Design of Quality Control Scheme for Construction Technology of Pile Foundation Engineering in Construction Projects

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Abstract
In recent years, the construction industry has achieved rapid development, and more and more attention has been paid to the investment in advanced technologies in buildings. Pile foundation engineering as an important building block, is the main construction quality control procedure of construction engineering. With the increase of pile types and the complexity of construction projects, some construction techniques of pile foundation engineering gradually faces problems as low construction quality and poor stability of buildings etc., which is not conducive to the development of the construction industry. Based on this, this paper first summarizes the related theories of pile foundations in construction engineering, and then studies in detail the design of quality control schemes for construction technology of pile foundations in construction projects in-order-to provide theoretical references for construction projects.

Keywords: Construction Engineering, Pile Foundation, Quality Control, Design.

1. RESEARCH BACKGROUND

1.1 Literature review
At this stage, with the gradual acceleration of urbanization in China, the pace of development of the construction industry is also accelerating. In this process, since the Chinese government has to vigorously alleviate the pressure of land in construction projects to solve the problem of resource shortage in its own country, the pile foundation occupies an important position in the construction process and can guarantee the overall quality of the entire construction project. The construction quality standards can be ensured if pile foundation engineering is strictly controlled (Chen, 2015). And the pile foundation construction technology plays an important role in the overall structure and stability of the construction project. In the construction project, the relevant construction unit shall select the pile foundation technology that matches with the construction technology according to the actual conditions so that the integrated construction project can satisfy the relevant project requirements, and to further ensure the overall quality of construction (Mou and Guo, 2016). In the whole construction project, the pile foundation works as the foundation of the whole building, the construction technology management and quality control of which are the key control points to ensure the quality of the construction. The discussion over the quality control methods of related technologies in pile foundation engineering can ensure the structural stability of the whole building (Sun et al., 2013). As the basic part of the construction project, it is necessary to pay attention to the improvement of construction technology and real-time monitoring of the construction process in the process of pile foundation construction in-order-to effectively ensure the quality of the pile foundation construction in the construction project and lay a good foundation to ensure the solid structure of the building (Hong and Wang, 2012). Therefore, the combination with good pile technology can lay a solid foundation for the design of buildings. According to the current situation of pile foundation construction and related programs, the design of construction and concrete engineering organizations, including the selection of materials, concrete proportion and quality control etc., and the concrete vertical mill technology is determined through design to make the entire construction process to meet the design and production requirements, which are conducive to the improvement of construction efficiency (Zhou and Sima, 2011).

1.2 Research purposes
At present, there are many choices over different forms of pile foundation for construction projects. In the course of selection, the bearing capacity and deformation effect of pile foundation are generally required to be focused. In general, large-diameter pile foundation has the advantages of good carrying capacity and good construction
quality, which can effectively improve the economic benefits of construction (Jiang et al., 2003). Under construction background, according to the pile foundation inspection program, the core inspection is carried out. It is found that if the compressive strength of the pile foundation cannot meet the need of engineering design, the core needs to be expanded and verified to further verify whether the same situation exists to ensure the orderly progress of the project (Yu et al., 2016). With the extensive application of pile foundation engineering in the field of construction, some construction units often cause some quality problems in construction projects for some reason. In view of the key points of pile foundation technology, the frequently encountered problems in pile foundation engineering and the causes of these problems are analysed and then some suggestions about quality control are put forward according to causes, which can effectively solve some problems in construction engineering (An, 2011). It is helpful to monitor the quality of the project by analysing the process of pile foundation in construction, and discussing the influence of some factors in each process on the pile foundation, and then putting forward the key control points in the construction technology of pile foundation construction technology (Liang and Guo, 2013). With the development of modern technology and urbanization, in order to improve the construction level of construction projects, the construction department gradually sets new requirements for pile foundation engineering to ensure the quality of pile foundation construction (Li, 2014). Therefore, this paper studies the fact that in the construction project, the design of quality control program for construction technology in pile foundation is of great significance.

2. BASIC CONCEPT DEFINITION OF BUILDING PILE FOUNDATION

In recent years, with the advancement of science and technology and the development of high-rise buildings, high-rise buildings continue to emerge in various cities. In the overall structure of high-rise buildings, seismic resistance and overall stiffness, as the main indicators to ensure the stability and safety of building structure, play an important role. Construction pile foundation mainly refers to the pile foundation used in high-rise buildings. Before construction, general construction personnel need to use pile foundation in advance to fix the whole structure of the building, and then add some concrete on the basis of pile foundation, and finally connect into a whole building structure. At present, pile foundations with more use on the market mainly include concrete prefabricated pile foundation, reinforced concrete pile foundation, perfusion pile foundation and pre-stressed concrete pile foundation. In the structure of the building, fake pile is relatively common. In the actual construction process, if the materials and types of the pile are not fully considered, there will be a great problem in the structure and the stability of the building, which not only affects the normal use of the building, but also leads to great risk to personal security. Therefore, in practical applications, its closure needs to be calculated, and the following formulas for quasi-closed solutions are used to calculate it.

