Construction Technology and Quality Control Measures of Cement Mixing Pile in Water Conservancy Project

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Abstract: In modern society, with the rapid development of science and technology and the in-depth utilization of natural resources by human beings, as an important part of infrastructure construction, water conservancy projects are increasing in scale and complexity. As an advanced construction method, cement mixing pile technology plays a vital role in ensuring the stability and safety of water conservancy projects. Cement mixing pile can effectively improve the bearing capacity and seismic performance of foundation by injecting cement slurry into soil, mixing it with soil and curing it. Based on the analysis of the meaning of cement mixing pile technology and the key contribution of cement mixing pile during construction, this paper discusses the construction technology of cement mixing pile, and puts forward measures to control the construction quality of cement mixing pile in water conservancy projects. It is hoped to improve the construction quality of cement mixing piles and provide strong technical support for the sustainable development of water conservancy projects.

Keywords: water conservancy project; cement mixing pile; construction quality; improvement measures

With the rapid development of our society, the number of water conservancy projects is increasing, and the water conservancy cause is also booming. In various hydraulic engineering technologies, cement mixing piles are widely used because of their high efficiency [1]. This technology takes cement as the main curing agent, and strengthens the soft soil foundation by mixing process, thus improving the bearing capacity of the foundation. Facing the threat of flood, the standard of flood control safety has also been improved. Cement mixing pile technology not only optimizes the engineering quality, but also realizes the dual advantages of cost-effectiveness, improves the construction efficiency, ensures the safety of construction, and brings remarkable economic benefits and social values to the construction unit [2].

1 Cement Mixing Pile Technology Overview

The inherent coagulation and solidification characteristics of cement make it an excellent curing agent. In the process of construction, it is necessary to equip special mixing machinery. When drilling, especially in soft soil, cement-based slurry will be injected into the soil layer by pouring or spraying, and the soil layer and pile structure will be firmly combined to build a more stable foundation by using the coagulation and solidification ability of cement. This not only significantly improves the

viscosity and strength of soft soil layer, but also makes the foundation structure have better compressive capacity and strength standard, thus ensuring the foundation construction quality to meet the design specifications and requirements. This is not only an efficient construction method, but also a key reinforcement technology for soft soil foundation treatment.

In the foundation construction of water conservancy projects, we are faced with complex foundation challenges. These construction operations are extremely difficult, and strict and even harsh requirements are put forward for construction technology and ability. Cement mixing pile technology is designed to solve the technical problems encountered in foundation construction of water conservancy projects. Its unique construction methods and strategies can ensure that the pile structure is tightly fixed with the soil layer in contact, so that all kinds of stresses and forces are evenly distributed in the soil layer and pile body. As a comprehensive foundation treatment method, this technology can effectively deal with various unfavorable conditions and potential risks, ensure the stability and safety of the foundation, improve its compression resistance, strength and bearing capacity, and prevent collapse or collapse accidents caused by foundation deformation. At present, cement mixing pile technology has been widely used in many water conservancy projects, especially in the face of complex soil layer geology, such as clay or silty soil layer, showing its excellent construction ability.

2 The Role of Cement Mixing Pile in Water Conservancy Construction

In the construction of water conservancy projects, cement mixing piles play an indispensable role in the following three aspects:

2.1 Improve Construction Safety and Efficiency

In the field of water conservancy projects, the requirements of construction quality and safety are extremely demanding, not only to ensure the safety of construction personnel, but also to ensure the smooth and stable progress of the project. Using cement mixing pile technology to replace the traditional supporting structure construction method has greatly improved the performance and stability of the supporting structure and effectively guaranteed the safety and stability of the construction site. By using various curing agents and additives, cement mixing pile technology can meet diversified construction needs, maintain a high level of construction efficiency and quality, thus shortening the construction period, speeding up the project progress and reducing the possibility of problems.

