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Discussion on Construction Technology of Steel Composite Supporting Body Inserted At the Top of Deep Foundation Pit Pile

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Abstract—**Based on the deep foundation pit project of a high-rise building, this paper analyzes the construction technology of vertical excavation cantilever type supporting cast-in-place pile of deep foundation pit in built-up area by combining numerical simulation with field practice, and introduces the construction technology principle and construction flow of the steel composite supporting system inserted at the top of deep foundation pit. The engineering results show that: The construction technology of steel composite support system inserted at the top of deep foundation pit piles successfully solves the difficult problem of safety in the process of foundation pit excavation, and effectively shortens the construction period, and the technology has a good application prospect. The study of construction technology can provide better guidance for similar construction of vertical excavation cantilever supporting cast-in-place pile, and help to promote the progress of foundation pit supporting construction technology.**

Key Words—**Deep foundation pit; Cast-in-place pile; Section steel; Composite support system;**

I. Introduction

In recent years, with the acceleration of China's urbanization construction, the buildings are developing towards a highly intensive level, and the traditional slope excavation has gradually withdrawn from the urbanization construction[1-3]. In response to the ground height, the depth of the underground foundation pit of buildings is also increasing day by day, and the deep foundation pit technology has developed accordingly, and the foundation pit support technology is an important content[4-7]. In the construction of deep foundation pit support engineering with dense buildings and narrow space in the city center, how to ensure the safety and economy of the foundation pit support structure and ensure the project period is an urgent problem to be solved in the construction of foundation pit engineering[8-10].

Based on this, the article combined with a high-rise building deep foundation pit project, introduces the deep foundation pit pile at the top of the insert steel composite support system construction technology principle and construction process, summarizes the important role of the construction technology in deep foundation pit construction, similar vertical excavation cantilever support system construction provide valuable construction experience.

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II. Project Overview

A high-rise building has 2 floors underground, 22 floors above ground, and the excavation depth of two basement is 10m. Engineering geology from top to bottom is ①0.4m~2.8m thick miscellaneous fill soil, ②1.0m~3.0m silty clay, ③1.3m~2.5m silt clay, ④2.5m~5.0m silty clay, ⑤0.8m~6.6m silt, ⑥3.2m~11.7m silt. The foundation pit bottom plate is located in the silty layer.

Due to the dense surrounding buildings, the large area of the foundation pit and the small site, the traditional slope excavation method is difficult to meet the requirements of the site construction. In order to strive for space and reduce the disturbance to the surrounding buildings, the project adopts the top insert type steel cast-in-place pile combined with the mixing pile foundation pit support system and vertical excavation method. At the same time, in order to avoid the safety risks of the overhang part of the support system caused by vertical excavation, the earthwork excavation is conducted before the foundation pit excavation, and the waist beam with load transfer is poured first, and then the concrete wall is sprayed, and then the crown beam construction is carried out.

III. Construction Technology Principle

The composite support system of type steel combined with mixing pile at the top of the deep foundation pit cast-in-place pile is a recyclable H-type steel inserted at the top of the foundation pit support system of the cast-in-place pile and mixing pile to form a composite support system of the top of the foundation pit with common force. The center of the displacement pile in the system is the insertion point of H-type steel. After the construction of the cast-in-place pile, the H-type steel is inserted, and the construction of the waist beam (300300mm section size) can be carried out. The construction process is closely connected and the construction progress is fast. When the lateral soil pressure on the mixing pile inside side wall, through the waist beam to H steel, make by H steel, waist beam, spray concrete and cement mixing pile stress system, the composite support system can give full play to the mechanical properties of H steel and concrete, high structure reliability, can ensure the safety of foundation pit construction. At the same time, the exposed H-shaped steel top has poured the crown beam to connect the peripheral cement mixing pile, which is safer and more economical than the traditional cantilever support pile.

IV. and for a Finite Element Analysis

4.1 Computational model

Based on ANSYS finite element software. Among them, the concrete structure adopts eight-node hexahedral unit

SOLID65 simulation, mixing pile and H-type steel adopts SOLID45 unit simulation, the waist beam is considered according to the line elastic model, where the elastic modulus E=25000MPa, Poisson's ratio v=0.167. The model grid division is shown in Fig. 1.

