Research on Fiber Grating Materials based on Civil Application Engineering

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Abstract: Based on the defects of brittle failure of fiber reinforced composites, a study on fiber reinforced composites based on civil engineering applications was proposed. The characteristics of fiber reinforced composites were analyzed and repeated demonstration. The results showed that the normal cross section of the reinforced polymer reinforced polymer reinforced concrete beams was in bearing capacity, cracking bending moment and material resistance. Durability and so on are of practical value and great significance in practical civil engineering.

Keywords: Civil engineering; Applied research; Composite materials

1. Introduction

A bridge built by the U.S. state government is the first fully composite material bridge, which is made of almost cement [1-4]. It is designed to refer to the American highway system and technology. After the completion of the construction, the carrying capacity and strength of the University of delhwa were tested in a comprehensive way. The test results showed that it fully met the requirements. The completion of this composite material bridge determines the status of the composite material in the design and application of the bridge structure[5-7].

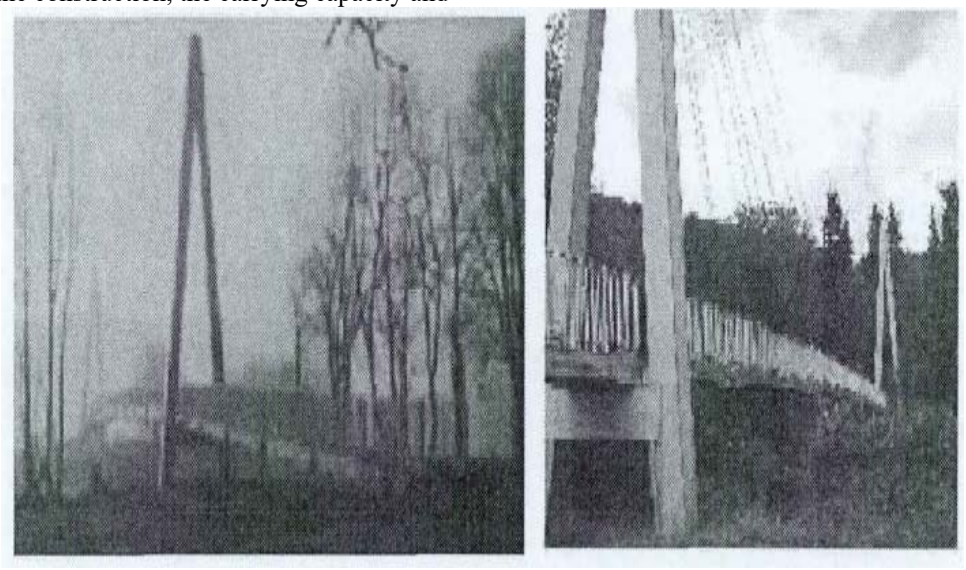

Figure 1. Fiber reinforced composite bridge

Japan is an early research country on fiber reinforced composites, as shown in Book 1. The world's first prestressed concrete bridge with carbon fiber reinforced polymer bars was born in Japan [8-9]. The smooth completion of the bridge also indicates that the prestressed carbon fiber reinforced polymer disk can replace the steel plate to build a long-span bridge, but the construction must be strictly observed in the construction, and the quality and quantity should be completed. With the characteristics of fiber reinforced polymer reinforcement, the safety hidden danger caused by corrosion of steel bar can be eliminated by replacing prestressed steel strand anchor with prestressed fiber reinforced polymer reinforcement. In the 80s of last century, non-metallic anchor rods were replaced by fiber reinforced polymer bars abroad to replace traditional steel bolts.

2. Structure and Principle of Fiber Prague Grating

Fiber Prague grating (FBG) is the most common fiber Bragg grating. It is formed by changing the refractive index of the fiber core region and producing small periodic modulation. The refractive index change is usually between the fiber core and the ultraviolet light source of the periodic space, and the refractive index change can be produced in the fiber core. One of the main techniques used to make this fiber Bragg grating is to illuminate the optical fiber by using the spatial interference fringes formed by two coherent ultraviolet beams, thus forming a permanent periodic refractive index modulation in the core of the fiber.

The refractive index distribution and reflection and projection characteristics of fiber Prague grating are shown in Figure 2.

