first grade, and the important factor of the side wall of the foundation pit is 0 = 1.10. After careful analysis and comparison, it is more reasonable to use row piles and steel strand bolt support.

According to the surrounding environmental conditions around the different, divided the foundation pit into 6 sections, the calculation results and optimization is adopted by LIZHENG 7.0 Deep Foundation Pit design software. Ground overload surface is in accordance with 10-20kPa, the housing 20kPa/ layer. The load in the design of foundation pit support includes the active earth pressure and passive earth pressure, the building load in the excavation of the foundation pit, and the ground overload. When the slope is stable, the load effect combination is the basic combination of the load effect under the limit state of bearing capacity, and the partial coefficient and the combination coefficient are 1.0. The load effect combination uses the basic combination of the load effect under the limit state of bearing capacity, to determine the dimensions of the support structure and the strength of the reinforcement and checking the material. When precipitation design according to the maximum drawdown of 10.30 m as the control target, the layout of the 30 deep well dewatering in the foundation pit, well designed specifications. According to the results of internal force calculation the design of each support section is shown in figure 2.

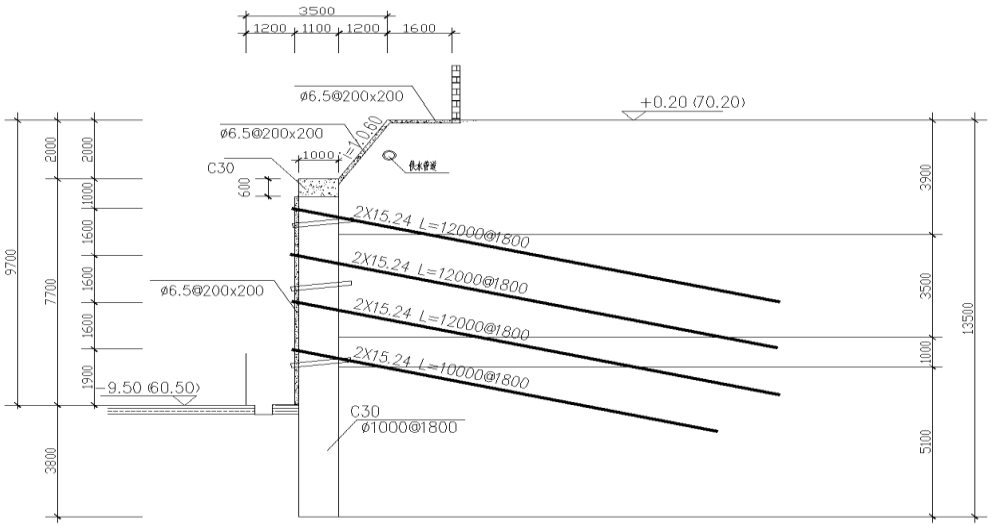

Figure 2. Section of a support design

6 **Construction Monitoring**

6.1 *Horizontal displacement of supporting structure*

According to the technical regulations of the foundation pit, the monitoring points are arranged according to the monitoring program of the foundation pit. The horizontal displacement monitoring point spacing is generally less than 20 m, which is arranged on the continuous beam of bored pile. S1, S2, S3, S4, S5 are taken as the monitoring points of the foundation pit from the monitoring points of the horizontal and vertical displacement of the foundation pit. The observation frequency is every 2 days after the excavation of the foundation pit, and the excavation depth of the foundation pit is 6m once a day for 2 days, and the excavation depth is below 6m once a day. In case of rain or unusual circumstances the frequency of observation should be increased.

The horizontal displacement of monitoring points is shown in figure 3. From the monitoring curve, change with time of retaining structure horizontal deformation, horizontal displacement of 1 -2 mm from the beginning gradually rose to about 10 mm, which proved reasonable design and appropriate measures adopted of the foundation, the overall structure is safe and reliable. From the time point of view, after the excavation of the foundation pit to 60 d, the deformation tends to be stable. In the process of monitoring, it is found that the displacement of the individual points is larger, the maximum horizontal displacement of the foundation pit is located at S5, and the maximum horizontal displacement is 18.85 mm, which is about 0.15% of the excavation depth of the foundation pit.

