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Quality Control Measures of Bored Pile in Bridge Construction

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Abstract: In order to improve the quality of bored piles in bridge construction and ensure the overall quality of the bridge, we analyzed a series of problems in the construction process of bored piles, then propose corresponding quality control measures, in hopes of improving quality control of bored piles in bridge construction in our country.

Keywords: Bridge construction; Bored pile; Quality control

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1. Introduction

Before the construction of bored piles, technical training with the development of social economy, bridge engineering occupies an important position in construction engineering. The quality control of bored piles in bridge engineering is a highly specialized job, which needs to be carried out in strict accordance with relevant standards throughout the construction process. Therefore, the requirements for bored piles quality control for are very strict.

2. Characteristics of bored piles

2.1. Deep foundation form of bored pile

With the development of our country's national economy and the development of engineering, the volume of buildings is also increasing, so the bearing capacity of the foundation is becoming increasingly important. In many construction projects, deep foundation pits are usually created to ensure the safety of the building. Especially on soft grounds in our country, foundation pits are an indispensable element of building construction. Pile foundation is currently the most widely used foundation in civil construction technology in our country, with the most common type being bored piles. In construction, bored pile foundations are usually used as a bearing pile foundation, and it can also be used as an uplift pile foundation, and it plays a dual role in construction. Compression piles are usually built on relatively hard strata such as bedrock and gravel layers and has high requirements of the load-bearing layer.

2.2. Advantages and disadvantages of bored pile method

2.2.1. Advantages of bored pile method

(1) The bored pile method is versatile, it can be used on soft and hard grounds, and can improve the construction effect. (2) In terms of pile hole selection, the longer the length and diameter of the bored pile, the stronger the relative bearing capacity. (3) The pile body has good bending resistance and can meet the requirements of large loads. (4) The pile body has good bending resistance and can withstand heavy loads.

(5) The bored pile method is a more advanced and complex technology, has better construction conditions, and requires less equipment. Bored piles can be installed by using ordinary engineering without additional equipment.

2.2.2. Disadvantages of bored pile method

(1) In bridge engineering, due to the constraints of various conditions, problems such as diameter expansion, diameter reduction and pile breakage may occur. (2) On the basis of end-bearing piles, when the foundation is used as the bearing layer, it is difficult to effectively control the sediment at the bottom of the pile, which severely restricts the bearing capacity of the pile. (3) Because the construction of the cement layer of the side wall of the pile body is very difficult, if the quality of the cement layer of the side wall is not up to standard, the lateral tensile performance of the foundation will be reduced, which will seriously affect the overall foundation. Slippage will occur when encountering slopes and high-level soil; in the process of drilling, the mud retaining wall of bored piles has a great impact on the surrounding environment.

3. Problems in the construction of bored piles

The construction of bored piles is a relatively important task in bridge construction, and strict quality control is required throughout the whole process. However, due to the many problems encountered during the construction of bored piles, it is difficult to guarantee the quality of the project. For example, problems such as broken piles, presence of silt, shrinkage cavity, and excessively thick pile bottom sediments. As a result, the quality of bridge engineering has been affected to a certain extent, so it is necessary to carry out corresponding quality control measures to ensure that the construction quality of bored piles is improved. Specifically, there are two main reasons for broken piles during the construction process: firstly, there is too much sediment on the top of the pile due to mechanical operation errors; secondly, the wall of hole collapses due to shrinkage cavity while drilling. These reasons can be analyzed from the aspects below.

3.1. Mechanical operation errors leading to excessive sediment on the top of the pile

In the process of bridge construction, if the equipment is not operated correctly, the problem of excessive sediment will appear at the top of the pile. For example, when pouring concrete, the vibrating rod is not placed in the correct position, causing the conduit to be buried too deep in the concrete, which will cause the distance between the pile concrete and the conduit to be too large, resulting in too much sediment on the top of the pile. The second example is when the underwater concrete is poured, the depth of the catheter insertion is not enough, resulting in too much sediment on the top of the pile. Therefore, in the process of bridge construction, it is necessary to strengthen the training of equipment operators, so as to ensure that the construction quality can be improved.

