

Study on the Key Technologies and Targeted Measures to Improve the Construction Safety and Efficiency of High Bridge Pier Construction

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Abstract. As an important support structure of the bridge, the construction technology of the bridge pier has a crucial impact on the overall stability of the bridge. This paper firstly outlines the key aspects of high bridge pier construction technology, including foundation construction technology, formwork support technology, concrete pouring technology and other construction technology. Subsequently, an in-depth analysis of the impact of bridge pier construction technology on the stability of the bridge structure, specifically discusses the development trend of the three main construction methods of sliding molds, turning molds, crawling molds, as well as the possible impact of different construction techniques and the use of the selection and use of aspects of the construction process. In order to improve the bridge pier construction technology and stability, the article puts forward a series of targeted measures, including the design of the main structure of the bridge pier with a reasonable structure, the construction of safe and efficient construction formwork structural system, the choice of excellent economic formwork materials and support to enhance the stability of the formwork, strict control of the key factors of the concrete pouring in order to improve the quality of the pouring, as well as strict control of the quality of the material in order to ensure that it meets the design requirements. design requirements. The implementation of these measures aims to improve the construction quality of the bridge piers and the overall stability of the bridge.

Keywords: High bridge pier construction; Bridge structures; Formwork construction techniques; Structural stability; Economic efficiency.

1. Introduction

Bridges are key components connecting two banks and crossing obstacles, and play a pivotal role in modern transportation engineering [1-2]. They carry vehicles and people through the task, its function is not only a means of transportation, but also has to promote regional economic development, strengthen cultural exchanges and other functions. Bridge piers is an important support structure of the bridge, its stability and carrying capacity will be directly related to the safety and service life of the bridge. With the booming development of highway construction in recent years, high bridge projects across large rivers, canyons and other terrain obstacles, the need to use high pier construction technology to support the bridge structure, its height often exceeds 40 meters. High pier construction technology has become a key factor in ensuring the safety, stability and economy of bridges. In the face of the key problems in the design and construction of high piers, the safety and durability of high pier construction of bridges can be significantly improved through the use of advanced construction technology and strict construction processes. Therefore, it is of great significance to carry out the research on the construction technology and stability of bridge abutments to improve the quality of bridge construction, ensure the safety of transportation and promote the sustainable development of transportation construction.

2. Key Technology Overview of Bridge Pier Construction

The bridge span is getting bigger and bigger, and the technical difficulty of construction is also getting higher and higher. Especially in some high mountain valley areas, the terrain is complicated

High bridge pier column construction mainly has “overturning form”, “climbing form” and “slipping form” three modes [3-7]. Among them, turning the mold in the construction process repeatedly many times to dismantle the template there is a very high risk of construction safety; climbing mold is a complex system of components, the template cost is turning the mold 2-3 times, the template dismantling security risk is high, and time-consuming and laborious, in the general construction of high piers in no competitiveness; sliding mold is a simple construction of high efficiency, but its “soft demoulding” Resulting in defects in the appearance of the pier, directly affecting the durability of the surface layer of concrete, has been listed as a restriction on the use of technology. High pier and tower construction has been a high-risk operation, in 2016, Jiangxi Fengcheng cooling tower construction platform collapsed 73 people died and 2 people were injured. 2018 Ganzhou Jingkai District, Venture Road, pier pouring 4 people died in a fall at height, 2019 Chengchuan high-speed 7-11 pier template dismantling and installation of the pier fall at height, 3 people died and 1 person was injured, 2020 Mulin high-speed 8.15 Matei Pingpalu Interchange, ramp C, 8# pier tie beam construction pier fall 1 People died in 2021, Huizhou Avenue Hangbu River Bridge project abutment bracket collapse 4 people died. How to reduce the risk of high pier construction has become a priority. The solidity of the formwork is the key to the construction of concrete pouring. However, in the actual construction process, the stability of the formwork is often not good enough, which seriously affects the quality of concrete pouring. Because the formwork is not strong enough, the concrete pouring process is prone to “running mold leakage” phenomenon, which leads to the concrete structure form size can not be accurately controlled, affecting the structural bearing capacity and stability. In addition, due to the deformation and displacement of the formwork, cracks and depressions appear on the surface of the concrete, seriously affecting its appearance and durability. This will not only reduce the overall stress performance of the concrete structure, but also affect the safe operation of the whole project. Therefore, it is necessary to pay great attention to the lower quality of concrete pouring caused by the lack of formwork solidity, strengthen the quality control of formwork design, manufacture and installation, ensure the strength and rigidity of the formwork, and provide a strong guarantee for improving the quality of concrete pouring.