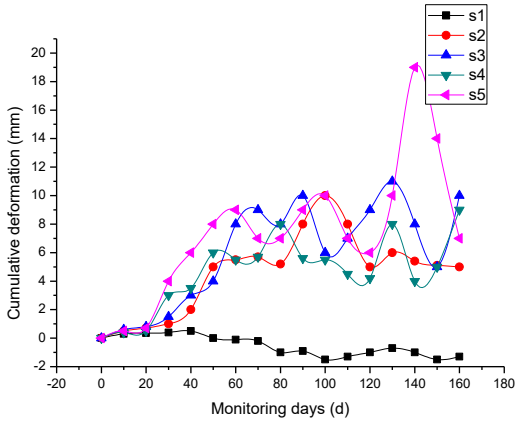

Figure 3 Monitoring curves of horizontal displacement

6.2 *Displacement monitoring of surrounding buildings and roads*

Since the excavation of the foundation pit is large, and the project is located in the important traffic area, in order to reduce the influence of the surrounding soil settlement on the surrounding environment during the excavation of the foundation pit and the precipitation process, 5 monitoring points are set up for settlement observation.

Analysis of road monitoring curve shows (Figure 4), the actual monitoring results, the small settlement of the surrounding soil, the largest settlement in the Central Plains Road, the largest settlement of the road is 14.67 mm, does not affect using. Analysis of the reasons for the monitoring point near the excavation of a major excavation during the whole mouth, most of the earth excavation and concrete, steel and other materials are transported through the mouth of the previous. The dynamic load of vehicle transportation is larger, and the relative horizontal displacement of the supporting structure reaches the maximum of 16.32 mm.

According to the building foundation pit monitoring curve, (Figure5), the maximum settlement of surrounding buildings located in the bus station mixed with 4 floor corner point, the largest settlement is 13.51 m, This is related to the excavation of foundation pit, the deformation and

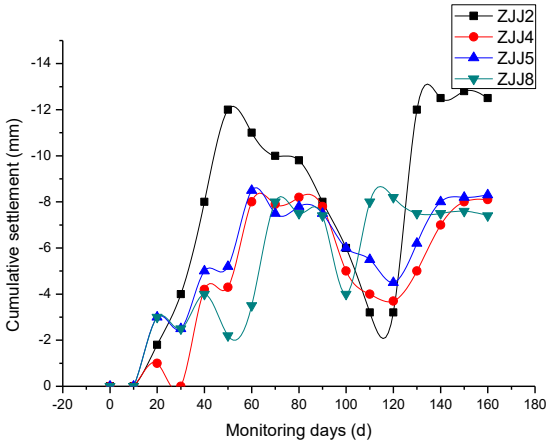

Figure 4 Road subsidence monitoring curve

stress of pile body, and the settlement deformation is far less than the requirement of 30mm. pit excavation, settlement deformation is far less.

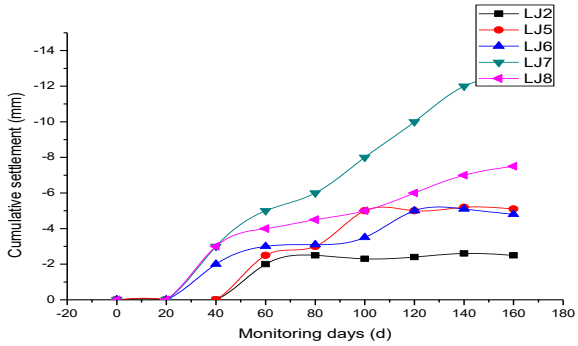

Figure 5 Vertical displacement curve of surrounding buildings

7 **Conclusion**

(1) The maximum horizontal displacement of the retaining structure of the foundation pit is 18.85mm, and the maximum settlement of the surrounding road is 14.67 mm. The maximum settlement of the

corner of the building is 13.51 mm, which is far less than the requirement of 30mm, which shows the reliability and rationality of the design and construction of the supporting structure.

(2) The maximum horizontal displacement of the pile head of the engineering foundation pit supporting structure is 18.85 mm, and the relative excavation depth is 0.15%, far less than the standard 40 mm requirements. We suggest that, when dealing with foundation pit excavation depth of similar proposals, apply high prestress on the anchor cable of the pile anchor structure, in order to achieve the purpose of controlling deformation. Safety standards can be reduced in similar cases to the appropriate safety standards to save cost.

References

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