2.2 Simplify the Construction Process

Cement mixing pile construction technology provides an efficient and simplified scheme for foundation and foundation pit construction. This technology reduces the need of traditional supporting structure and anchor pulling, and ensures the stability and safety of construction. Cement mixing pile effectively prevents water infiltration and related erosion damage, and eliminates the necessity of dewatering process. In addition, this method enhances the waterproof and seepage-proof performance of the foundation and the main structure, and greatly reduces the safety risks in the construction process.

2.3 Improve the Flexibility and Adaptability of Construction

The construction technology of cement mixing pile shows its flexibility in adjustment and improvement, and adapts to the increase of construction difficulty and the improvement of engineering construction intensity. With the change of construction conditions, this technology can effectively adjust the construction mode and method, and ensure to meet the requirements of the design scheme by adopting more suitable treatment measures and matching strength grades. The flexibility of cement mixing pile is that it can be adjusted in depth and width according to needs, which is very suitable for the construction needs of complex foundation of water conservancy projects. In addition, cement mixing pile technology can also cooperate with various practical reinforcement and stability measures to effectively improve the safety and quality level in the construction process.

3 The Main Content of Cement Mixing Pile Construction Technology in Water Conservancy Projects

Cement mixing pile construction technology plays an important role in the current construction of water conservancy projects, which effectively promotes the smooth progress of the construction process and is of key significance for significantly improving the construction quality and efficiency.

3.1 Construction Positioning and Pile Test Execution

Construction positioning is the basic step to ensure the accurate position of cement pile and reduce the risk of engineering quality. Cement mixing pile depends on the accurate measurement of pile position by technicians. When carrying out construction positioning, we can use a variety of modern scientific and technological tools and measuring methods to minimize common errors and ensure the smooth progress of the construction process. At the same time, pile testing is the key measure to confirm the effectiveness of construction technology. Before the large-scale cement pile construction, the pile-forming test of cement mixing pile shall be carried out according to the design requirements, and usually no less than 5 test piles are required. Through the comprehensive analysis of the test pile results, key technical parameters, such as drilling speed, mixing speed and lifting speed, can be obtained, which provides important data support for the actual construction and lays a solid foundation for the subsequent mixing and grouting processes [3].

3.2 Deep Soil Mixing Pile Construction Technology

In water conservancy projects, it is a method to use cement or other curing agents to mix with soil through deep mixing technology to form a solidified structure similar to cement columns. The implementation of this technology is based on the standards of civil engineering and waterproof construction technology at home and abroad, including cement slurry mixing, cement powder mixing, concrete column reinforcement and high-pressure rotary jet mixing. When selecting suitable deep mixing equipment for soil, it is necessary to consider the collocation of deep mixer, curing agent and lifting equipment, as well as the diameter of foundation, construction depth and other factors to meet the needs of different projects. The construction process includes key steps such as positioning, centering, mixing and

cutting soil to ensure the construction quality and efficiency.

3.3 Preparation and Preparation of Cement Slurry

The preparation of cement slurry is to mix cement with water in a certain proportion to form a slurry suitable for construction. In the construction process, when the deep mixer reaches the set depth, the cement slurry should be poured into the mixing container for full mixing to ensure its uniform mixing. As the mixer moves down and reaches a predetermined depth, the cement slurry is injected into the soil by a specific spraying technology to form a solid supporting structure. In the process of construction, the mixer needs to be stirred and lifted repeatedly at a predetermined speed to ensure the uniformity of the mixture. In the preparation stage of cement slurry, it is necessary to clean the mortar pump to remove the residual soft soil on the mixing head, so as to avoid affecting the quality of subsequent cement piles and ensure the smooth construction.

