

Pile Foundation Problems and Reinforcement Techniques in Highway Bridge Engineering

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Abstract: *The construction of road and bridge pile foundations is a complex system engineering that involves many construction links. There are many common problems that can have a significant impact on the overall quality of road and bridge pile foundation construction. Therefore, it is necessary to face the quality issues of road and bridge pile foundations and take corresponding technical measures to strengthen the stability and safety of the bridge. The article discusses common pile foundation problems and reinforcement techniques in road and bridge engineering.*

Keywords: Highway and bridge engineering; Pile foundation construction; Exploration of Reinforcement Technology.

1. INTRODUCTION

With the rapid development of the economy, various countries' infrastructure projects are also steadily advancing and have already achieved initial results. In recent years, with the increasing number of railway networks in China, the development of the transportation industry has also accelerated, and various logistics and express delivery companies have entered a period of rapid development. Highway is a major factor in the development of China's national economy, and the rapid development of transportation has led to an increasing load on various traffic bridges. In order to ensure the safety of vehicles, it is necessary to improve the quality of engineering. On this basis, some common problems in road and bridge engineering were proposed, and corresponding treatment strategies were proposed, as well as corresponding pile foundation treatment technologies.

Soybean trade is closely related to the daily life of Chinese people, economic development and even China's food safety. The sustainable development of national economy also promotes the increase of soybean demand. Because of the people's rich material and animal husbandry development, the demand for soybean in our country is getting higher and higher. Since China's accession to the WTO in 2003, the international trade deficit of soybeans has been increasing [1]. Although China is a big importer of agricultural products, it does not have the right to price in the world [2]. China's own arable land is limited, and the yield of soybeans per unit area is not as good as other crops, and the economic benefits of soybeans for farmers are not very high, so the production of soybeans is stagnant, and has not kept up with the pace of rising demand. Despite the strength of the national subsidy policy for soybeans, the price is still greatly affected by the international market [3].

In recent years, due to China's increasing dependence on foreign soybean imports, China's soybean producers will suffer more and more economic losses with the sharp rise in soybean imports, especially the farmers in the former major soybean producing areas of China, they will also suffer great economic damage. At the same time, the sharp increase in soybean imports in the short term will also increase the price of soybeans in the world, which will lead to the increase in the consumption cost of Chinese soybean consumers. Excessive reliance on soybean imports, and China's soybean import sources are too concentrated, subject to people, in the case of China's soybean demand is so high, and can not find suitable soybean substitutes in the short term, in case of fluctuations in the international soybean market, it is easy to cause China's domestic food safety problems. This paper will combine the actual data and chart analysis, combined with the background of The Times, point out the existing problems in China's soybean trade, so as to provide more comprehensive and more specific countermeasures to ensure the security of China's soybean trade

2. MECHANISM ANALYSIS OF PILE FOUNDATION REINFORCEMENT

According to Table 1 obtained from the database of the General Administration of Customs, PRC [4], it can be seen that the scale of China's soybean trade continues to expand, with the total import and export volume of soybeans increasing from 216.616 billion yuan in 2015 to 409.425 billion yuan in 2022. The import value of soybeans increased from 215.8441 billion yuan in 2015 to 408.489 billion yuan in 2022, with an average annual

growth rate of 18.9% since the COVID-19 epidemic in 2020. Exports increased from 775 million yuan in 2015 to 936 million yuan in 2022, with an average annual growth rate of 5.86%. It can be seen that soybeans are still mainly imported.

Table 1: China's soybean import and export volume from 2015 to 2022 (unit: RMB 100 million)

Year	Total export-import value	Import value	Import growth rate	Outport value	outport growth rate
2015	2166.16	2158.41		7.75	
2016	2253.61	2246.47	4.079855	7.14	-7.87097
2017	2693.83	2687.64	19.63837	6.19	-13.3053
2018	2509.87	2503.33	-6.85769	6.54	5.654281
2019	2443.8	2437.46	-2.6313	6.34	-3.0581
2020	2748.41	2743.48	12.55487	4.93	-22.2397
2021	3457.85	3452.36	25.83872	5.49	11.35903
2022	4094.25	4084.89	18.32167	9.36	70.4918

^a Data are obtained from General Administration of Customs of the People's Republic of China database.

