Application of new carbon fiber material in sports equipment

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Abstract. The application of a large number of carbon fiber composite materials in competitive sports improves the level of competitive sports and promotes the development of sports. Select the carbon fiber composite matrix to optimize the design of sports equipment structure, and obtain the optimal form, thickness and number of layers of reinforcement grid; based on the obtained information and number of layers of reinforcement grid, establish the finite element model of sports equipment reinforced plate, analyze the relationship between the stability of sports equipment reinforced plate and bending stiffness, obtain the optimal structure of stiffness in the design space of sports equipment, and complete the optimization of stiffness.

Keywords: Carbon fiber; composite material; sports equipment; structural rigidity;

1. Introduction
Materials, energy and information technology are the three pillars of modern civilization. The research, development and application of carbon fiber composites have become the focus of science and technology competition in the world. Sports competition is also a venue for countries to show their comprehensive scientific and technological capabilities.

2. The role of carbon fiber composite materials in the development of sports
The application of carbon fiber composite in sports is mainly reflected in two aspects: one is direct application, the other is indirect application. Indirect application refers to various material requirements related to sports ground, referee equipment, information display, command communication, etc. Direct application refers to various material requirements related to athletes' equipment, including sportswear, sports shoes, hats, training equipment and competition equipment. At present, the carbon fiber composite materials used in sports equipment manufacturing mainly include carbon fiber composite materials, ademila fiber, boron fiber, new ceramic composite materials, amorphous metal fiber, single crystalline silicon carbide fiber, thermoplastic plastics (resin), etc. These carbon fiber composite materials are used in tennis rackets, badminton rackets, golf heads and clubs, bicycle racing, pole vault pole, baseball bat, fishing rod, ice knife, ice hockey stick, snowboard, mountaineering boots, rowing, sailing, canoeing, rowing, surfing, fencing, boxing, gymnastics training and competition platform, shooting and archery equipment, high jump equipment, various training ratios The game ball and various facilities are widely used. The extensive use of carbon fiber composite materials in sports greatly improves the quality and performance of field equipment and ensures the safety of athletes. Especially in recent years, with the significant progress of carbon fiber composite materials and new technology,
it greatly mobilizes the potential of athletes, promotes the continuous improvement of their own quality, and enhances their confidence to win. At the same time, it also puts forward higher requirements for human beings to overcome nature and challenge themselves.

3. Application of carbon fiber composite materials in competitive sports

When designing the carbon fiber matrix of sports equipment, because the external load position of the main bearing plate of sports equipment is set well, and its constraint direction is also set well, the main bearing plate is set into three parts: the upper panel, the lower panel and the rib grid through the carbon fiber composite forming process. Therefore, the optimization work is carried out from these three aspects. When the mass of sports equipment structure is constant, the bending rigidity increases, and the critical instability load of the structure will reach the maximum. If the compression stiffness increases to a certain level, the maximum critical instability load of sports equipment structure will reach the limit. With the increase of bending stiffness, the bearing capacity of sports equipment structure can be improved. The stable fold line at the top corresponds to the local instability of the skin. It can be seen here that if the skin instability occurs, the structural mass and stiffness changes of sports equipment will not significantly improve the bearing capacity. The high-efficiency panel design of sports equipment needs to follow the matching relationship between small mass and appropriate stiffness. The setting of material and stiffness has a high correlation with the bearing capacity of the structure.

In order to analyze the effectiveness of the method in this paper, the finite element model is constructed. Through the Patran finite element analysis, the first 5 frequencies of the main bearing plate of a sports equipment are obtained as shown in Table 1. According to Table 1, the first five natural frequencies of the main bearing plate of the experimental sports equipment optimized by the method in this paper are all greater than 400 Hz under different modal quantities, which shows that the rigidity of the main bearing plate of the sports equipment optimized by the method in this paper meets the actual application requirements, has high rigidity and meets the design requirements.

Table 1. First five natural frequencies of main bearing substrate of sports equipment after optimizing

| Modal Quantity | Frequency/Hz |
|----------------|--------------|
| 2              | 489.7        |
| 4              | 552.3        |
| 6              | 591.6        |
| 8              | 682.1        |
| 10             | 813.5        |

According to table 1, the natural frequencies of the first several steps of the main bearing plate of the experimental sports equipment optimized by the method in this paper are all greater than 400 Hz under different modal quantities, which shows that the rigidity of the main bearing plate of the sports equipment optimized by the method in this paper meets the actual application requirements, has high rigidity and meets the design requirements.