\[ R_e = \frac{1}{2} (1 - J_c) \cdot \left[ F(t_1) + Z \cdot V(t_1) \right] + \frac{1}{2} (1 - J_c) \cdot \left[ F \left( t_1 + \frac{L}{c} \right) + Z \cdot V \left( t_1 + \frac{L}{c} \right) \right] \]  

\[ Z = \frac{E A}{c} \]  

In the above formula, \( R_e \) mainly represents the pile's compressive carrying capacity; \( J_c \) mainly represents the relevant resistance coefficient; \( t_1 \) mainly represents the corresponding time at the peak velocity; \( t_1 \) mainly represents the building's hammering force; \( V \) mainly represents velocity of particles corresponding to pile foundation; \( Z \) mainly represents the mechanical resistance of pile; \( A \) mainly represents the cross-sectional area of pile material; \( L \) mainly represents the length of the pile. Calculating the bearing capacity of pile foundation according to the above formula is helpful to prevent the unfavourable influence on the building due to the poor pile structure. After the calculation, if the relevant requirements are met, the following construction procedures can be entered, which needs to compare the pile foundations with different bearing capacity. The comparison formula is as follows:

\[ Q_{ak} = u q_{ak} l + q_{ak} A_p \]  

In the formula, \( Q_{ak} \) mainly represents the bearing capacity standard of a single pile foundation; \( q_{ak} \) mainly represents the resistance standard of the pile foundation in a certain layer of soil; \( q_{ak} \) mainly represents the resistance standard of pile foundation; \( l \) mainly represents the thickness of pile foundation in crossing a certain soil; \( A_p \) mainly represents the area of the bottom of the pile; \( u \) mainly represents the total length of the pile. Then, further calculation of the spiral reinforcement of the pile foundation is calculated, and the main formula is as follows:
The total length of pile helix:

\[ I = 2000na/p \times \left[ 1 - \frac{e^2}{4} - \frac{3}{64(e^2)^2} - \frac{5}{256(e^2)^3} \right] \]  

(4)

The calculation formula of pile foundation spiral rib length in the worksheet:

\[ INT \left( \frac{a^2 + D^2}{4} \right) = \frac{4a^2 - D^2}{(4a^2)D} \]  

(5)

Elliptical pile length = \( \sqrt{h^2 + [(\pi D + 2p)n]^2} \)

According to the above formula, after determining the relevant parameters of the pile foundation, you can determine the type of pile foundation and the area of the bottom of the pile in the building. In practical applications, the pile foundation is generally divided into the following three types according to the diameter: firstly, when \( d \leq 250 \text{mm} \), the pile foundation used is a small diameter pile foundation; when \( 250 \text{mm} < d < 800 \text{mm} \), the pile foundation used is a medium diameter pile foundation; when \( d \geq 800 \text{mm} \), the Pile foundation used is the largest diameter pile. If the soil in construction environment is relatively sparse, and requirement on noise in the construction is not high, you can use hammer pile when there is a large number of piles. In addition to satisfying the above construction conditions, the pile foundation used in the construction can also guarantee to offset the problems of high cost and difficult delivery of pile foundations in the construction process, and ensure the economic benefits of the construction project under the condition of ensuring the structural safety of the building.

3. DESIGN OF QUALITY CONTROL SCHEME FOR CONSTRUCTION TECHNOLOGY OF PILE FOUNDATION ENGINEERING IN CONSTRUCTION PROJECTS

3.1 Determining design process and related parameters

Based on the above analysis process, it is found that in the design of quality control scheme of pile foundation construction technology, the construction pattern is mainly compiled, the flow of construction procedure is predetermined, and the pile foundation application program in building is prerequisite for ensuring construction safety. Construction technology quality control guidelines lay a good foundation. In determining the main process of pile foundation construction in the construction process, the bending of the steel in the pile need to be measured; the specific measurement formula is as follows;

Measurement difference\( = \text{outsourcing size-axis size} = (A'B' + B'C') - ABC = 2 \left( \frac{D}{2} + d \right) \tan \frac{\alpha}{2} - \pi(D + d) \frac{\alpha}{360} \)

Added value of end hook\( = \text{straight segment+arc section} = \frac{D}{2} + d = 3d + \frac{\pi}{2}(D + d) - \left( \frac{D}{2} + d \right) = 6.25d \).

According to the above formula analysis, it is not difficult to find that after calculation, the bending diameter of the steel bars in the pile foundation shall not be less than 5 times of the overall diameter of the steel bars. The range of the steel measures of different foundations is shown in Table 1. And the diameter of curved section of steel bar shall not be less than 2.5 times of the overall diameter of steel bar.