2.1 Effectively improve the conditions of the bearing layer, thereby increasing the bearing capacity of the pile

In the construction of bored piles, factors such as soil interference, pile bottom pressure, pile bottom pressure, and pile bottom sediment have a certain negative effect on the bearing capacity of the pile. In order to further improve and improve the bearing capacity of Pile foundation, during the grouting of high-pressure piles, the stress at the ballast is affected by the pressure, resulting in cracks in the mud. In order to improve the physical and chemical properties of load-bearing materials and restore and improve the strength of load-bearing soil, it is necessary to fill and compact the original loose gravel.

2.2 The pile side friction resistance continues to increase

Due to the large gap between the drilled cast-in-place pile and the soil, combined with the combination of the pile mudguard and the surrounding soil, the lateral friction resistance of the pile body will be reduced. On the other hand, under pressure, mud will penetrate and spread along the boundary of the pile foundation. At this time, concrete and filling agents must be used to reduce filling and replacement, which can greatly improve the lateral resistance of the pile, increase the pressure of the pile body, foundation pressure, and load transfer.

3. COMMON PILE FOUNDATION PROBLEMS AND STRATEGIES IN ROAD AND BRIDGE CONSTRUCTION

In view of the current construction of Pile foundation of engineering construction units, many situations often occur in the construction of road and bridge pile foundation projects. If not solved in time, it will bring great harm to the safety of bridges [2]. In order to effectively address the above issues and clarify the reasons, this article focuses on some common problems that arise in road and bridge engineering Explored the issue:

3.1 Slurry leakage in the hole

When drilling to reach the bridge, problems such as water seepage and mud may occur. However, there is a major problem during drilling, which is that there is a large gap that is not noticed by the engineering and technical personnel. Therefore, to solve this problem, it is necessary to increase the burial depth of the roadbed sheath and add an appropriate amount of soil during construction to reduce the speed during construction, in order to achieve the goal of preventing wellbore water loss.

3.2 Oblique hole

The problem of oblique holes often occurs in drilling and hole forming operations. Due to soft geological conditions, inclined and uneven rock accumulation, drilling equipment generates oblique holes during the drilling process, which affects later construction. To achieve this, it is necessary to hang the drill pipe of the drilling rig at the inclined position of the well and repeatedly sweep the hole inside the well until the wellbore is in a vertical position before stopping the operation. If the hole has a large inclination angle, a certain amount of cohesive soil and debris should be filled on the slope of the hole. When the quality of the backfill reaches a certain level, drilling can be carried out [3].

3.3 Stuck drill

In drilling construction, drilling accidents often occur due to various reasons, some of which are due to a sudden decrease in the diameter of the wellbore during drilling operations, resulting in the tilting of the punch used. It is also possible that the worker accidentally threw something into the hole or hit a stone while drilling a well. During the drilling process, if there is a jamming phenomenon and it is not possible to pull it out with brute force, a small hammer needs to be used to impact it or squeeze the surrounding soil to loosen it, making it easy to remove the drilling rig [4].

4. PROBLEMS AND STRATEGIES OF PILE FOUNDATION CONSTRUCTION IN ROAD AND BRIDGE CONSTRUCTION

4.1 Neck constriction

In the road and bridge pile foundation project, due to the pressure effect of the soil during the construction process, a certain amount of water pressure in the hole will be caused, so that a large number of newly poured cement will appear in the process of pulling out the pipeline in the project, making the Pile foundation part prone to settlement and shrinkage. Another scenario is due to work. When people pull out the pipeline, they act too aggressively, causing soil blockage around the pipeline and causing the pile to contract. When shrinkage problems occur, immediate action should be taken. Firstly, during the pipe pulling operation, construction workers should ensure that the cement surface inside the steel pipe is below the ground surface to ensure sufficient expansion pressure of the pipe, usually within the range of 50-70mm. Different methods should be used during the pipe pulling process, and the pipe pulling rate should be controlled.

4.2 Broken pile

In pile foundation engineering, pile breakage is a common problem, and its biggest problem is that the distance between the pile bottom and other piles is too small, which can cause pressure on the pile foundation during other foundations. At this time, the pile foundation does not have enough bearing capacity and strength, and it is likely to fracture. In foundation engineering, the spacing between two adjacent Pile foundation must reach 4 or more. After the completion of Pile foundation, the strength on Pile foundation shall meet the requirements before the construction of adjacent Pile foundation [5].