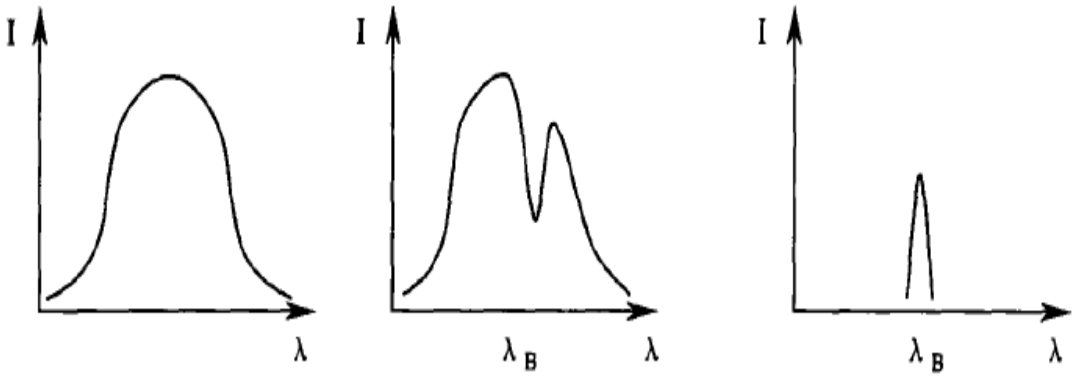

Figure 2. Schematic diagram of fiber Prague grating

The mathematical relationship between the central wavelength and the effective refractive index of fiber Bragg grating is the basis for the study of fiber Bragg grating sensing. Based on the Maxwell classical equation and the optical fiber coupling model theory, the basic expression of the reflection wavelength of the Prague grating is obtained by using the orthogonal relation of the transmission mode of the fiber Bragg grating.

$$\bar{s}_e = \arg\min \bar{s}_e(r) \tag{1}$$

From the formula (1), it can be seen that the wavelength of the fiber Bragg grating is determined by the effective refractive index of the fiber Bragg grating and the optical fiber period. Any physical process that changes the two parameters will cause the wavelength shift of the fiber Prague grating.

Characteristic analysis of matrix material for fiber reinforced composites

Fiber reinforced composites consist of fibers and polymers. Because of the structural characteristics of fibers, they hardly react with alkali solutions. The interaction between the matrix and the medium leads to corrosion, which is divided into two parts: physical action and chemical action. Chemical action mainly refers to the failure of the resin molecules due to the destruction of the chemical bonds under the action of the medium, resulting in the destruction of the whole structure and the decrease of its performance. Therefore, the most fundamental reason that affects the corrosion resistance of resins is their own chemical structure. Physical action is the swelling and dissolution of the matrix due to the adsorption medium, resulting in the destruction of the resin structure and the decrease of its performance. The epoxy resin is mainly formed by the curing of acid, and the acid matching agent can have the effect of vinegar bond saponification with the alkali solution, which has an irreversible effect on the composition of the fiber reinforced composites, and the quality and water absorption of the fiber reinforced composites change.

3. Calculation of Polymer Reinforced Concrete Bridge With Fiber Bragg Grating

The fiber Bragg reinforced concrete beam reinforced concrete beam will show the curve when it bears the crack of the building bridge, so that the tensile strength of the concrete can be maximized and play the most important role, as shown in Figure 3.

The formula for the cracking bending moment is as follows:

$$\bar{s}_e(s) = \left\langle \frac{said_i}{\bar{s}} \right\rangle . \frac{1-\bar{s}_e(s)}{r(\bar{s})} \tag{2}$$

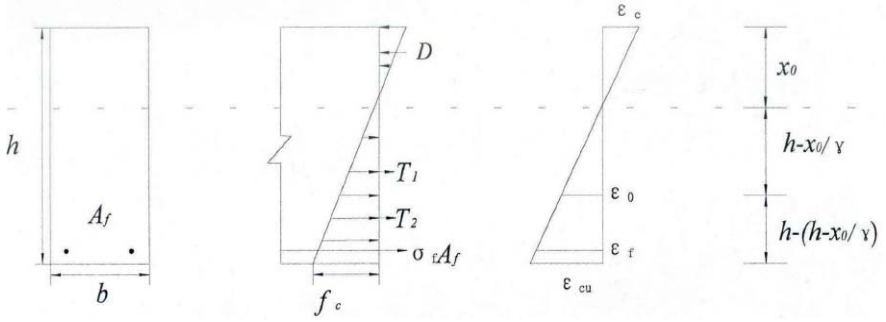

Figure 3. Tensile strength of concrete

In the formula, the bending moment generated by the load on the fiber reinforced polymer reinforcement; $\bar{r}(s)$ is the bending moment produced by the load on the concrete in the cross section. $\bar{s}_e(s)$ is the design value of the axial compression strength of the concrete, and the $\bar{s}_e(s)$ is the elastoplastic resistance moment of the reinforced concrete beam section of the reinforced polymer reinforcement. This plastic deformation is mainly produced by the plastic deformation of the concrete in the drawing zone.