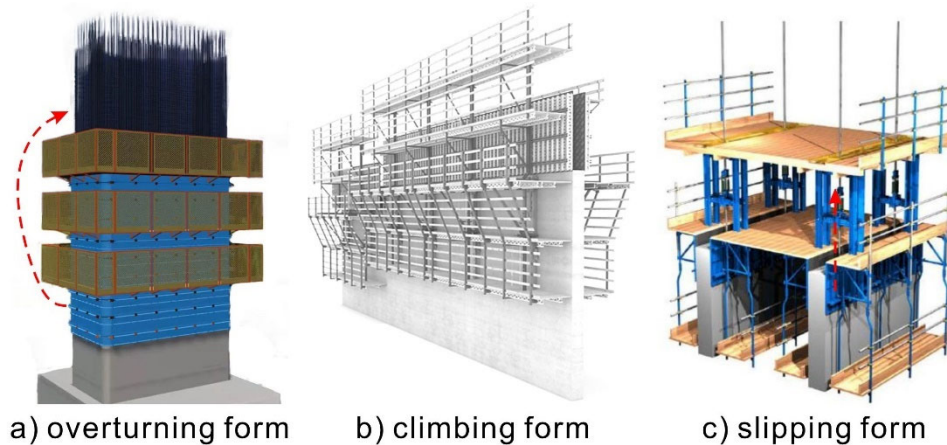


Figure 3. High bridge pier column construction mainly form systems

Form-turning construction is a common construction process used in high pier and column projects, see Fig 4(a). Turning the mold construction sequence is: the template segments installed after the completion of pouring concrete; to be the lower concrete solidification, the removal of the lower template, the use of cranes or other equipment, the lower template will be lifted to the template is not dismantled, connected to a single unit, and continue pouring. Repeat in this order until the design height of the pier column is reached. To solve the safety risk of turning the mold construction can only be the template dismantling mechanization, and ultimately became a climbing mold, but climbing the mold to solve the safety but greatly increased the template cost and reduce the construction efficiency. Unlike the overturning formwork construction, climbing formwork generally

choose to use hydraulic technology for construction see Fig 4(b), hydraulic climbing formwork adopts hydraulic to guide rail lifting system to solve the safety problem of overturning formwork dismantling and installing, but its mechanism is complicated resulting in high price, and there is a pair of tensile screw resulting in the appearance of poor and process increase. The most prominent common disease or problem of sliding formwork construction is poor appearance quality see Fig 4(c), the root cause of which is the direct friction sliding between the formwork and the concrete which is not fully solidified, and the friction and adhesion between the two develop with time, resulting in premature demolding, the lower part is easy to deform, collapse, fall off, and even lead to safety accidents. A little longer time out of the mold may lead to concrete surface loosening, cracking or falling blocks, too long time out of the mold is difficult to slide up to lead to the yielding of the support bar, platform tilt and other problems, serious cases can not lift the formwork.

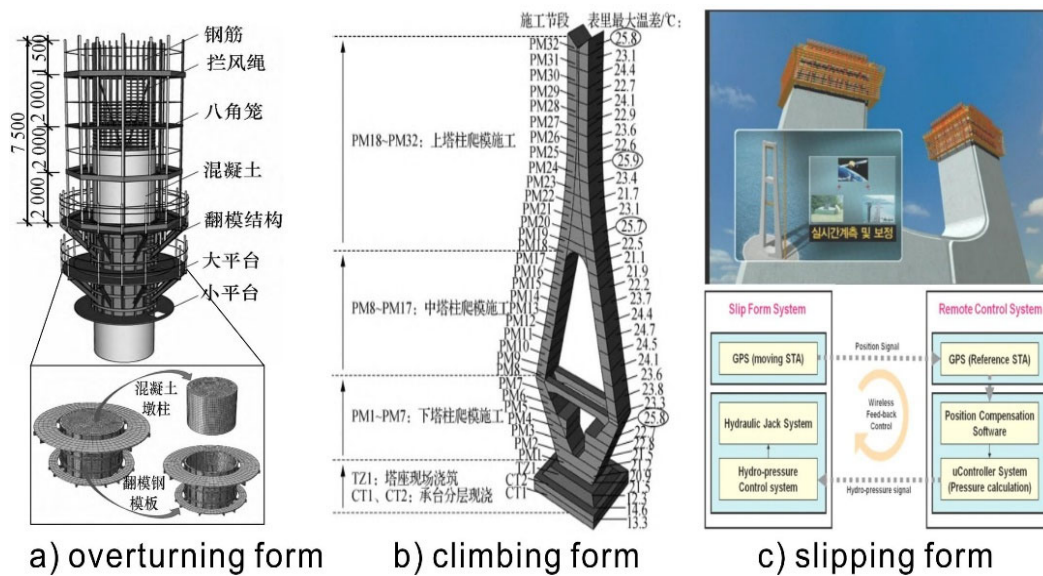


Figure 4. The load analysis of formwork and the analysis of key control factors for stability [8-10].

