

Research on Application Technology of Prefabricated Concrete in River Retaining Wall Engineering

Gewei Wang, Qian Liu

China Construction Second Engineering Bureau Civil Engineering Group Co., Ltd., Beijing 100000

Abstract: Prefabricated concrete is widely used in river retaining wall projects. As a new type of construction material, its application in river retaining wall projects not only effectively improves the construction progress but also greatly enhances the construction quality. The Infrastructure Project of Dianjun District Electronic Information Industrial Park (General Contracting for Ecological Environment Comprehensive Treatment Project of Qiaobian River) undertaken by China Construction Second Engineering Bureau Civil Engineering Group Co., Ltd., as a key water safety guarantee project in Yichang City, adopts prefabricated concrete retaining walls. Starting with the introduction of prefabricated concrete, this paper analyzes and elaborates on the needs and challenges of river retaining wall projects, the application, cases, and prospects of prefabricated concrete in river retaining wall projects, aiming to provide reference for the practice of river retaining wall projects and promote the better development of river retaining wall construction.

Keywords: Prefabricated concrete; River retaining wall engineering; Design principles; Construction technology; Quality control.

1. INTRODUCTION

With the acceleration of urbanization and the improvement of people's living standards, river retaining wall engineering, as an important part of urban water conservancy projects, has received increasing attention. Traditional retaining wall engineering has problems such as long construction period, high cost, and high maintenance cost, which restrict its application in urban water conservancy projects. As a new type of material, prefabricated concrete has the advantages of fast construction, short construction period, and controllable quality, and is widely used in retaining wall projects. The application of prefabricated concrete in river retaining wall projects has corresponding requirements. Only by following relevant design principles, strengthening the application control and management of construction technology, and at the same time enhancing quality control, can the construction quality of river retaining wall projects be better guaranteed.

The total length of the river course for the treatment of Qiaobian River in Yichang is 11.8km, among which the main stream of Qiaobian River is 6.3km, from the intersection of Dianjun Avenue and Qiaobian River (river pile number K16+650) to the intersection of Jiangnan Third Road and Qiaobian River (river pile number K10+350). The main construction contents include river water safety guarantee project, water environment treatment project, and water ecological restoration project, with about 200 meters using prefabricated concrete retaining walls.



Figure 1: Treatment of Qiaobian River in Yichang

This paper discusses the application technology of prefabricated concrete in river retaining wall engineering based on the project situation and development status.

2. INTRODUCTION TO PREFABRICATED CONCRETE

Prefabricated concrete is a new type of material widely used in current construction engineering. Since its prefabricated components are produced in a manufacturing workshop and then assembled on-site, compared with traditional cast-in-place concrete, it has characteristics and advantages such as fast construction speed, short construction period, stable quality, environmental protection, and energy conservation. The production process of prefabricated concrete can strictly control the material ratio and processing quality, making it have higher strength, durability, and waterproofness. In river retaining wall projects, prefabricated concrete can be custom-made according to the design requirements of the retaining wall and quickly assembled on-site. This not only improves construction efficiency but also reduces construction risks and the occurrence of casualties, so it has been widely used in retaining wall projects.

3. REQUIREMENTS AND CHALLENGES OF RIVER RETAINING WALL ENGINEERING

River retaining wall engineering is an important civil project, playing an irreplaceable role in protecting urban water conservancy facilities and the safety of people's lives and property. The main function of a river retaining wall is to resist the erosion and damage to the riverbank caused by external factors such as floods, waves, and impact forces, and maintain the normal water level and flow of the river. However, there are a series of requirements and challenges in retaining wall engineering.



Figure 2: River Retaining Wall

First, river retaining wall engineering needs to have excellent performance such as high strength, durability, and waterproofness. Because the retaining wall is in a harsh environment and subject to large external forces, if the retaining wall itself has insufficient strength, it will lead to failure of the retaining wall, causing floods and safety accidents. In addition, the retaining wall needs to have good waterproof performance to prevent water seepage from causing damage to the retaining wall and affecting its service life and effectiveness.

Second, the construction of river retaining walls needs to consider construction efficiency and quality issues. Because river retaining wall engineering needs to be constructed in the river, the construction difficulty is high, the construction period is tight, and the requirements for construction personnel are also high. In addition, ensuring construction quality is also an important issue in retaining wall engineering; if there are mistakes in the construction process, it may lead to problems such as unstable structure and lack of durability of the retaining wall, affecting the effect of the retaining wall project.

Finally, since the construction and use of retaining walls will have a certain impact on the environment, such as land occupation and noise pollution, if environmental factors are not fully considered, it will lead to the unsustainability of river retaining wall engineering, thereby limiting its application in urban water conservancy projects. Therefore, environmental protection and sustainability are also issues that need to be considered in the construction of river retaining wall engineering.

