

Study on the Principle and Construction Technology of High Pressure Jet Technology

Zhen Zhang, Hui Guo, Shijiao Sun, Yazhu Zhang

Shandong University of Science and Technology, QingDao 266590, China.

742129065@qq.com

Abstract

Based on the existing problems of artificial hole forming pile, the principle of high pressure rotary jet technology and the high pressure jet process are discussed in this paper, and the pile forming mechanism of high pressure jet grouting is further studied, and the consolidation situation is analyzed. Finally, the construction process is expounded. This paper can provide reliable technical reference for industrial and civil construction projects under similar geological conditions.

Keywords

Artificial hole forming pile, high pressure jet technology, construction technology.

1. Introduction

At present, when the artificial pore forming pile is encountered in the complex geological layer, such as the flow sand layer and the silt layer, the usual method is to reduce the height of the one-off wall protection, or to use the submerged steel tube. There is a big hidden danger in traditional technology, so it is imperative to research and use new technology. High pressure jet technology combines the principle of high pressure water jet technology and chemical grouting technology in hydraulic coal mining, jets the soil with high pressure cement slurry or high pressure water, and mixed the slurry with the soil particles, and forms a solid cylindrical consolidation body after chemical reaction in the stratum (The added solid is generally called a rotary jet pile). Therefore, it is of great practical value and economic benefit to study the concrete construction process of the high pressure jet technology under the complex geological condition of the artificial hole pile.

2. The Principle of High Pressure Jet Technology

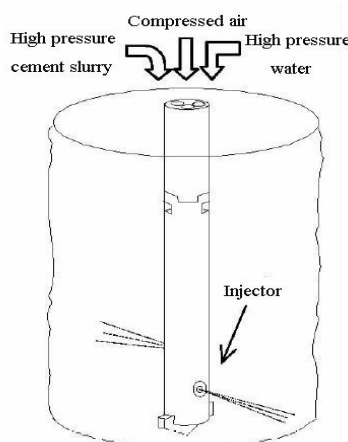


Fig. 1 Rotary Jet Principle

The technical principle of the high pressure jet grouting method is to drill the grouting pipe with the nozzle into the predetermined position of the soil layer by drilling machine. The high pressure equipment makes the slurry or water the 20 ~ 40MPa high pressure jet ejected from the nozzle to cut,

disturb and destroy the soil, and the drill rod is gradually increased with a certain speed, and the slurry and the soil particles are stirred up. After mixing, the slurry solidified, forming a cylindrical consolidation body in the soil (Fig. 1) to achieve the purpose of strengthening the foundation or sealing the water and seepage. The high pressure swirling step is shown in Fig. 2.

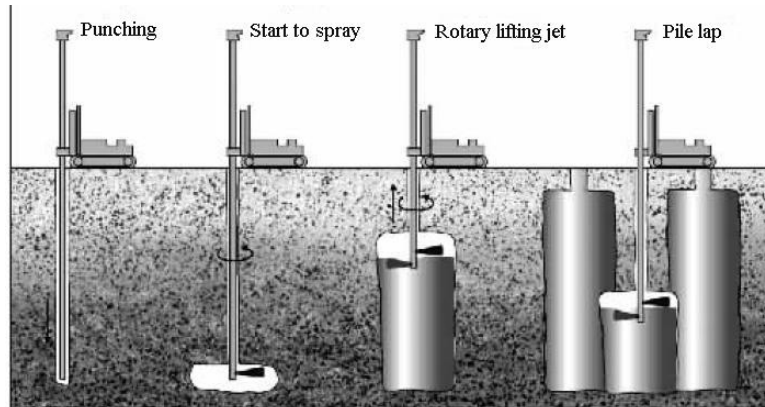


Fig.2 High Pressure Swirling Process

3. Pile Forming Mechanism of High Pressure Jet Grouting

Due to the failure of high pressure jet flow to the soil, the soil becomes loose from the whole state. With the continuous punching and moving of the jetting jet, the depth and scope of the soil destruction are expanding. In jet jet, the high pressure jet is a cement slurry, that is, cement is used as a hardened agent, and the edge of the rotating edge is slowly raised at a certain speed. A part of the tiny particles of cutting down are replaced by the slurry, and the fluid is brought to the ground with mud in the form of mud. (Called pulping). The rest of the soil particles, under the joint action of the jet pressure, the centrifugal force and the gravity, rearranged regularly on the cross section and mixed with the slurry to form a new type of cement soil network structure. As the jet flow lost the punching force in the end area, the surrounding soil was not cut down, and it could be mixed with the slurry, but it still had pressure to squeeze the surrounding soil. For sandy soil, the slurry can also penetrate into a certain thickness outside the compression layer to form a permeable layer. Therefore, the swirling body formed in sandy soil and clayey soil is divided into the main parts of the slurry, mixing, compressing and permeating from the center (there is no permeation layer in the clayey soil). After a series of hydration and physical chemical action between cement, water and soil, the rotary jetting body formed by cement, water and soil finally hardened, that is to say, after a certain time, it solidifies into a consolidation pile with higher strength and less permeability. On the longitudinal section, when the local layer is distributed in multilayer, the quality of the soil particles in each layer is not uniform, and the mass of the soil particles will sink under the action of gravity before curing, and some small soil particles will float to make vertical exchange. If the upper soil layer is gravel and the lower part is clay, the jet grouting pile of cohesive soil is not a mixture of soil and slurry but a mixture of sand and soil.