Based on the consideration of the effect of the plastic deformation on the coagulation in the drawing area, the plastic coefficient $\bar{r}(s)$ is introduced, and the elastoplastic stress is simplified into a strain of elastic stress in combination with the material mechanics method. The calculation formula of the cracking moment of the reinforced concrete beams with fiber reinforced polymer is established. At this time, the concrete stress in the tensile area is linearly distributed, and the concrete stress at the edge is $\bar{r}(s)$. The formula for replacing $\bar{s}_e(s)$ is:

$$\bar{s}_e = \arg\min \bar{s}_e(r).\frac{1-\bar{s}_e(s)}{\bar{r}(s)} \qquad (3)$$

4. Mechanical Properties of Fiber

Different composites, types, contents and properties will affect the mechanical properties of fiber reinforced polymer bars. The mechanical properties are closely related to the load status, the duration of the load, the temperature and humidity in the air, and also play an important role. The compressive strength of the fiber reinforced polymer can be maximized and the mechanical properties are very high. Even when the ultimate tensile strength is reached, the deformation and bending will not occur, so the manufacturer should pay attention to its arrangement and initial stress condition when producing the material. Because the fiber reinforced polymer material has the brittle side, it is difficult to test its strength value. In order to get the tensile strength, the special anchorage device will be used in the test. It can guarantee the strength failure of the fiber reinforced polymer specimen to take place in the measuring range.

5. Application of Fiber Reinforced Polymer Bars In Civil Engineering

Glass fiber is one of the earliest materials used in all fiber reinforced polymer materials. Because of its practicality and cheap price, it is widely used in high-tech products and so on, which greatly reduces the waste and investment of resources. In the military field, it is also possible to use the particularity of this material to transport it to a variety of military facilities, which can effectively prevent it from radar jamming and create an advantage for the electrochemical environment.

With the development of fiber, matrix materials and composite molding technology, the application of fiber reinforced polymer tendons has a new direction. The tensile strength of the fiber reinforced polymer is very high, and the tensile strength of the glass fiber reinforced composite reinforcement is one. It can be arranged in the tensile zone of the beams and columns, such as the ordinary force and the internal and external tendons. The application of fiber reinforced polymer in various civil buildings will be very extensive and will become an important engineering material after the basic materials such as reinforcement and concrete.

In the process of the application of fiber reinforced polymer, it is found that although the glass fiber reinforced polymer is cheaper, its quality is large and the modulus is low, it is not recommended to be applied in some projects with high specific modulus and high specific strength, which can be used for the selection of lighter carbon fibers and aromatic groups according to the specific strength requirements. Polyphthalamide fibers and their corresponding reinforced composites. In

the field of civil engineering, fiber reinforced polymer has the characteristics of light and high strength. In the design of various light house structures, fiber reinforced polymer members can be selected. The design of fiber reinforced polymer is strong. It can be made according to the requirements of use, and can be applied in the daily items such as decorative material and water tank..

5.1. Problems in the application of civil engineering

The applications of fiber reinforced polymer tendons in bridges mainly include the following problems:
Fiber reinforced polymer is a brittle material which is used in bridge structures. The ductility of such bridges is not better than that of reinforced concrete bridges. Therefore, fiber reinforced polymer tendons are not suitable for bridge structures with higher ductility requirements, such as bridge structures with high seismic requirements.
Because of its poor fire resistance, fiber reinforced polymer bars are not suitable for use in bridge structures often in high temperature.
The glass fiber reinforced polymer bar is cheap, but the quality is large and the modulus is low. The use of the no economic carbon fiber and aramid fiber reinforced polymer in the bridge structure is light and high strength, but the cost of the product is high. Under the same condition, the cost of the bridge with these two kinds of fiber reinforced polymer reinforcement is better than that of the steel bar. The bridge is large.

