

Discussion on Quality Control of Underwater Bored Pile Top of Bridge under Engineering Education

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Abstract: With the rapid development of the domestic economy, the proportion of infrastructure investment is increasing. The number of bridges built in rivers, lakes, and reservoirs is increasing. The development direction of bridges is increasingly focused on deep foundations, high piers, and large spans. . For a single bridge, the basic construction technology and management work is a key part of the whole bridge construction, especially the construction of the underwater bridge foundation, which directly affects the investment benefit and risk control of the entire bridge construction. Today, bored piles are widely used in high-rise building foundation engineering. However, due to the complicated construction process of bored piles, the construction quality is often difficult to guarantee, especially the insufficient concrete strength of the underwater bored piles is a common quality problem. In this paper, the quality control measures for underwater bored pile construction of bridges are proposed.

1. Introduction

Bored piles are one of the basic forms commonly used in construction engineering, Due to their strong adaptability, strong resistance to expansion, simple equipment, convenient operation and safe construction, they are more and more widely used. [1-2]. Bored pile construction technology is a concrete technology with low construction cost, simple construction operation, no vibration, noise and squeezing effect [3-4]. At present, the construction technology of bored piles has been widely applied to the field of construction engineering [5]. A large number of practical cases show that the bored pile has high safety and strong stability, that is, the concrete slurry penetrates deep into the soil layer, which can make the soil layer and the pile pile tightly combined, so that the foundation is more firm and reliable. At the same time, the cast-in-place pile can effectively control the settlement of the foundation, thus producing compaction effect on the soil layer [6-9]. The bored piles have good penetration, compaction and splitting action on the soil layer, and the interaction between the three can make the soil layer more stable [10]. The construction environment of bored piles is extremely harsh, so the application process is bound to be affected by many factors [11]. It can be seen that it is of practical significance to strengthen the application research on the construction technology of bored piles. This article deals with measures related to quality control.

2. Overview of Bored Piles

2.1 Bored Pile.

The cast-in-place pile refers to a pile formed by forming a pile hole in the foundation soil by means of mechanical drilling, steel pipe squeezing or manual excavation at the project site, and placing a steel cage and pouring concrete therein, according to different hole forming methods. The piles can be divided into immersed tube piles, bored piles and bored piles. In this paper, the bored pile is used. The bored pile is made by injecting concrete into the hole with auger, submersible drilling rig, etc. There is no vibration and no soil during construction, but the pile settlement is slightly larger. The auger should be used for cohesive soil, sand and artificial filling above the groundwater level. The drilled clods rise along the spiral blade on the drill pipe and the hole is about 300mm, and the drilling depth is 8~12m. The soil and water content are selected for the drill

pipe. The submersible drilling rig should be used for cohesive soil, sand, silt and silty soil, etc. It is especially suitable for forming holes in the soil layer with higher groundwater level. In order to prevent the pupil from retaining the wall when drilling. Drill in the clay with clean water, self-made mud to protect the wall; in the sand should be injected into the prepared mud drilling. The mud circulation is used to remove the soil debris under drilling, and after drilling to the required depth, the hole should be cleaned to remove the soil debris sinking at the bottom of the hole, and the settlement of the pile is reduced. At present, large-diameter bored piles, which are widely used in large-scale projects such as high-rise buildings and bridges, are mostly constructed by this method. The pile diameter is more than 1m, and the bottom of the pile can be reamed. The bearing capacity of a single pile can reach several thousand tons.

2.2 Current Status of the Use of Bored Piles.

With the emergence of more and more large-span bridges and various super high-rise buildings, bored piles have become one of the first choices for building foundations. Bored pile is one of the most commonly used basic forms of bridge engineering. It has strong adaptability, less impact on adjacent structures, strong seismic performance, low construction noise, no vibration, simple equipment, convenient operation, safe construction, etc. Features; and the bored pile can evenly transfer the dynamic and static loads from all the upper structures to the deep stable soil layer, thus greatly reducing the foundation settlement and uneven settlement, so the bored pile is widely used. . The foundation form of most bridges is bored piles, and bored piles are recognized as one of the safe and reliable and extremely effective basic forms. The quality control of bored pile construction is a very important task that needs careful consideration and careful organization. Although there are many factors affecting the construction quality of bored piles, as long as a detailed quality control plan is developed and the construction preparation is completed, the quality can be controlled well. In the construction of underwater bored piles for bridges, to ensure the quality of the project, shorten the construction period and create good engineering benefits, we must thoroughly study the construction technology of the bored piles, do all the preparatory work before construction, and strengthen the technical management. To minimize and avoid accidents, ensure the quality of bored piles, and provide reference for the construction of bored piles in the future. At present, the overall level of China's deepwater bridge infrastructure construction is at the forefront of the world and a new stage of simultaneous development with the world.