No matter cross section or vertical section, the cement content and strength of each part of the consolidation body are different. Therefore, the pile forming mechanism of high pressure jet grouting piles can be explained by five functions: (1) High pressure jet flow cutting undermines soil. The jet flow pressure strikes and destroys the soil in the form of impulse, resulting in cavitation and cracks in the soil. (2) Mixed agitation. In the process of rotary lifting, the drill rod forms a gap in the rear of the jet, forcing the soil to move to the direction of the opposite direction of the nozzle moving in the direction of the nozzle, that is, the direction of the small resistance, and mixing with the slurry to form a new structure. (3) Elevating displacement. At the same time, when the high speed water jet cuts the soil, the soil particles cut off by the compressed gas are discharged from the ground. The clearance of the soil after the discharge is supplemented by the cement slurry. (4) Filling and osmosis consolidation.

The high pressure cement slurry quickly fills the gap between the washed channel and the soil particles, consolidating the water and consolidating the sand layer, and penetrating into the sand layer to form a consolidation body.(5)Compaction. In the process of cutting the broken soil layer, high pressure jet flow has residual pressure on the edge of the broken part, and it can produce certain compaction effect on the soil layer, so that the compressive strength of the edge part of the rotary jet pile is higher than that of the central part. The situation of the rotary jetting consolidation body is shown in Fig. 3.

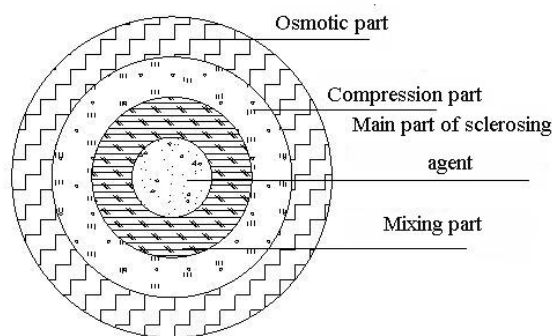


Fig. 3 Diagram of Rotary Jetting Consolidation

4. Construction Process Flow

The construction process of rotary jet technology in dealing with complicated geological conditions of artificial bored pile is as follows:(1)Drilling machine positioning. When the mixer is transported to the site, it is installed and debugged. When the speed, pressure and measuring equipment are in place normally, the rotary jetting pile machine is moved to the designated pile position, the drill is aligned with the center of the hole position, and the drill is leveled smoothly and horizontally, and the perpendicularity deviation of the drill pipe is not more than 1% to 1.5%. After setting up, the low pressure (0.5MPa) water injection test is first conducted to check whether the nozzle is smooth and the pressure is normal.(2)Cement slurry is prepared. When the pile machine is shifted, the water mixture will be mixed according to the designed mix ratio. First, the water is added to the bucket, then the cement and the admixture are poured in, and the mixer is stirred for 10~20 minutes, then the bottom valve is unscrewed, and the first sieve (aperture is 0.8mm) is put into the slurry pool, then the second filter net is pumped through the mud pump (the hole diameter is 0.8mm), and the slurry is poured into the slurry after second filtration. In the bucket, spare when the pulp is pressed.(3)Drill holes. The purpose of drilling is to put the grouting pipe into the predetermined depth, and the drilling method adopts single pipe rotary drilling rig. Before drilling, each drilling rig will measure the total length of the drill rod, calculate the number of drills according to the length of the pile, the height of the design pile top, the original ground elevation, and mark the end of the drill pipe in the last section.On the one hand, the pressure of cement slurry less than 10Mpa is used to prevent the plugging of the nozzle. On the one hand, the nozzle is prevented. On the other hand, the first injection is carried out to the soil, which makes the soil a mixture and reduces the resistance of the soil in the spray, so that the slurry can be fully stirred, and the depth of the design should be drilled for 40 seconds after the bottom of the hole. After drilling, check holes, Kong Shen and verticality to see if they meet the design requirements.(4)When the rotary jet grouting pipe is used for drilling operation, the two processes of drilling and intubation can be combined into one. When the first stage is penetrated into the soil, it can be penetrated by the injection or vibration of the spray tube itself. The process is to start the drilling rig, and to open the high pressure mud pump at the same time to carry the cement slurry in low pressure, so that the drill rod will vibrate along the guide frame and sink into the hole; until the pile bottom is designed, the observation current should not be greater than the rated value.(5)After lifting the nozzle and stirring, after the design depth is reached, the high pressure water pipe and air pressure pipe are connected, the high pressure water pump, the mud pump, the air

compressor and the drilling machine are revolving, and the pressure, flow and air volume are controlled by the instrument. The pressure, the flow and the air volume are controlled by the instrument to start up, continue to spin and lift, until the expected reinforcement is reached. Stop after the degree.(6)Drill the drill. When the rotary jet pile reaches the design height, the jet is stopped and the drill pipe is put forward. In the process of construction, it is necessary to pay attention to checking whether the initial setting time of the slurry, the flow and pressure of cement slurry, the speed of lifting, the angle of swing and the method of injection are in conformity with the design requirements. In case of failure, it should be eliminated and recorded at any time. The grouting should continue after the design top elevation, and the slurry will be kept to stop when the mud comes back from the hole to ensure the quality of the top of the consolidation body. After the injection operation is completed, the suction pipe of the grouting pump is moved to the water tank and sprayed on the ground to remove the slurry in the slurry pump and the grouting pipe so as to prevent the residual cement slurry from blocking the pipeline. The drilling machine is shifted to start the construction of the next pile.

The construction site of single pipe spinning is shown in Figure 4.



Fig. 4 Single Pipe Spinning Construction Drawing

5. Conclusion

Combined with the engineering example of the coal mine washing system in a company, the construction technology of high pressure rotary jet technology used in the treatment of the complex geological conditions of the artificial Kong Zhuangzhong is systematically studied. The research measures for the application technology of artificial pore forming pile under the complicated geological conditions such as deep laminar sand and aquifers are mastered, and the research of this paper is studied. The results can provide reliable technical reference for industrial and civil construction projects under similar geological conditions.

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