3. Measures to Improve High Bridge Pier Construction Technology and Safety

3.1. Enhancing pre-construction preparations

In order to ensure the smooth implementation of the project and high quality completion of the project, it is necessary to do a good job in the preliminary preparatory work. Among them, detailed geological exploration and foundation design are essential links. On the basis of the preliminary work, in-depth exploration of the geology of the area, accurately grasp the stratigraphic structure of the area, the water level and the nature of the rock body and other key information, so as to provide a scientific basis for the subsequent foundation design. On the basis of the detailed geological investigation information, the designers can better develop a more reasonable and safer foundation design program, effectively avoiding the geological risks that may arise during the construction process.

3.2. Rigorous control of construction process

To ensure the quality and safety of the project, the construction process must be strictly controlled. This requires us to carry out the construction in strict accordance with the construction specifications and operating procedures to ensure that each process is accurate and meets the required standards. This requires not only fine control of the construction process, but also comprehensive and standardized management of raw materials, equipment performance and personnel operation. This will minimize construction errors and significantly improve the quality of the project.

3.3. Application of advanced construction techniques and system

The adoption of advanced construction techniques has become an important means of improving construction quality and increasing construction efficiency. Among them, the introduction of the formwork support system is a significant progress. The system adopts advanced materials and technologies such as high-strength steel and precision connecting mechanism to ensure the stability and precision of the formwork, which can significantly improve the quality of concrete pouring and molding. Besides, to avoid friction sliding between the contact surfaces of formwork and concrete, we innovatively propose a “soft release” construction method see Fig 5, which is envisioned to add a layer of rotating belt between the steel formwork and the concrete, using the difference in friction coefficient between the rotating belt and lifting the formwork, the rotating belt is bonded by the concrete with a great friction forcing the rotating belt to run in cycles. After lifting the formwork, the rotating belt is bonded by the concrete with great friction forcing the rotating belt to circulate.

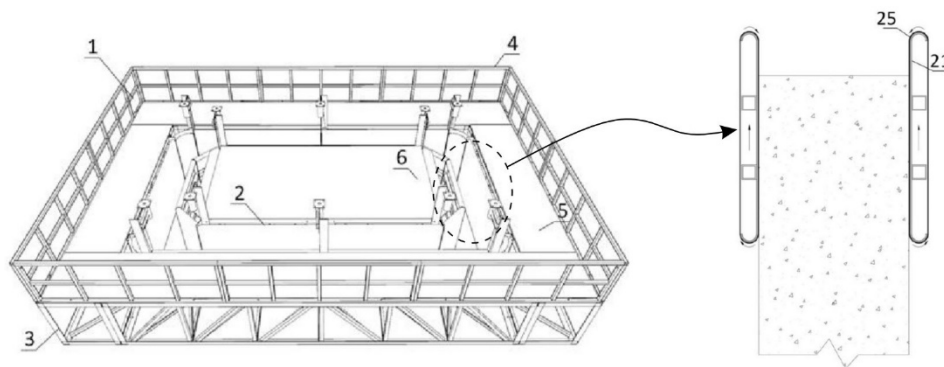


Figure 5. The rolling formwork system for soft release construction.

4. Summary

The current research direction of high pier construction is presented as safer, more economical, more convenient, more environmentally friendly and more intelligent. Bridge pier high pier construction technology is an important part of the bridge support structure, and the level of its technology is directly related to the overall stability and safety of the bridge. High-quality bridge pier construction technology can ensure that the complex environment and loads under the action of the bridge pier can still maintain stability, while improving the safety construction level and productivity. The current bridge pier construction mainly adopts turning mold, climbing mold construction process, construction efficiency is low, high cost. Sliding template technology construction speed, but there are many defects, and poor appearance, the current high pier construction belongs to the industry's high-risk operations, turning the mold construction is gradually out of the trend, through the new rolling mold construction process and other innovative construction methods of research, highway high pier quality control has important practical significance and theoretical value. Continuously explore the new advanced bridge pier construction technology, to ensure the stability of the bridge structure, the quality control of highway high pier column has important significance.

Acknowledgements

This work is supported by the Science, Technology and Innovation Project Foundation of Yunling construction co, ltd of YCIC group (YLJS-KF-2024-01).

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