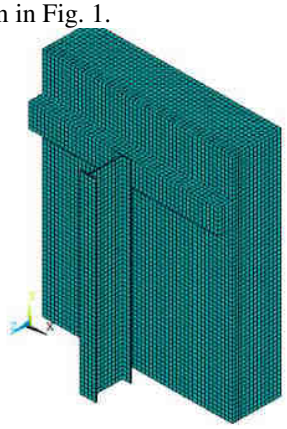

Fig.1 Model mesh division of the foundation pit support system

4.2 Analysis of the calculation results

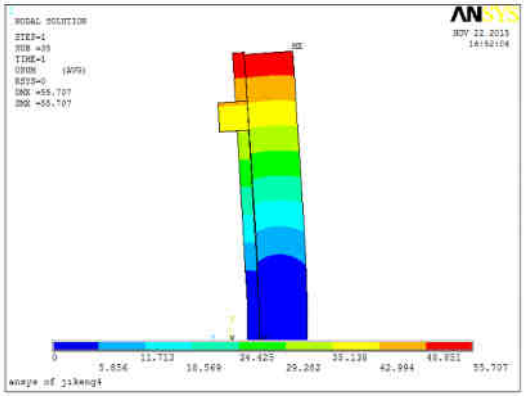

Fig. 2 Model deformation diagram of less steel foundation pit support system

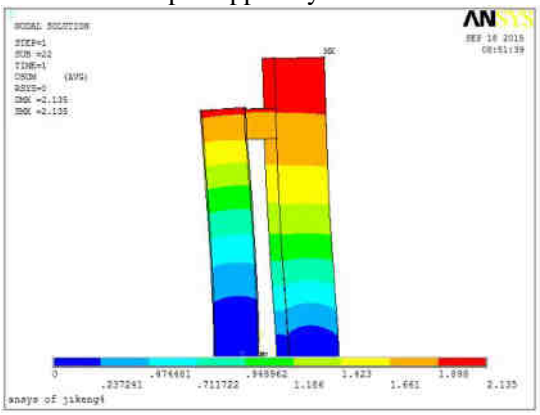

Fig. 3 Model deformation diagram of the steel foundation pit supporting system

Fig. 2 and Fig. 3 respectively show the deformation diagram of the section steel foundation pit supporting system and the section steel foundation pit supporting system under the action of lateral soil pressure. As can be seen from the Fig., the top of the maximum deformation amount of 55.707mm, the maximum deformation of the steel foundation pit supporting system is only 2.135mm, far less than the deformation of steel foundation pit supporting system, the top of the steel foundation pit supporting system is beneficial to reduce the deformation of the foundation pit, improve the stiffness of the foundation pit support system, enhance the resistance of lateral soil pressure, ensure the safety of foundation pit engineering.

With the help of ANSYS finite element software, the three-dimensional numerical model of the steel composite support system on the top of the cast-in-place deep foundation pile can simulate the structural deformation and stress distribution of the support system under the action of lateral soil pressure. At the same time, according to the spacing, dimension and detail structure of H-type steel can be adjusted. The top of the plug-in-place pile in the supporting system is equipped with H-type steel and the waist beam is poured to connect the peripheral cement mixing pile. The combination of H-type steel, the waist beam and the external cement mixing pile is used to jointly resist the lateral soil pressure, effectively avoid the potential safety risks that may occur before the foundation pit backfill, and ensure the safety of the foundation pit project.