5.2. Application effect

Because of the similar shrinkage rate between fiber reinforced polymer bars and concrete, the cohesive force between them is not easy to be destroyed, so as to ensure their joint stress.
The fiber reinforced polymer bar has less density compared with the steel bar. Therefore, applying it to the bridge structure can lighten the weight of the bridge.
Through the research on the bearing capacity of the cross section size and the section area of the reinforced bar under the same conditions, because of the corrosion resistance of the fiber reinforced polymer, it should be used in the component to reduce the structural bearing capacity caused by corrosion and can effectively improve the durability of the structure. The high tensile strength of the fiber reinforced polymer can not only make the strength of the structure higher than the strength of the ordinary reinforced concrete structure under the same condition, but the amount of the fiber reinforced polymer can be more widely applied in the construction project of the damp and alpine areas than the ordinary steel bar.

5.3. Reinforcement application of civil bridge structure

Due to the characteristics of carbon fiber reinforced polymer cloth, carbon fiber reinforced polymer cloth can be applied to bridge reinforcement. The use of carbon fiber reinforced polymer sheets under the plate can enhance the bending and shearing ability of the plate and prolong the service life, such as the bridge deck with serious wear and tear, and the method of no destructive concrete plus carbon fiber reinforced polymer cloth can be applied.
The surface of the cracked plate is leveled
Apply a layer of fine sand concrete as the leveling layer on the reinforced concrete beam table.
The epoxy resin is coated on the tensile area of the bridge, and the carbon fiber reinforced polymer cloth is coated at the same time.
A concrete example is given to illustrate the reinforcement method of fiber reinforced polymer cloth for bridge members. The method of carbon fiber reinforced polymer cloth can be applied in the repair works of pier as shown in Fig. 4.

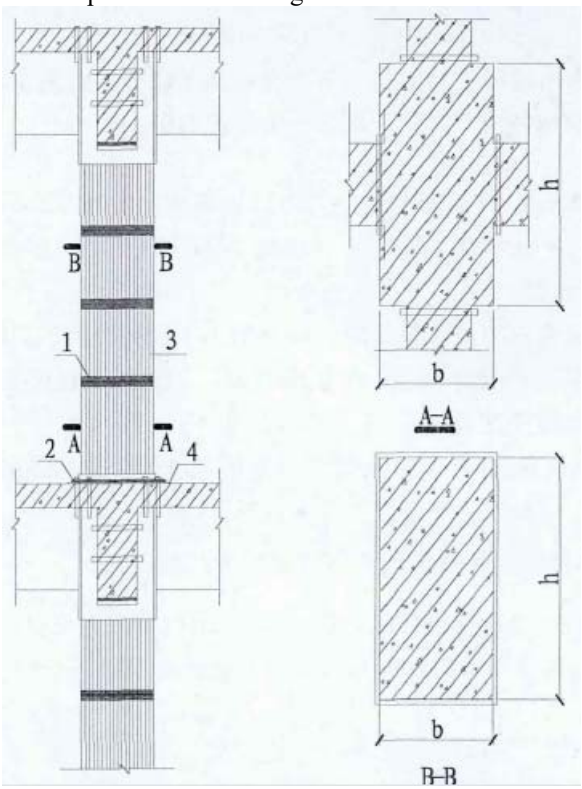

Figure 4. Reinforced concrete pier with carbon fiber reinforced polymer cloth

Carry out the construction according to the following construction plan:
First use shotcreting concrete to smooth the pier surface
Treatment of surface with sand blasting method after maintenance.
The adhesive polymer resin is covered in the area to be reinforced, and the multi-layer carbon fiber reinforced

polymer cloth with high thickness is covered. The circular fiber hoop is attached to the picture, and the longitudinal carbon fiber reinforced polymer cloth is bonded at the node. In the course of strengthening the concrete structure, the amount of carbon fiber is added to strengthen the polymerization cloth to ensure the rigidity and strength needed to reinforce the concrete component. However, the excessive adhesion of carbon fiber reinforced polymer cloth may cause the interface bonding and stripping failure of carbon fiber reinforced polymer cloth to achieve the desired reinforcement purposes, so the carbon fiber reinforced polymer cannot be overpasted in the application..

6. Conclusion

With the application and development of civil engineering construction materials, people have a better understanding of the application and performance of fiber reinforced composites and corresponding concrete structures, and have been widely used. Because fiber reinforced composite has the characteristics of light strength, high strength and design, it can play an effective reinforcing role in masonry and concrete structure. So that the building can better carry a certain weight and play a reinforcing effect. This paper not only gives an analysis, but also proves that the material is not available in the traditional material of steel and concrete. It has a wide application prospect and reference value in civil engineering.

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