4.3 Excessive concrete pouring

In engineering practice, concrete grouting is a key factor affecting the quality of the entire Pile foundation, which must be fully concerned. During the pouring process, relevant regulations should be strictly followed and the injection quantity should be controlled. If too much cement is injected into the borehole, it is easy to cause drilling and other situations, therefore, strict cement grouting must be carried out. In the Pile foundation project, if there is a large amount of concrete pouring, it is necessary to immediately contact the design department and use other piles suitable for the project needs.

5. PILE FOUNDATION REINFORCEMENT TECHNOLOGY IN ROAD AND BRIDGE CONSTRUCTION

5.1 Analysis of solidification process for micro piles

In road and bridge construction, engineering drilling machines can be used for pile foundation construction. During the drilling operation, the specific situation of the Pile foundation structure in the road and bridge construction shall be investigated in detail to find out its specific location, geographical location, etc., and select the appropriate drilling technology for construction. There are generally two methods used for bridge pier construction: dry drilling and cyclic drilling. There are significant differences between the two types of drilling methods. Adopting the dry drilling method requires a large amount of manpower. In this case, the construction personnel should ensure the cleanliness of the borehole and remove the residual cement inside the borehole to ensure its cleanliness. After completing the impurity cleaning work in the borehole, the steel bars, cement slurry, etc. can be poured into the borehole. If the drilling method of circulating mud mud is chosen, then it should be carried out according to the construction plan, which can accurately control the depth of the drilling. Therefore, after meeting the relevant specification requirements, it is necessary to control and master the drilling depth, and then appropriately treat the cement slag in the borehole [6].

In the process of road and bridge construction, in the stage where the drilling diameter is small, a single steel bar should be selected. If the drilling diameter is large, a steel bar cage model should be used before proceeding to the next step of construction. From then on, filling and grouting began. Before filling and grouting, scattered stones with a diameter of 14 centimeters were sprinkled into the foundation pit of the bridge pier, and a large amount of dry cement and cement slurry were poured into the hole. On the premise of ensuring the pouring quality, the pile foundation of the road and bridge structure has been reinforced. During the grouting construction process, if casing materials are selected, special attention should be paid to: sufficient pressure must be given to ensure sufficient grouting. Generally, the grouting working pressure should be controlled at 0.5MPa.

5.2 Characteristics of micro pile reinforcement technology in road and bridge construction

(1) Micro piles can form a set of small pile systems, which can improve the bearing capacity of high road bridge pile foundations, and each pile foundation can withstand different pressures, thereby achieving better reinforcement effects.

(2) Micro pile reinforcement technology can make pile installation more convenient, technology more complete, and use fewer equipment, so its cost is lower, adaptability is better, and it is suitable for various geological foundations of roads and bridges.

(3) The micro Pile foundation is adopted for reinforcement, and the reinforcement effect is obvious, and after completion, it can have a better bearing capacity. The use of micro Pile foundation reinforcement technology for road and bridge foundation reinforcement can effectively improve the bearing capacity of Pile foundation and make it more significantly strengthened [7].

5.3 Precautions for Strengthening Road and Bridge Pile Foundations with Micro Piles

When using micro pile reinforcement technology to treat road and bridge engineering, due to many quality issues that occurred during the early construction process of road and bridge engineering, the first problem to be solved in the reinforcement process is how to apply pile foundation reinforcement technology to improve the overall quality and performance of the project. Therefore, in the application of micropile technology for road and bridge foundation reinforcement, the following issues should be considered: firstly, before conducting formal reinforcement, the design drawings of the project should be carefully reviewed, and the technical plan formulated should be submitted to the construction team for technical disclosure; Secondly, strengthen the quality control of various building materials to meet technical specifications; Thirdly, strengthen the quality control and inspection of the project, strengthen the construction quality of the project, in order to achieve the goal of engineering quality.