3.2. Shrinkage occurs when drilling

In the construction process of bridges, due to the high fluidity of bored piles, a certain degree of shrinkage might occur during the drilling process, and this problem will lead to the collapse or caving of the wall of hole, which will affect the construction quality of the project. Shrinkage is mainly caused by insufficient pressure during the drilling process or that the incorrect proportion of mud, which hampers the process of drilling. The solution to this problem is to increase the mud density or adjust the drilling pressure. In addition, the shrinkage cavity can also be reduced through the following way: one is to make preparations before the drilling of the hole, including measurements, equipment installation, and many more; the other is to strictly control the proportion of mud, mud density and the drilling pressure during construction; the third way is to check the drilling rig regularly, and repair it in time if any problems are found [1].

3.3. Inclined pile hole

Inclination of the pile body is a common problem. When forming a pile, displacement of the pile in the hole makes the installation of the pipeline is difficult, resulting in the settlement of the steel pipe. Therefore, the reason for this problem is due to the fact that the hole is too tilted which happens when the relevant regulations and operating standards are not followed [2].

3.4. Concrete buried pipe problem

If the concrete is not poured in the correct way, it will cause difficulties in lifting the pipeline [3]. To prevent this from happening, when the pipe is buried, it is necessary to regularly pull out the casing, which can reduce the risk of the pipe being buried, thereby solving the problem of buried pipes. In addition, when lifting the pipeline, care should be taken to prevent the flange edge of the pipeline from hanging on the steel cage, so that the problem of buried pipeline can be prevented.

4. Quality control measures during construction

4.1. Construction preparation

Training should be given to relevant personnel to ensure that they fully understand the construction plan and technical points, and can only work after passing an examination and obtaining a qualification certificate. During the construction of bored piles, drilling should be carried out according to the design drawings and the construction plan. The center of the hole position should be used as the reference point. After the drilling is completed, it is necessary to check the verticality of the hole before proceeding to the next process. When checking and accepting the pile holes, it is first necessary to strictly measure the position, diameter, depth, and other related parameters of the hole. During the drilling process, the standard operating procedure must be strictly followed, and the aperture, depth, and inclination must be measured every 3 meters or so. In addition, relevant data such as the specific gravity and viscosity of the mud should be tested to ensure that the relevant requirements are met [4-6]. After the bored pile is completed, the conduit is buried in the concrete at the pile end. For the embedment of conduits, it is necessary to select the appropriate conduit specification and buried depth depending on the actual situation during the construction process. When the specific gravity of the mud reaches about 1.2, the conduit should be lowered to 3–5 m in the mud. In the process of pouring concrete, related indicators such as its elevation and verticality must be strictly controlled to ensure that the design requirements are met.

4.2. Manufacture and installation of steel reinforcement cage

The steel reinforcement cage must be constructed in strict accordance with the design drawings to ensure that the centerline of the steel reinforcement cage is consistent with the centerline of the pile position, with appropriate spacing and thickness of protective layer. The steel reinforcement cage should be constructed using a Computer Numerical Control machine. After it is built, inspection should be carried out in time, and any unqualified parts should be rectified in time. After the steel reinforcement skeleton is processed, it must be connected to ensure that its connection is firm. After the connection is completed, the steel reinforcement cage must be installed in accordance with the relevant specifications and design requirements. The overlap processing technology should be used when installing the steel reinforcement cage, and the length of overlapping should reach 50 cm. The welded overlapping parts shall be inspected to ensure that their quality meets the design requirements. After the steel reinforcement cage is installed, it will be hoisted to the ground for placement. During the process of lowering, the cage should be kept vertical, and after it is lowered to the designed elevation, some adjustments will be needed to make its height consistent with the designed elevation [7,8].