Table 1: Comparison of Advantages and Disadvantages of Common River Ecological Slope Protection Forms

Types of Ecological Slope Protection	Advantages	Disadvantages
Plant-type Slope Protection	Low cost, simple and convenient construction, easy to maintain.	Limited ability to resist water flow and wind-wave erosion, high requirements for water flow conditions, and prone to deep gullies formed by rainwater erosion in the early stage, affecting the slope protection effect.
Self-Embedded Retaining Wall Slope Protection	Strong flood control capacity, layered structure, material-saving, variable shapes, low foundation requirements, good seismic performance, simple construction.	Not suitable for rivers with too large curvature, requires a large amount of stone materials.
Ecological Gabion Slope Protection	Strong integrity, water permeability, erosion resistance, and ecological suitability; wide application range, conducive to the growth of natural plants; low cost.	Requires a large amount of stone materials; local revetment damage needs to be repaired in time to prevent internal stone leakage and affect the stability of the bank slope.
Vegetation-type Ecological Concrete Slope Protection	Can provide a substrate for plant growth; good erosion resistance; high slope protection porosity, providing a breeding place for animals and microorganisms.	Needs alkali reduction treatment, and the price is higher compared to other revetment types.
Ecological bag slope protection	Good stability, with water-permeable and soil-impermeable filtering function, conducive to the rapid restoration of the ecosystem; simple and quick construction.	Easy to age; if the pores of the ecological bag are too large, the bag-like material is easily washed out by water flow, causing settlement and affecting the stability of the bank slope; while too small pores hinder the extension of plant roots, affecting the structural stability of the flexible slope and reducing water permeability.
Porous structure slope protection	Diverse forms; the pores of porous bricks can be used for planting grass, and the underwater part can serve as habitats for fish and shrimp; with strong water circulation capacity and erosion resistance.	The slope of the river embankment cannot be too large; the embankment must be firm, and the soil needs to be compacted; high cost, low construction difficulty, and large construction workload; not suitable for sandy soil layers or rivers with many bends.

4. ANALYSIS OF APPLICATION TECHNOLOGY OF PREFABRICATED CONCRETE IN RIVER RETAINING WALL ENGINEERING

4.1 Design Principles

The design of river retaining wall engineering needs to be analyzed and evaluated based on specific terrain, water level, water flow and other factors to determine parameters such as the length, height, and width of the retaining wall. When selecting prefabricated concrete as the material, factors such as its strength, waterproofness, and constructability should be considered. In addition, it is necessary to design key technologies such as the size, connection method, and prestress design of prefabricated concrete components.

4.1.1 Strength Design Principle

Among the factors affecting the safety and stability of river retaining walls, the strength of the retaining wall is undoubtedly the most critical. The strength design of prefabricated concrete retaining walls should consider factors such as the height, length, width, and load of the retaining wall, and adopt appropriate design parameters to ensure the strength and stability of the retaining wall. At the same time, sufficient mechanical performance testing of prefabricated components should be carried out to ensure their quality and strength.

4.1.2 Waterproof Design Principle

The retaining wall is in a complex environment with large water flow, so waterproofing is an important issue in retaining wall engineering. The waterproof design of prefabricated concrete retaining walls should fully consider factors such as the construction joints, connectors, and waterproof performance of materials of the retaining wall,

and reasonably select waterproof materials and waterproof processes to better ensure the waterproof performance of the retaining wall.

4.1.3 Assembly Design Principle

The assembly design of prefabricated concrete retaining walls should fully consider the on-site construction conditions to ensure that the size and shape of prefabricated components can meet the construction requirements of the retaining wall. In the design, it is necessary to consider the connection method during assembly and the construction sequence to ensure the structural integrity and stability of the retaining wall.

4.1.4 Maintainability Design Principle

The design of prefabricated concrete retaining walls should fully consider the convenience of maintenance. In the design, it is necessary to reasonably set inspection ports and maintenance doors to facilitate the inspection and maintenance of the retaining wall. At the same time, when selecting materials and components, their maintainability and maintenance costs should be considered to reduce the engineering maintenance cost and difficulty.

4.2 Construction Technology

Compared with traditional concrete construction, the construction process of prefabricated concrete in river retaining wall engineering is much simpler and faster. From the perspective of construction practice, the construction technology of prefabricated concrete in river retaining wall engineering is mainly controlled and managed from the following aspects.

4.2.1 On-site Measurement and Evaluation

Before construction, it is necessary to measure and evaluate the site to determine parameters such as the length, height, and width of the retaining wall, and assess construction conditions and construction risks. During the measurement process, it is necessary to accurately measure parameters such as the height, width, and length of the retaining wall to facilitate subsequent design and construction.

4.2.2 Prefabricated Component Production

The prefabricated components of the precast concrete retaining wall are completed in the production workshop, including the retaining wall's columns, beams, connectors, etc. Prefabricated components need to be manufactured in accordance with design drawings and strictly inspected and controlled according to quality standards. During the manufacturing process, attention must be paid to issues such as concrete mix ratio, pouring thickness, and concrete uniformity to ensure the quality and strength of prefabricated components.

