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Research Article

Application Strategy of Carbon Fiber Composite Materials in Bridge Reconstruction Project

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Abstract: Initially, the materials used in the process of bridge construction were mainly wood, stone, etc., and gradually the concrete, steel and other types of special materials currently in-use were developed. With the current vigorous development of science, technology and social economy in China, the development of bridge projects has also been accelerated to a large extent. In recent years, China has not only studied on how to strengthen the performance of concrete, steel and other materials in bridge projects, but also the performance of the recently developed smart, nano-, fibrous and other types of materials. This paper focuses on the application strategy of carbon fiber composite materials in bridge reconstruction projects to serve as a reference.

Keywords: Carbon fiber; Composite material; Bridge reconstruction

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1 Introduction

As far as carbon fiber composite material is concerned, it is a new type of fiber material with high performance, and has application properties in terms of acid and alkali resistance, corrosion resistance, and electrical and thermal conductivity. On the whole, it has very broad development prospects. It is widely used in the fields of automobile, chemical industry, machinery, etc., especially showing excellent application effects in bridge projects. Based on carbon fiber composite materials, this paper analyzes its application strategies in bridge reconstruction projects, showing certain practical research significance.

2 Overview of Carbon Fiber Composites

The so-called carbon fiber is produced by a series of heat treatment conversion of the original organic fiber. Among them, the inorganic high-performance fiber with carbon content higher than 90% is a new type of material with certain application advantages developed in the current mechanical performance research. On the one hand, it has the inherent characteristics of the carbon material itself; on the other hand, it also has the soft and processable characteristics of the textile fiber, which is the most recent reinforcing fiber being developed.

3 Application Strategy of Carbon Fiber Composite Materials in Bridge Reconstruction Projects

3.1 Bridge Construction

The application of carbon fiber composite materials in bridge construction mainly refers to the production of carbon fiber composite materials into strands and rods, and then mixing them with steel bars for use. Carbon fiber composite materials can also directly replace the steel bars. Therefore, it plays a role in strengthening the concrete structure in bridge projects. The advantages of carbon fiber composite materials in terms of corrosion resistance and alkali resistance stand out when they are applied in concrete. Anger will corrode the metals, which will affect the lifespan of bridges. In the early 1990s, carbon fiber composite materials were made into strands and used in the

construction of post-tensioned pre-stressed concrete high-speed bridges for the first time in Germany, where a wedge-shaped system was adopted to anchor the bridge[1]. Overall, the application of carbon fiber composite materials in bridge construction, especially the production of strands and rods for use in bridge pre-stressed tendons and external tendons, provides a good basis for the application of this material in cable materials for larger-span bridge projects in the future.

3.2 Cables of Cable-stayed Bridge

When the cable-stayed bridge is in use, the main reason for the damage of the cables and slings is the corrosion of the components. As far as the engineering properties of cable-stayed bridges are concerned, the requirements for material fatigue and corrosion resistance are relatively high, and carbon fiber composite materials have good performance in corrosion resistance and fatigue resistance. Under such research background, some scholars have made carbon fiber composite materials into cable and sling materials used in cable-stayed bridges. For example, the Winterthern Storchenbrucke Bridge in Switzerland was partially constructed with carbon fiber composite materials. On the whole, the cable-stayed part of the bridge was made of 2 carbon fiber composite bars, and each cable was assembled from 241 of 5mm carbon fiber composite tendons. With the vigorous development and progress of science and technology in the current era, the performance of carbon fiber composite materials in bridge projects will also be greatly improved, and it can further reduce the investment in cost at the same time. The strength of materials such as cables and slings incorporated with carbon fiber composites will also be improved.

3.3 Bridge Reinforcement

For the application of carbon fiber composite materials in bridge reinforcement, it specifically refers to the use of resin materials to bind carbon fiber composite materials to the surface of the bridge structure or bridge components. In this way, the structural part becomes a composite. The purpose is to promote the existing reinforced concrete and carbon fiber in the bridge to form a bearing surface, so as to further strengthen the bending and shearing capacity of the bridge project structure.