Table 2. Optimized results of agency model for stiffness and structural efficiency of sports equipment

| Number of layout bars | Overall effective height/ mm | Bottom flange width/ mm | First order loss | Structure of sports equipment Stiffness mass/ kg |
|-----------------------|------------------------------|-------------------------|-----------------|-----------------------------------------------|
| 9                     | 25.38                        | 19                      | 1.012           | 2.236                                         |
| 10                    | 26.75                        | 11                      | 1.006           | 2.233                                         |
| 11                    | 29.35                        | 6.44                    | 1.038           | 2.245                                         |
| Types of sports equipment                | Methods of this paper | Eclectic optimization | Optimization method of maximum stiffness shape |
|-----------------------------------------|-----------------------|-----------------------|-----------------------------------------------|
| Competitive sports equipment            | 0.99                  | 0.76                  | 0.75                                          |
| National defense military sports equipment | 0.99                  | 0.75                  | 0.76                                          |
| Folk sports equipment                   | 0.97                  | 0.78                  | 0.72                                          |
| Fitness equipment                       | 0.98                  | 0.77                  | 0.71                                          |
| Children's sports equipment             | 0.96                  | 0.79                  | 0.74                                          |
| Disabled sports equipment               | 0.99                  | 0.76                  | 0.72                                          |
| Auxiliary equipment                     | 0.97                  | 0.71                  | 0.72                                          |

Seven different types of sports equipment are set up, including competitive sports equipment, national defense military sports equipment, folk sports equipment, fitness equipment, children's sports equipment, disabled people's sports equipment and auxiliary equipment. Three methods are used to optimize the stiffness of the seven sports equipment. The stiffness coefficients of the equipment optimized by the three methods are analyzed and compared. The comparison results are shown in Table 3. According to table 3, after 3 kinds of optimization and 7 kinds of sports equipment are adopted, the rigidity coefficient of equipment optimized by this method is as high as 0.99, and the maximum rigidity coefficient of equipment optimized by compromise optimization method and maximum rigidity shape optimization method is 0.79 and 0.76 respectively. The results show that the stiffness coefficient of the optimized equipment is the highest and the optimization effect is the best.

4. Development prospect of new materials in sports equipment in the future

In the 20th century, human beings have made an unprecedented impact on their physical limit. However, recent scientific research shows that the era of breaking the world record, such as searching for things, has gone forever, and competitive sports have reached the edge of human physical limit. The essence of sports competition in today's world is the competition of science and technology, and advanced materials are one of the important conditions to improve the level of sports science and technology. In order to make new breakthroughs and create better achievements in the regions near the limit, people will hope to rely on the application of new technologies and materials. Therefore, all countries in the world, especially the developed countries, are sparing no effort to develop various high-tech materials and apply them to sports training and physical education equipment.

The new science and technology in the 21st century has studied the human body function from the molecular level and is affecting the development of competitive sports in all aspects. Its profound influence not only promotes the rapid growth of competitive sports achievements, but also promotes the scientific, humanized and personalized development of competitive sports

Exhibition. The new materials can build microchips, sensors and interface biomaterials that can improve the performance of competitive sports. They play an important role in muscle contraction, cell movement and differentiation, vesicle transport, signal transmission, especially DNA replication, curling and translation. People can develop a kind of micro biochip which can be implanted into human skin, simulate the glucose detection system in healthy human body to monitor the blood glucose level in the process of exercise, then release the sugar and other substances timely according to the needs of human body, maintain the blood glucose level in the process of exercise, and effectively improve the exercise ability of the body. Athletes can also plant micro biochips and artificial red blood cells with oxygen supply function in different body parts to improve the body level of the human body in the process of exercise, so as to effectively improve the oxygen transport capacity of athletes, and then achieve excellent results; through nano sensors, we can monitor the changes in the morphology and number of cell structures caused by exercise training. As well as the functional state of the functional
structure of each organ reflected by these changes, nano remote control is used for low-cost and effective health care. In the research of the mechanism of sports fatigue, due to the breakthrough of nanotechnology in medicine, the research on the mechanism of sports fatigue, especially in the central nervous system and its target organs and target cells will be more in-depth, which makes the mechanism of sports fatigue and excessive fatigue clear, and makes the methods of early detection simple and timely formulation of countermeasures. This has played a direct reference and supervision role for coaches to make training plans, and provided a basis for the scientific training process and training regulation.

Because of the fierce antagonism of competitive sports, sports injury is inevitable. Therefore, the repair of injured body is more important than prevention. But how to make more drugs enter the blood circulation through the skin and improve the efficacy of drugs is still a problem. Research shows that nano materials may play a role in promoting drug penetration through the skin barrier. Because of the particle diameter and large selective adsorption capacity, nanodrugs can have stronger penetration ability, so that more drugs can pass through the skin barrier, enter the blood circulation, and improve the drug efficacy. Especially with the application of nanotechnology in traditional Chinese medicine, traditional Chinese medicine has a better effect on the prevention and treatment of sports injuries and sports diseases. Nano ceramic has a wider application prospect in the field of artificial organ manufacturing and clinical application, such as artificial joint, artificial bone, ear and ossicular prosthesis, which provides material guarantee for the disabled to improve sports technology and body function, and create excellent sports achievements.

5. Conclusion
The development of modern sports must rely on the development of science and technology, which will inevitably promote the development of sports. In order to make new breakthroughs and create better results in the regions close to the limit, all countries in the world, especially the developed countries, are sparing no effort to apply various high-tech and new materials to sports training and sports equipment to improve sports performance. In the 21st century, with the continuous development and application of multi-phase composite materials, nano materials, information functional materials, superconductive materials, biomaterials, environment and energy materials, sports will further promote the scientization of sports equipment and venues, further mobilize human potential, improve the ability to overcome natural challenges, and thus promote the development of human civilization. Finally, it has a huge and far-reaching impact on the development of the whole human being.

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