4.3. Underwater concrete pouring

When pouring concrete, construction personnel must strictly follow the relevant regulations to ensure that there will be no grout leakage during the pouring process. The depth of the conduit inserted into the concrete must meet the design requirements, and the conduit should be lifted time to time according to the actual situation. When the concrete pouring height reaches 1.5 meters, it is necessary to stop lifting the conduit and pull out the conduit for 3–5 meters before proceeding to the next process. After the underwater concrete pouring work is completed, the appearance quality should be inspected to ensure that it meets the design requirements. After that, the quality of underwater concrete should be checked. The inspection should be divided into two parts: one is to observe the appearance quality; the other is to inspect the quality of the steel reinforcement cage, pile diameter and hole depth. After passing the inspection, the steel reinforcement cage can be hoisted to the cast-in-place pile and inserted into the concrete. After the pouring is completed, the length and depth of the pile should be measured [9].

4.4. Site cleaning

Before the construction of bored piles for bridges, the surface of the bridge body should be clean and free from dirt and grime. In addition, all kinds of sundries on the construction road should be cleaned up to prevent them from being mixed into the concrete, which will lead adverse consequences on the overall quality of the bridge project. In addition, after the completion of the project, the road and ground should be cleaned to ensure the sustainable development of the environment and minimize pollution, so as to achieve a healthy development of the industry and ecology.

4.5. Handling of abnormal conditions

When drilling pile holes, some external factors might cause unexpected problems or restrictions, resulting in some engineering problems. For such emergencies, construction companies should set up a special emergency team to formulate corresponding emergency plans for various problems of bored piles installation, and at the same time improve the on-site management to ensure that emergency problems can be resolved in a professional and timely manner to prevent irreparable losses.

4.6. Quality check

Since the construction of bored piles is a concealed work, the overall construction specification of the project should be standardized, scientific, and reasonable. Besides, the quality and the strength of the perfusion, which are usually determined according to the actual situation of the bridge body are also important. After the perfusion is completed, relevant tests should be carried out, including the setting of the drilling hole, the relevant records and pressure test during the perfusion implementation. Next, the drilling equipment should be inspected, and the size and number of holes should be determined, followed by a grouting test. Lastly, the progress of the entire project should be carefully tracked once a day, without neglecting any details, including the deployment of building materials and on-site workers, and a comprehensive study of abnormalities in construction. On this basis, the hydraulic test of drilling should be carried out according to the requirements, and the corresponding average hydraulic pressure can be obtained.

4.7. Hole forming quality control

When installing the casing, it is necessary to stake out accurately to ensure that the location of the casing is accurate. The first batch of concrete be poured within 1 hour after drilling to the designed height. Before pouring concrete, the hole should be checked again, and the depth of the hole should be measured with a measuring rope, and the concrete can be poured only after the requirements are met. The connection and installation of the conduit should be firm; the lower end of the conduit should be connected to the orifice for more than 1 m to prevent the pile from breaking due to water entering the conduit. The wall of hole should remain stable, and the diameter of the hole should be within the specified range. Before pouring concrete, the amount, strength, and ratio of ingredients of the underwater concrete should be checked. During the pouring process, the buried depth of the conduit, the thickness of the filter cake, and the pouring time should be strictly controlled. The steel reinforcement cage should be processed and formed with a steel bar with a diameter of not less than 12 mm. The upper end of the steel reinforcement cage can be connected to the conduit with a threaded buckle, and the lower end can be fixed with the conduit. The bottom of the steel reinforcement cage should be padded more than 1 m thick to prevent deformation. During construction, it is necessary to prevent deformation, the reinforcement cage must be firmly positioned, and the joint connection must meet the requirements [10].

5. Conclusion

With the development of society and economy, the quality and level of bridge engineering construction are constantly improving. As an important part of bridge engineering, bored piles are playing an increasingly important role in bridge construction. However, in actual construction, due to various factors, many problems have appeared in the construction of bored piles, such as casing sinking, unstable hole formation, concrete segregation, broken piles, and many more. Therefore, quality control must be carried out in strict accordance with relevant standards and specifications throughout the construction process. In order to ensure the quality of bored piles, it is necessary to strictly control the hole-forming process, raw materials, steel reinforcement cage production, conduit installation, and hole cleaning during the construction process, so as to ensure that the quality of bored piles are up to standard and to provide a better foundation for bridge engineering.

Disclosure statement

The authors declare no conflict of interest.

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