The reinforcement of carbon fiber composite materials can be divided into two types, one is reinforcement by carbon fiber cloth; and the other is reinforcement by carbon fiber board[2]. For the reinforcement in bridge projects, carbon fiber cloth is mainly used, and it has the following advantages:

First, it has very prominent reinforcement effects. Through epoxy resin, the carbon fiber cloth and the reinforced concrete components are bonded together to promote the cooperation between the two, thereby increasing the strength of the bridge. Meanwhile, the bearing capacity of the concrete structure and components in the bridge will also increase to a certain extent, thereby exerting functions on repair and reinforcement.

Secondly, it has the anticorrosion effects against acid, alkali and other media. Carbon fiber cloth is used in the reinforcement of bridges. During this period, the epoxy resin material is needed while other types of metallic materials are not required, so there will be no rusting issues and no need for carrying out regular rust prevention and maintenance of the bridge with the sticking steel method. This is especially suitable for the reinforcement of components where the bridge is located in a relatively harsh environment, especially in coastal areas and areas with relatively high air humidity.

Thirdly, it has the advantages of convenient and quick construction. As far as the nature of carbon fiber cloth itself is concerned, it has the characteristics of relatively low density, relatively light-weight, and good flexibility. It is used in the reinforcement of bridge projects, and the size is tailored according to engineering requirements, with very strong operability. During the construction period, small electric tools can be used to carry out the corresponding operation and construction, with no need of using large machinery and equipment, and no need of installing fixed facilities on the construction site. The occupied area is relatively small, and the requirements for the spatial environment of the operation are relatively low. In addition, the processing speed is also very fast. Compared with the sticking steel reinforcement construction, the reinforcement effect of carbon fiber is between 4 times and 8 times greater.

Fourthly, it can ensure that the original bridge structure is not altered and improve the aesthetics of the bridge. This part of advantage is not only reflected in the multi-layer carbon fiber cloth binding on the original surface of the bridge structure, but

also the ability to tailor and bind the carbon fiber cloth according to the bridge components, and these operations will not alter the original bridge structure. Meanwhile, the ornamentality of the bridge and the safety and reliability in actual operation can be further enhanced through decorative coatings, fireproof materials and other drawing operations on the outer layer of the bridge[3]. In addition to the above, as the carbon fiber material itself has the characteristics of light-weight and thinness, its thickness is only about 1mm after a single-layer carbon fiber cloth binding and the unit area weight after binding does not exceed 1.0kg, where this part of the weight includes the resin material. Based on the above, after the completion of the construction work, there will be no excess mass and system for the bridge components; in addition, the bolts do not need to be anchored in the epoxy resin binding process, so there will be no new damage to the original structure of the bridge, and multi-layer carbon fiber cloth binding can be carried out according to the stress of the bridge.

Fifthly, in addition to the above advantages, the cracks in the closed concrete structure of the bridge can be treated accordingly to help further extend the service life of the concrete structure; in addition, in the process of strengthening the bridge, carbon fiber composite materials have the characteristics of relatively simple operation, relatively short construction time, and also great flexibility. It can be used for various types of bridge reinforcement and repair operations without being restricted by factors such as component structure type, shape, and construction location. Meanwhile, this is also an advantage that many current structural reinforcement methods cannot match.

Regarding the application principle of carbon fiber cloth in bridge reinforcement construction, specifically, with the help of external force, the adhesives can concentrate the strength of the carbon fiber threads itself to promote the carbon fiber threads into forming a collective force in the carbon fiber cloth, thereby exerting a binding force on the core concrete, which can play a role in avoiding the yielding of the main reinforcement, further strengthen the bearing capacity of the reinforced concrete in the bridge, and play a role in strengthening the bridge.

4 Conclusion

In summary, the application of carbon fiber composite materials in bridge reconstruction projects can reduce the cost of reconstruction and has good application effects, and it is also the first choice for bridge reconstruction and construction; whereas the use of carbon fiber composite metals as the tendons in the pre-stressed concrete of the bridge, the cable or sling in the cable-stayed bridge, etc., can maximize the application characteristics of the materials, thereby reducing the proportion of steel in the bridge projects, continuously improving the application comparison of carbon fiber composite materials, which is of positive significance for the healthy development of China's bridge industry.

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