5.4 Optimize the conditions of the bearing layer and enhance the bearing capacity of the pile foundation

In order to improve the bearing capacity of the pile body, continuous optimization must be carried out in the pile body engineering to strengthen the bearing capacity of the pile body. Among these factors, the load at the bottom of the pile, the movement of the pile skin, and the soil layer have a significant impact on the bearing capacity of the pile. Therefore, factors such as pile bottom load, pile skin, and soil movement can be utilized to improve the bearing capacity of the pile body. In the process of pile foundation grouting, the process involves using ultra-high pressure grouting slurry, using a vibrating hammer in the soil, using pressure difference to break the permeable nitrogen gas, grouting, and compressing the soil on the pile side to solidify into a larger soil mass. This can achieve

the best improvement in the state of the bearing layer and also increase the bearing capacity [8].

5.5 Enhance the lateral friction resistance of pile foundation

By filling and thickening the Pile foundation, a protective cover is formed around the pile. Without cement mortar injection, the hole wall and inner layer sediment on the foundation produce a certain friction force on the Pile foundation. If the difference in pore size between the pile body and the pile body is significant, the compressive strength of the lower pile will increase with the difference in pile diameter, resulting in the lateral friction coefficient of the pile body. When there is a gap between piles, filling material is used as an auxiliary means to inject cement into the borehole to ensure the diameter of the pile and the density of the soil layer. During grouting, the backflow of cement slurry will remove the sludge and cover the sludge in a sense, thus improving the coordination around the borehole and increasing the side friction coefficient of Pile foundation.

5.6 Overview of other solidification processes for pile foundation structures in road and bridge engineering

In the process of road and bridge construction, the most commonly used technology is pile foundation reinforcement, and on this basis, several other pile foundation reinforcement technologies have also been promoted. However, they are all operations such as on-site setting out, foundation drilling, installation of steel bars, and pipe insertion. During the construction process, a drilling head is used to chisel a circular hole on the bridge pier, and then a crane is used to lift the track components, and with manual assistance, Insert the track structure completely.

After the drilling is completed, the slurry of mineral powder and concrete is injected into the track to avoid cavities in other boreholes. Add an appropriate amount of fine coal ash, chemical shrinkage formula, or composite strengthening formula to the concrete to improve its strength. The spacing between each rail should be controlled within 0.2 meters. To avoid the sinking of track components, the rails must be made into sharp shapes. During the construction phase, trial runs must be carried out near bridge piers to accumulate experience, grasp the timing, and ensure the completion of track pile foundation construction within the specified time. After completing the construction process of the steel rail bridge pier, select appropriate steel to weld into a steel rail, and install it on the steel rail. This can form a complete steel rail bridge pier, which can increase the resistance of the steel rail to lateral inclination. Then, use manual excavation to chisel a rectangular hole on the steel rail [9]. Then, using a secondary process, select suitable steel bars for welding in a 3.5 meter deep borehole. When welding, steel plates can be selected to cover the gaps of each rail, and then the iron bars can be placed into the steel plates. The rail joints and welding can be carried out to ensure that the foundation of the bridge pier does not expose the steel rails, thereby ensuring the construction quality of the project. When excavating rectangular holes, in order to avoid collapse of the surrounding soil structure, steel bars and sheets must be selected for shaping.

6. ELEMENTS TO PAY ATTENTION TO WHEN IMPLEMENTING THE CURING PROCESS

The settlement and grouting of Pile foundation can be effectively overcome by strengthening the road and bridge pile foundation. At present, many problems have arisen in road and bridge engineering, and doing a good job in basic engineering construction is an important part of ensuring project quality. If the project quality does not meet the standards, it will have a great impact on project construction.

Therefore, it is particularly important to strengthen the application of technology in road and bridge pile foundation engineering. To strengthen technology, it is necessary to: ① carefully review the design drawings, and strictly follow the design in all work. If there are any errors in the design, the project will have significant problems. Therefore, technical workers can ensure the correctness of the design scheme through technical communication; ② In the selection of materials and equipment, try to choose appropriate materials and equipment to avoid delaying the construction period [10].

7. CONCLUSION

With the rapid development of China's society and economy, the demand for roads and bridges is increasing day by day. Therefore, in the process of rapid development, it is necessary to pay attention to their quality issues. In the construction of specific road and bridge projects, we should not only deeply study the reinforcement technology of

Pile foundation, but also consider the actual situation of the site, and then discuss with relevant experts to finally select the reinforcement technology of Pile foundation, improve the construction quality, and fundamentally ensure the construction quality of road and bridge.

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