<table>
<thead>
<tr>
<th>Bending angle of steel bars in pile foundation</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>range of steel bar measures</td>
<td>0.35d</td>
<td>0.55d</td>
<td>1d</td>
<td>2.5d</td>
</tr>
</tbody>
</table>

Table 1 Measurement Range of Foundation Steel in Pile Foundation

The mutual cohesion of pile foundation and concrete is the main process in the construction process. Before construction, computers shall be used to calculate the coordination degree of different concrete so as to ensure the quality and safety of high-rise buildings. Among them, the coordination strength of concrete and pile foundation shall be calculated according to the following formula:

\[ f_{cu} \geq f_{cm} k + 1.645\sigma \]  

(6)
Among them, $f_{cu,k}$ mainly represents compressive standards of the concrete in buildings; $σ$ mainly represents strength standards of the concrete used in building. At the same time, the water cement ratio in the pile foundation cement is calculated, and the calculation formula is as follows;

$$W/C = \frac{a_f f_{cc}}{f_{cu,0} + a_f a_b f_{cc}} \tag{7}$$

In the above formula, $a_f$ mainly represents the value of the regression coefficient of the materials used in the building, $f_{cc}$ mainly represents the actual value of the compressive strength test of the cement used in the building. If the actual test value of cement cannot be determined due to limitations of conditions, the following formula can be used to determine the value of its test.

$$f_{cc} = γ_c \cdot f_{cc,0} \tag{8}$$

After the water-cement ratio is determined, the amount of cement used in the construction can be determined according to the actual situation. The calculation formula is as follows.

$$m_{c0} = \frac{m_{eq}}{W/C} \tag{9}$$

In high-rise buildings, if the amount of cement used is less than the corresponding standard requirements, the relevant construction personnel will be required to make corresponding adjustment to the amount of water and gravel according to national standards. However, in the use of gravel, the amount of gravel must be calculated, and the formula is as follows.

$$m_{c0} + m_{g0} + m_{i0} + m_{w0} = +m_{cp} \tag{10}$$

$$β_i = \frac{m_{i0}}{m_{g0} + m_{i0}} \times 100\% \tag{11}$$

In the above formula, it is required to collect statistics on the amount of cement, the amount of coarse aggregate, the amount of fine aggregate and the amount of water used, and then determine the proportion of gravel in the building material and then determine the total weight that shall be used per cubic meter.

### 3.2 Design of quality control scheme for construction technology of pile foundation engineering in construction projects

In the construction project, the quality control of the pile foundation engineering technology guarantees that the general design of the construction project conforms to relevant standards and meets the key technology of engineering operation. Quality control system is the main management behaviour of engineers to make judgments, decisions and amendments in construction engineering and technical operation. The quality control method of the engineers is mainly to ensure that the product features used in construction comply with the standards, and can also be used for the related supply and demand analysis and the formulation of the structural design indexes of the building. In the quality control of building design, it mainly includes two aspects: the quality control of work and the quality control of materials used in building engineering in the process of building design. Among them, in the aspect of quality control, in addition to controlling the process flow and standardization of the construction process, it is necessary to control the work efficiency of the construction and require real-time monitoring before construction, during construction and after construction so that the corresponding construction technology can meet the standard requirements. In quality control of construction materials, it mainly requires the relevant quality control personnel to control the construction materials, instrument and equipment in the construction process, not only requiring the use of materials in the building comply with the relevant standards but also requiring the corresponding instrument operation not pose any threat to operators, thus contributing to the implementation of the entire project design and quality plan. In the specific operation, the entire quality control system in the construction project is shown in Figure 1.
Figure 1. Quality Control System

As is shown in Figure 1, throughout the construction project, the pile foundation project mainly begins with the examination and approval of the contract. In the process of approval, the relevant personnel are required to strictly determine the structure and materials used in the project, including determining the contract of use with the relevant material manufacturing enterprises and requiring that their conveyance of materials must meet the domestic or inspection and quarantine certificate. After the contract is confirmed, the engineer shall plan the entire construction process, design the planning process and the construction process accurately, and then proceed to purchase the related materials. After the procurement is completed, the construction can be carried out. During construction, a safety officer is required in each construction site to monitor the entire construction safety and ensure the overall construction safety. And in the construction process, inspections and tests shall be carried out on relevant processes to ensure that the materials used meet the corresponding standards. When all the processes are over, the entire construction process has been completed. At this moment, the quality personnel are required to conduct the acceptance inspection of the construction project. If there are some detail problems, the maintenance service shall be provided correspondingly to ensure the stability of the building structure and ensure the safety of the corresponding personnel. At the same time, as Figure 2 shows that in the entire quality control system, it is of great significance to the long-term social stability to have not only effective monitoring of the construction process, but also the strict control of the key control points in the construction process to ensure the safety of construction workers in the construction process, and guarantee the safety of users after the construction process.

4. CONCLUSION

In a word, the analysis of the relevant theoretical overview of the pile foundation in the building, and then the design of the pile foundation construction program in the building, helps it possess great application value in the field of related construction and effectively solve some quality problems in the construction process. Some key control points in the construction process can be effectively monitored and greatly promote the improvement of construction efficiency. This also makes the pile foundation construction technology have a great development prospect in the construction project and can effectively guarantee the stability of the building structure and the safety of its use.

REFERENCES