2.3 Pre-Construction Preparation.

In order to promote the construction technology of water injection piles, good results can be obtained in bridge construction, and sufficient preparation is required before construction according to them. Firstly, the terrain of the construction site should be inspected on site, and the site should be leveled. According to the characteristics of the construction site, the site should be leveled and compacted as a construction platform. The pile foundation is then staked out to determine the pile level and the ground level. When the pile position is staked, the pile position deviation is within the allowable range of the specification, and guard piles are respectively set at 2 meters from the center of the pile before and after the pile to check the pile center and elevation at any time. Each rig is equipped with a test rope for inspection of the drilling depth at any time. In addition, the selection of the casing is made, the casing is made of 6mm thick steel plate, the inner diameter is 20cm larger than the pile diameter, the clay is filled around the roof, the top of the casing is 30cm higher than the ground, and the length of the casing is not less than 1.2m. Review, check whether the center position of the pile after the measurement stakeout and the casing is buried, and the mechanical equipment plan, the mechanical equipment can be selected according to the geological conditions and the application conditions of various drills.

3. Quality Problems Caused by Underwater Bored Pile Construction of Bridge

3.1 Pile Bottom Concrete Infusion is Insufficient.

Accurate measurement of concrete surface is a very difficult task, especially with the development of bridge construction, the deeper the pile is, the lack of sufficient experience is difficult to control the concrete filling height of the pile top. Some technicians believe that the surface of the concrete is not allowed or the measurement is too troublesome, reducing the number of measurements or even unexpected. The general case is calculated by multiplying the theoretical calculation by the required filling factor estimate, which is ok if the wall of the hole is stable and the amount of concrete is accurate. However, when the pile hole field is serious and the amount of concrete is often insufficient, this kind of estimation will have a big difference with the actual, and the underfill of the pile top concrete is inevitable. At the same time, the unstable underwater formation and the pipe are fast. Inadequate measures to protect the wall from the unstable formation cause the wall of the hole wall. When the pipe is lifted, the amplitude is too large and the speed is too fast. This suction will bring the hole wall to the pile body, but the surface concrete has poor fluidity. The air that is forced into the concrete of the pile in the duct is not easy to be bred, resulting in loose concrete and insufficient strength on the pile body.

3.2 The Bottom of the Hole can not be Completely Cleaned.

According to the construction specifications, the mud and sediment at the bottom of the hole should be completely removed after drilling, but in the actual construction process, it is difficult to completely remove it due to the difficulty of underwater drilling. During the construction of the back cover, the first batch of concrete passes through the bottom of the pipe and impinges on the bottom of the hole. It is mixed with the flushing liquid in the hole to form a dilution layer of a certain thickness of the slurry. The underwater concrete rises from the bottom to the top, and the first concrete is poured. Always at the top. Due to the effects of impact and agitation, the first-filled concrete is mixed with the bottom sediment, mud, etc., and finally a certain amount of floating layer is formed on the top of the pile. Obviously, the thickness of the floating layer depends on the degree of cleanness in the hole. If the hole is not completely clean, the wall of the hole is thick, and there is much sediment at the bottom of the hole. The upper layer of the slurry will be thick, which may easily lead to misjudgment by the construction personnel. Even sometimes the super-irrigation of the pile top is high, but the concrete strength below the design elevation does not meet the design requirements. On the contrary, the cleaner the drilling, the less the sediment at the bottom of the hole, the thinner the upper floating layer. Under the condition of overfilling a certain height, the concrete strength below the design elevation after the float is removed can reach the design required strength value. Therefore, controlling the thickness of the slag at the bottom of the hole is a prerequisite for ensuring the quality of the concrete at the top of the pile.

3.3 The Super Pressure is Small, which Makes the Concrete Jacking Difficult.

The super-pressure is the difference between the static pressure of the concrete mix column in the conduit at the outlet section of the pipe and the static pressure of the outer mud column and the concrete mix column. Underwater conduit concrete is poured by the pressure of the concrete inside the duct, and the concrete is compacted by its own gravity. Practice has proved that the sediment at the bottom of the pile hole is absolutely clean, that is, the sediment is "zero" is difficult. The bottom of the pile hole in front of the concrete is poured at different thicknesses of sediment. When the water blocking plug is lifted or the partition is lifted, the initially poured concrete flows to the bottom of the hole at a rapid rate, so that the sinking floats on the concrete surface. Since these sediments and mud mixes are less heavy than concrete, the sediments always float to the top. At the end of the infusion to the end of the pile, the elevation of the concrete column inside the pipe is reduced. The mud outside the pipe is seriously increased, the sediment is increased, the overpressure is reduced, and the depth of the pipe has to be reduced. Therefore, the weight of the concrete poured on the top of the pile is always small, and the concrete on the pile and the sediment

and the thick mud are solidified. Together, the strength is naturally not as high as the middle and lower parts.