4.2.3 On-site assembly and splicing

The on-site construction of the precast concrete retaining wall is carried out in the river channel, and the construction process needs to ensure the safety of construction personnel and construction quality. During the construction process, on-site assembly and splicing of prefabricated components are required, using technologies such as expansion bolts and steel bar connections to ensure the strength and stability of the retaining wall. At the same time, strict control over issues such as the mix ratio of concrete materials, pouring thickness, and concrete uniformity is necessary to ensure construction quality.

4.2.4 On-site quality control

The construction quality control of the precast concrete retaining wall is an important guarantee for ensuring project quality and effectiveness. During on-site construction, it is necessary to strengthen the quality control of concrete materials and the monitoring of construction quality to ensure the quality and stability of the retaining wall. At the same time, during the construction process, attention must be paid to the management and control of on-site environment and safety issues to ensure the safety of construction personnel and the quality of the project.

4.3 Quality Control

Quality control of precast concrete in river channel retaining wall projects is an important guarantee for ensuring project quality and effectiveness, mainly including three aspects: material quality control, on-site construction quality control, and structural quality inspection and control.

4.3.1 Material quality control

Material quality control of precast concrete retaining walls is a key link in ensuring project quality and stability. The quality requirements of concrete raw materials must comply with relevant standards, and quality inspection and control of raw materials shall be carried out. During the production process of prefabricated components, strict control over issues such as concrete mix ratio, pouring thickness, and concrete uniformity is required to ensure the quality and strength of prefabricated components.

4.3.2 On-site construction quality control

On-site construction quality control is a key link in ensuring construction quality in precast concrete retaining wall projects. During the construction process, strict control over issues such as the mix ratio of concrete materials, pouring thickness, and concrete uniformity is necessary to ensure construction quality. At the same time, it is also necessary to carry out on-site assembly and splicing of prefabricated components in accordance with the design drawings and requirements of the retaining wall, and use technologies such as expansion bolts and steel bar connections to ensure the strength and stability of the retaining wall.

4.3.3 Structural quality inspection and control

Structural quality inspection and control is an important quality assurance measure in prefabricated concrete retaining wall projects. By inspecting and evaluating key indicators such as the structural strength and waterproofness of the retaining wall, the quality and stability of the retaining wall are ensured. Common inspection methods include ultrasonic testing and tensile testing.

In practical applications, the quality control of prefabricated concrete in river retaining wall projects needs to be comprehensively grasped and managed in combination with actual conditions. It is necessary to strengthen the training and management of on-site construction personnel to improve their sense of responsibility and awareness of construction quality. At the same time, problems and defects in the project need to be rectified and improved in a timely manner to ensure the quality and stability of the project.

5. APPLICATION PROSPECTS OF PREFABRICATED CONCRETE IN RIVER RETAINING WALL ENGINEERING

With the rapid development of China's economy and the acceleration of urbanization, the construction and renovation tasks of river retaining wall projects are becoming increasingly urgent. As a new type of river retaining wall structure, prefabricated concrete has the advantages of fast construction, stable quality, safety and reliability, and will be more widely used in future engineering practice.

Looking to the future, we need to further deepen research and promotion in the following aspects:

5.1 Research on the Application of New Materials

Materials have a direct impact on the construction cost and quality of the project. Although the application of prefabricated concrete in river retaining wall projects has been widely promoted and applied, in view of different engineering environments and requirements, and with the continuous development of the construction industry, new materials emerge in an endless stream, which will also put forward higher requirements for construction materials in river retaining wall projects. Therefore, we need to continuously research and explore new concrete materials and structures to meet different construction needs and engineering requirements, so as to promote the high-quality and high-efficiency development of river retaining wall projects.

5.2 Exploration of New Construction Techniques and Technologies

Construction techniques and technologies have a crucial impact on the construction quality of the project. Improper selection of process technology or inadequate application of quality control will directly affect the

construction quality of the entire project. Only by continuously exploring new construction techniques and technologies can we better promote the improvement and development of the construction quality of river retaining wall projects. Therefore, in actual engineering practice, we need to combine different engineering environments and construction requirements, strengthen the exploration and research of new construction techniques and technologies, so as to improve construction efficiency and quality, and reduce construction costs and risks.

5.3 Strengthen Quality Control and Management

The quality control of prefabricated concrete in river retaining wall projects is an important guarantee for ensuring project quality and effectiveness. It is necessary to strengthen the supervision and control of construction quality and improve the quality and skills of construction personnel to ensure the quality and stability of the project.

6. CONCLUSION

In summary, prefabricated concrete has broad application prospects and development space in river retaining wall projects. In future engineering practice, we need to further strengthen research and practice on prefabricated concrete retaining walls, continuously promote the improvement of construction technology and quality control, and contribute more to the construction and development of river retaining wall projects in China.

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