3.4 Cement Mixing Pile Construction

In the construction of water conservancy project, it is the key to improve the construction quality to make rational use of cement mixing pile technology, give full play to cement characteristics and accurately manage the construction process. The first task is to ensure the quality of pulping. According to the designed water-cement ratio, the cement slurry is prepared to ensure that the slurry meets the construction standards. The prepared slurry needs to be continuously stirred to maintain its stability, avoiding separation or standing for a long time, and the use grade of slurry exceeding 2 hours should be adjusted. When the slurry is added to the aggregate, it needs to be screened to prevent agglomeration. It is very important to control the process of pumping slurry. Before starting construction, it is necessary to ensure that the pipeline is wet and keep the pump pressure stable during pumping. Finally, it is necessary to control the quality of piles in an all-round way. Electronic automatic recording method is adopted to accurately record the drilling and re-stirring depth of drill pipe [4].

3.5 Quality Evaluation of Mixing Piles

After the completion of cement mixing pile construction, it is extremely important to evaluate its quality in time. According to the length and diameter of the pile, the uniformity of shotcrete and the sampling intensity in the repeated mixing area, the quality grades of the pile are judged, including excellent, qualified and unqualified grades. Through the scientific evaluation method, the construction effect of cement mixing pile technology can be ensured, and then the overall construction quality of water conservancy projects can be improved, providing a solid foundation for the success of the project [5].

4 Cement Mixing Pile Construction Quality Control Measures in Water Conservancy Projects

4.1 Quality Control Measures Before Construction

In order to ensure the quality of water conservancy project construction, the construction team must make comprehensive preparations before the project starts. This includes selecting the appropriate construction technology according to the specific needs of the project to ensure the smooth progress of the

construction schedule and process. The construction team needs to strictly control the quality of raw materials entering the site, carry out standardized management and inspection of every operation step and detail on the construction site, and verify the performance of construction equipment, so as to improve the construction quality of the whole project.

4.1.1 Quality Control of Construction Raw Materials

The quality of raw materials directly affects the reliability and safety of the whole construction process. In water conservancy projects, the key raw material for cement mixing pile construction is cement. Therefore, in the quality management of raw materials, we should choose high-quality cement that meets the construction requirements. This requires the personnel in charge of purchasing to give priority to high-quality cement when selecting cement, and ensure that the quality control report of cement and the certificate of the manufacturer are strictly audited to ensure that the quality of cement meets the construction requirements. Before cement enters the construction site, the person in charge shall conduct sample sampling and quality testing when necessary to ensure that the performance and strength of cement meet the construction standards. At the same time, the storage of cement should be arranged reasonably to ensure that the supply matches the construction demand, avoid the waste of resources and promote the smooth progress of the project.

4.1.2 Construction Site Quality Management

The preparation before construction must pay attention to the quality management of the construction site. This means that the construction team needs to devote themselves to monitoring the site quality during the construction of cement mixing piles, so as to ensure the smoothness of the construction site to meet the construction requirements, and then minimize its potential impact on the project quality. When the construction management team performs on-site quality monitoring of cement mixing pile operation, it should reasonably plan the access path of construction equipment, so as to facilitate equipment operation and reduce the access time of construction equipment. At the same time, according to the national standards, the temporary power supply at the construction site shall be maintained and protected, so as to ensure the safety of power supply, support the smooth progress of construction activities and prevent the influence of power facility failure on construction progress and efficiency.

4.1.3 Quality Control of Infrastructure Before Construction

The application of cement mixing pile technology plays a vital role in construction, and its performance and operation efficiency directly affect the construction quality of mixing pile. In the application of this technology, the pile driver is the core equipment, and its quality directly determines the success or failure of construction. Therefore, before the start of construction, the performance of the pile driver must be strictly checked, including the condition of the drill bit regularly to ensure that the size and length of the drill bit match the design standard. In addition, strict control and maintenance are carried out on the pipeline quality of the pile driver to prevent quality defects caused by cement slurry transmission problems in the construction process, especially to prevent the pipeline from leaking slurry and being blocked by cement, so as to ensure the quality and stability of the structure.