4. Quality Control Measures for Pile Top of Underwater Bored Piles of Bridges

4.1 Casing Buried.

The bridge pile construction generally uses a welded integral steel casing. The inner diameter of the casing is 20cm larger than the pile diameter. Both are made of A3 steel plate with a thickness of 5mm. It is used to strengthen the overall rigidity of the steel casing and prevent deformation. The joint is welded with a neck rib. First determine the position of the casing on the construction drawing, then use the total station to accurately measure the position of the casing on the platform, and fix the position of the casing with a box made of 10cm × 5cm channel steel. Then use the crane to hoist the pre-welded 5 7.5m protective cylinders to the pile holes, place them on the working platform and fix them about 1m, then use the crane to hang the upper ones and stack them in the lower section. The top of the casing is welded. Sink down and stack the joints until the bottom of the casing sinks to the surface of the riverbed. When the casing sinks to the surface of the riverbed, the casing is sunk to the design elevation by hammering and assisting the soil removal in the cylinder. When sinking, if you find the tilt, you should correct it in time. After the casing sinks, use the total station to measure whether the center position is correct and whether the casing is vertical. The deviation of the plane position of the casing is generally not more than 5cm, and the deviation of the inclination of the casing is not more than 1%.

4.2 Mud Control and Cleaning.

In the drilling process, the clear water retaining wall is first used. When the drilling is continued, the clear water in the hole is cut with the drill cone, and the mud is naturally formed under the impact agitation of the drill cone. The specific gravity of the mud is controlled at 1.2 to 1.4. During the drilling process, the mud weight can be controlled by placing clay or adding water. A slurry storage tank and a mud circulation purification system are arranged on the construction platform, and the slurry is pumped by the mud pump to enter the bottom of the hole through the high-pressure hose of the slurry, and the mud is sprayed downward along the drill cone to drive the drilling slag to rise to the orifice, and the other is The mud pump extracts the slag slurry for recycling and forms a reverse circulation process. It overcomes the shortcomings of impact drills generally stopping drilling and slag, and consuming too much time. It can achieve continuous drilling and increase speed. The requirements of various indexes of mud are shown in Table 1. After the drilling reaches the design depth, the hole is inspected through the final hole. The clearing hole should be carried out twice. The first clearing hole is carried out immediately after the hole is formed. The specific method is: lift the impact hammer on the construction platform, lower the clear hole pipe, and use the air compressor to press the air to clean the hole. In order to maintain sufficient head pressure in the hole and avoid boring, water should be poured into the hole in time. The second clearing is carried out after the installation of the lower rebar cage and the poured concrete conduit, and the second clearing is performed by the conduit and the air compressor. After the completion of the cleaning, the thickness of the bottom sediment should be determined to ensure that it is not more than 50 mm.

Table 1 Requirements for Mud Indicators

proportion	Viscosity (S)	Static force (Pa)	Sand content (%)	Colloidal rate (%)	Water loss rate (ml/30min)	Mud thickness (mm/30min)	PH
1.08~1.10	18~22	1~2.5	<4	>95	14~20	<2	8~10

4.3 Catheter Control.

The perfusion of underwater concrete is the key to ensuring the quality of the pile. The

underwater concrete of the bridge pile is filled by the direct pipe method. The concrete mix passes through the lower mouth of the pipe and enters the concrete under the initial pouring. The concrete is poured on the initial pouring concrete and the water above it rises. In order to make the infusion work smoothly, the perfusion time should be shortened as much as possible, and the continuous operation should be adhered to, so that the perfusion work is completed in the time before the first batch of concrete is initially set. First, the conduit is an important tool for infusing underwater concrete. Depending on the length of the pile, the diameter of the pile and the amount of concrete to be passed per hour, a quick joint pipe with a diameter of 250 mm is selected, and each section of the pipe is connected by a screw thread. Before the catheter is used and used for a period of time, in addition to careful inspection of its specifications, quality and splicing structure, it is also necessary to perform splicing, ball passing and watertight, pressure, joint, tensile and other tests. Secondly, the strength, grade and materials of underwater concrete prepared underwater concrete should meet the design requirements and the "Technical Specifications for Construction of Highway Bridges and Culverts". Finally, the number of the first batch of concrete poured in the pile foundation was calculated to be about 4m³. Insert the catheter centrally to the bottom of the hole 0.35m, connect the funnel to the pipe, and install a water plug at the interface to prevent the concrete from coming into contact with the water inside the pipe. Prepare a sufficient amount of concrete in the funnel; release the water blocking plug, and the concrete water level in the funnel suddenly rises and overflows, indicating that the concrete has been poured into the hole. If there is a sufficient amount of concrete to fall, the water in the duct is completely pushed out. The bottom of the conduit is buried in the hole 1 to 1.5 m deep to ensure that the water in the hole cannot flow back into the conduit. As the concrete is continuously poured into the hole through the funnel and the pipe, the concrete initially poured in the hole and the water above it are continuously lifted up; the pipe is continuously lifted and the pipe is removed until the concrete is completed.

5. Conclusion

Before construction, strict quality management system and reasonable construction plan should be formulated to eliminate the influence of invisible factors on concrete pouring at pile top, and strict control should be carried out from the aspects of sediment thickness, slurry preparation, tube embedding and pipe lifting speed. The construction of bored cast-in-place piles in every process must be carried out seriously and strictly. Any negligence may bring construction accidents or quality accidents to the pile foundation.

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