V. CONSTRUCTION TECHNOLOGY

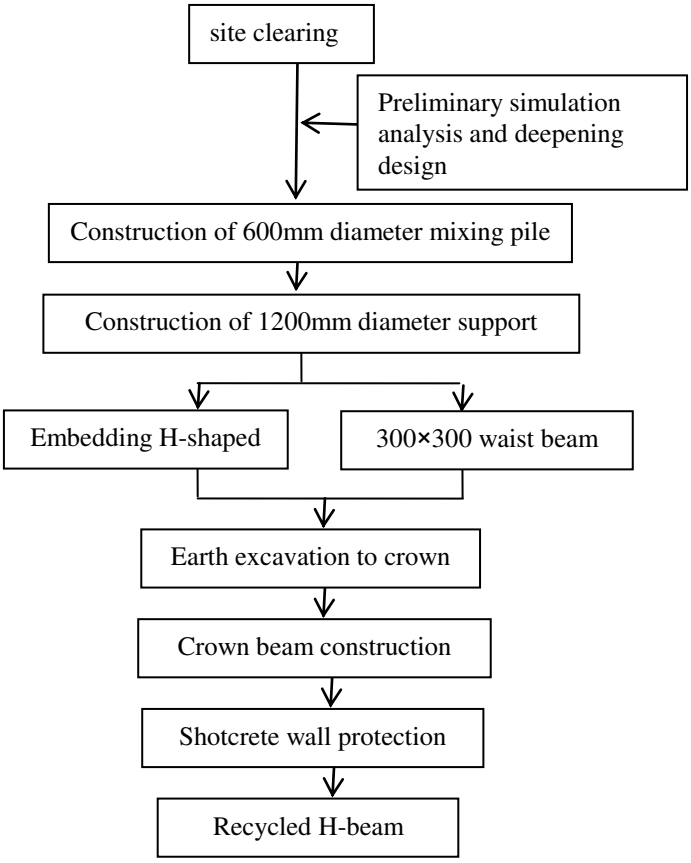

Fig. 4 Process flow chart

The construction process of the inserted steel composite support system on the top of the cast-in-place pile is shown in Fig. 4. The specific implementation steps are as follows:

(1) Construction preparation: remove the surface silt and debris in the construction area, level off the construction site, ensure the smooth and smooth road, the roadbed shall be subject to the 50t large crane, and do a good job of drainage.

(2) Construction of cement mixing pile: pile foundation positioning drilling cutting soil (while sending slurry and soil cutting) cement slurry preparation grouting mixing repeated sinking and lifting pile transfer machine to the next pile.

(3) Construction of rotary excavation and

cast-in-place pile: pile positioning drilling machine and retest the cylinder, correct the deviation between the pile position and the cylinder center, make the hole-forming steel cage and place the steel cage, fix the pouring pipe under the steel cage with the main reinforcement spot welding, and the second hole cleaning and underwater concrete cast-in-place pile pouring is completed.

(4) Precise positioning of the insertion position of H-shaped steel: after leveling the construction site, use the whole station according to the requirements of the design drawings, and position the insertion position of section steel. Use hoisting equipment to lift H-type steel in place, and check the insertion position of H-type steel to ensure the accurate insertion position of section steel. Fig. 5 shows the position review of H-type steel.

Fig. 5 Type steel position review

(5) Check the verticality of H-type steel and insert H-type steel: check the verticality of H-type steel by using the wire hammer to ensure that the deviation of the verticality of the type steel is less than 0.5%. During the insertion of H-shaped steel, the distance between the flange of the steel and the temporary positioning mark is measured. When 2 / 3 length of section steel is inserted into mud, use the tape measure to strictly control the depth of section steel inserted into mud. Fig. 6 shows the distance between the type steel to the positioning marker.

Fig. 6 measures the distance from the section steel to the positioning marker

(6) waist beam construction: when all the steel is installed in place, earthwork excavation can be carried out. After using mechanical excavation to the elevation of the bottom of the waist beam, install the waist beam template, reinforcement feeding and binding, concrete pouring, and the concrete strength grade is C30.

(7) shotcrete wall protection: after removing the side mold of the waist beam, spray 120mm concrete wall wall on the inside of the cement mixing pile in the upper part of the waist beam, with concrete strength grade C20.

(8) crown beam construction: earthwork excavation to the bottom elevation of crown beam, leveling crown beam bottom soil layer, cut loose concrete pouring pile top, and pile top all vertical reinforcement into the crown beam, into the length of not less than 50cm, with the pile cap crown beam steel welding together, clean up debris and build the crown beam side formwork, pouring crown beam and support beam concrete.

(9) Spray wall protection concrete and recycle H-shaped steel: set A 8@200200 distribution reinforcement on the side wall of the mixing pile between the top waist beam and the crown beam, and spray 120mm thick C20 concrete protection wall. After the completion of the replacement structure construction and the foundation pit backfill, the H-type steel can be recovered. Fig. 7 is a real scene photo.

Fig. 7 Real scene photo

VI. ENGINEERING FIELD MEASUREMENT AND ANALYSIS

In order to ensure the stability of the foundation pit construction of the high-rise building and the safety of the main structure, the tilt value of the supporting pile top, the horizontal displacement and the vertical displacement of the foundation pit top are tracked and monitored. The monitoring results are shown in Fig. 8, Fig. 9 and Fig. 10.