4.2 Quality Control Measures in the Construction Process

4.2.1 Conduct Operation Test of Mixing Pile in Advance

In the actual construction of water conservancy projects, technical pile testing is a crucial step. This means that the cement mixing pile must be tested according to the specific needs of the project before the construction of the cement mixing pile is officially started. This can provide scientific basis for cement consumption, mixing speed and drilling position. According to the actual situation of the project, the technical process of "four mixing and four spraying" can be adopted to ensure the construction quality of cement mixing piles to meet the design standards.

4.2.2 Control the Quality of Cement Slurry

During construction, the staff should always pay attention to maintaining a proper water-cement ratio to ensure the proportion of cement slurry and its uniformity and stability after use. According to the national code for construction of water conservancy projects, if the cement slurry is not used after 2 hours of mixing, the usage should be reduced as much as possible and the unused cement slurry should be treated, and the residue should be prevented from caking through screening and filtration to maintain the structural quality.

4.2.3 Precise Control of Construction Technology

In the construction of water conservancy projects, it is very important to accurately calculate and set construction parameters, including accurately calculating and setting construction parameters, such as hoisting process, slurry delivery speed and the time when slurry arrives at the injection port. Before starting the mixer, the working conditions should be adjusted to prevent slurry and soil from blocking the pipeline, and it is recommended to use clean water for pre-cleaning. According to the construction requirements, finely adjust the speed and time of mixing and spraying to ensure the accuracy of operation. A special person shall be appointed to record the lifting process of the mixer, so as to ensure the stability of the rising and falling speed, and ensure that the time error is controlled within 5 seconds and the depth error is not more than 100mm.

4.3 Quality Control Measures After the Completion of Construction

Quality management after the completion of construction is also very important. The design unit should detect the thickness of the pile by light dynamic penetration test within 1 to 3 days at the end of the pile, and the frequency is set at 5%. Whether the pile top resistance is up to standard is evaluated by the number of hammering within 30 cm. If the measured hammering times meet or exceed the preset times, the pile top resistance meets the requirements; Otherwise, it is judged as unqualified. Sampling and inspection of core samples should be carried out 28 days after the completion of construction, so as to evaluate the jet uniformity, thickness, integrity and length of cement mixing piles.

The bearing capacity of composite foundation should meet the design requirements. The evaluation value of a single pile should be higher than that of the second-class pile, and according to the standard, the first-class pile should account for more than 80% of the total proportion, so as to ensure that the bearing capacity of the foundation meets the requirements and the construction quality is at a good level; If the evaluation value of a single pile exceeds the

second-class pile, but the proportion of the first-class pile only exceeds 60% and meets the requirements of foundation bearing capacity, the construction quality is considered as qualified. The criteria for judging pile quality grade are shown in Table 1.

Table 1 Criteria for Determining Pile Quality Grade

Pile quality grade	First-class pile (excellent)	Secondary pile (qualified)	Tertiary pile (unqualified)
Length and diameter of pile body	comply with the requirements	comply with the requirements	Do not meet the requirements
Spray uniformity	well-distributed	Partial non-uniformity	irregular
Pile crack	without	Seamless crack	Have a fracture
Re-mixing section core	Complete continuity	complete	Loose and inconsistent
Column core sampling rate	Above 80%	More than 65%	Less than 65%
Compression regularity	rule	rule	irregular
Standard penetration blow count	comply with the requirements	comply with the requirements	Below the design requirements

5 Conclusion

With the continuous expansion of the scale of water conservancy projects, related technologies and development strategies are gradually optimized in the evolution. Battery mixing construction technology is a hidden work in waterproof engineering. If its structural quality is defective, it may become a potential hidden danger and it is difficult to control and repair it effectively. Therefore, it is particularly critical to comprehensively deal with the actual situation in the construction process, formulate accurate construction specifications and ensure that the quality of each construction link is strictly controlled. Adhering to strict quality control at every step of construction is the cornerstone to ensure the quality and safety of the project.

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