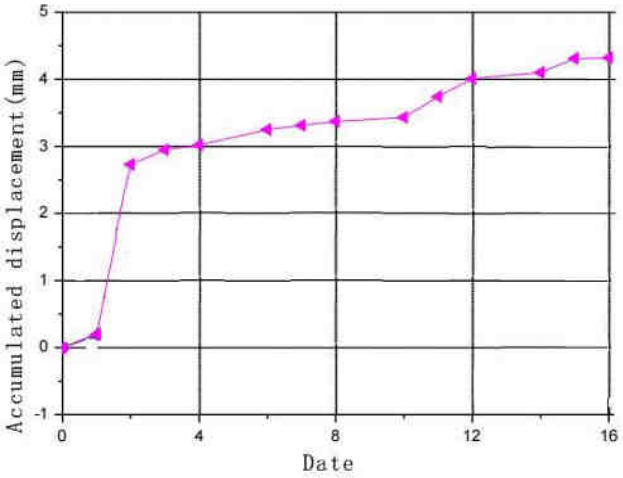

Fig. 8 lateral displacement-time relationship of supporting pile

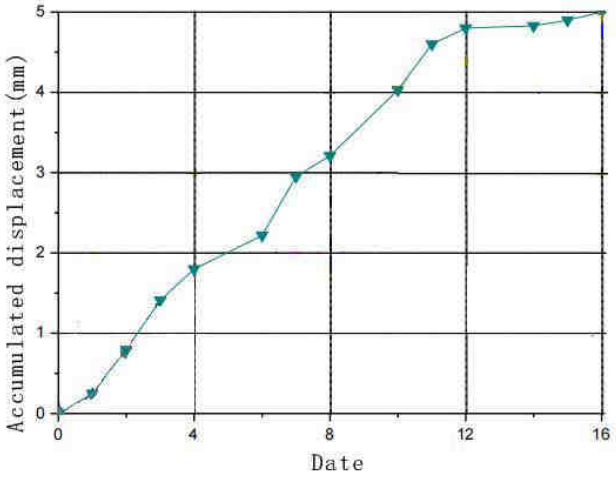

Fig. 9 Plot of the horizontal displacement-time relationship at the top of the foundation pit

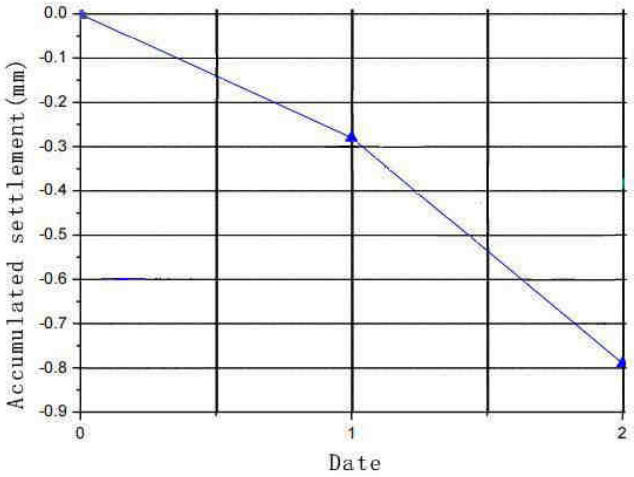

Fig. 10 Vertical settlement-time change curve at the top of the foundation pit

Fig. 8, Fig. 9 and Fig. 10 show the time change curves of the monitoring value of supporting pile top, horizontal displacement and vertical displacement, respectively. As can be seen from the Fig., the maximum change of lateral displacement of the pile is 4.32mm, the top of the top is 5.0mm, the maximum change of the vertical displacement of the top is 0.79mm, did not exceed the alarm value, indicating that the support system has been successfully applied in the kechuang building foundation pit engineering, its high reliability, not only solve the problem of safety in the process of foundation pit excavation, and effectively shorten the construction period, widely promotion significance.

VII. Conclusion

Based on the specific engineering practice, the type steel composite support system on the top of deep foundation pit is studied. The main conclusions are as follows:

(1) deep foundation pit pile at the top of the insert steel composite support system by cast-in-place pile, H steel, waist beam and external cement mixing pile combination force, can significantly improve the ability of the lateral soil pressure, effectively solve the foundation pit cantilever part before earthwork backfill possible safety problems, to ensure the safety of the foundation pit construction, at the same time shorten the time limit, reduce the construction cost, for similar vertical excavation cantilever supporting pile construction has a good guiding role.

(2) The large finite element software ANSYS is used to simulate the type steel composite support system on the top of the deep foundation pit pile, which can truly reflect the stress distribution and structural deformation of the support system under the action of lateral soil pressure, and provide theoretical guidance for the site construction.

Acknowledgments

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