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A review of experimental research on impact resistance of basalt fiber concrete

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Abstract

As a new material in recent years, fiber concrete has better performance than plain concrete. This article reviews the experiments on impact resistance of fiber concrete, especially basalt fiber concrete. This paper summarizes the experimental methods of some scholars at home and abroad for the study of concrete impact resistance, and introduces some applications and application scenarios of fiber concrete in today's society. It provides some basis for the future research on the dynamic experiment of fiber concrete in various fields, and accelerates some applications of new composite materials in today's society, especially in civil engineering.

Keywords

Basalt fiber concrete, impact test, numerical theory research, development and prospect.

1. Introduction

Concrete is a universal material and its fields are mainly in construction and engineering. In actual use, concrete needs to have a certain impact resistance to ensure the safety of buildings and projects. However, due to certain defects in materials, such as poor resistance to impact, cracking, and cracking [1-2], these shortcomings have hindered the development of the construction industry to a certain extent. In order to improve the practical application ability of concrete in daily life, many people have conducted research on the impact resistance of concrete.

In order to improve the impact resistance of concrete, more and more people are beginning to add fiber as a component to concrete to improve the impact resistance of concrete, thus fiber concrete was born. Since it can significantly improve the impact resistance of concrete [3], it is popular in various fields.

Fiber concrete is a concrete composed of adding fibers to the cement base material. It is a cement-based composite material composed of cement slurry, mortar or concrete as the basic material, and adding fibers as reinforcing materials. It is called fiber concrete. Fibers can prevent the further growth of cracks in concrete and improve its ability to resist cracks. Because the fiber itself has good tensile properties and is not easy to break, it can improve the tensile and bending resistance of concrete, and it can also greatly improve its impact resistance. Fiber concrete is divided according to fiber type.

So far, many researchers have done a lot of research on the mechanical properties of fiber concrete, and have also done a lot of experiments on basalt fiber concrete, polypropylene fiber concrete, steel fiber concrete, carbon fiber concrete, etc.

Researchers have done a lot of tests on fiber concrete, including some flexural and compressive tests, as well as some freeze-thaw tests. When multiple fibers are mixed together, researchers will look for the best fiber mix. quantity. In concrete mixed with multiple fibers, the mechanical properties of concrete are studied through different mixing methods [4-5].

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This article focuses on the impact resistance experiments of basalt fiber concrete. Since impact resistance experiments require a large amount of experimental research, it is particularly important to conduct a large number of material dynamics tests. Through the research results of domestic and foreign scholars and experts, we summarize the impact resistance performance of fiber concrete. We hope that it will be helpful to every scholar in various fields in the future to study fiber concrete.

2. Experimental study on impact resistance of basalt fiber concrete

In experiments to study the impact resistance of concrete, researchers usually use four different strain rate test devices to study the impact resistance of concrete, namely low strain rate, medium strain rate, high strain rate and ultra-high strain rate. In the drop weight impact experiment, some scholars will also use homemade drop weights to study the impact resistance of concrete, which provides certain help for studying the impact resistance of different concretes.

Research on the impact resistance of fiber concrete can be traced back to 1978. Hibbert and Hannant [6] designed a test equipment that can study the impact resistance of fiber concrete. By 1988, the American Concrete Institute [7] proposed a new test method that could improve research on the impact resistance of fiber concrete. With this method, many scholars at that time began to conduct a new round of experiments on the impact resistance of fiber concrete. During the experiment, many areas that were not good enough before were also improved.

Basalt fiber has the characteristics of high temperature resistance, corrosion resistance, and high bonding strength with concrete [8], and is suitable for being mixed into concrete. In order to study the impact resistance of basalt fiber concrete, Zhao Qingxin et al. [9] used a three-point bending impact test device to conduct research. In this experiment, the impact resistance of concrete is measured through the value of impact toughness. Tests have shown that chopped basalt fiber can improve the impact resistance of concrete, and the impact resistance is best when the fiber mass ratio is 0.36%. By obtaining the optimal quality of chopped basalt fibers in concrete, it provides a basis for future research in this aspect.

Li Dan et al. [10] used a homemade drop weight test device to study the optimal dosage of concrete impact resistance. By observing the number of damaging impacts of concrete, it was concluded that when the basalt fiber content is 3.15kg/m3, the impact energy of concrete, that is, the total impact energy absorbed reaches the maximum, and the impact resistance of concrete is the best.

In order to study the impact of fibers of different lengths on the impact resistance of concrete, Zhu Han et al. [11] used two types of basalt fibers of different lengths to make four different volumes of basalt fiber concrete, and used a drop weight impact test. Conduct an impact test on it. By observing the natural logarithm of the number of initial cracks and final cracks, it can be concluded that within a certain proportion range, the effect of short fibers is greater than that of long fibers, and the fiber content is proportional to the impact resistance of concrete. The greater the content, the greater the impact resistance of concrete , the better the impact resistance.

In order to study the effect of incorporating fibers at different ages, Dong Wei et al. [12] used a self-made drop weight test device to conduct research. Experimental results were obtained through five different dosages and under two different age conditions. The test results show that the impact ductility of concrete cured for 7 days is greater than that of concrete cured for 28 days. When the dosage is 1.0kg/m3, the impact ductility of concrete is the largest; when the dosage is 1.5kg/m3, the ratio of concrete's impact energy to impact toughness is the largest. Therefore, the optimal dosage of basalt fiber is between 1.0~1.5kg/m3. This study provides a

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rough quantification of the dosage of basalt fiber and provides a basis for a more accurate quantification in the future.

Studying the impact resistance of concrete is also of great significance for road engineering. In order to study the impact resistance of basalt fiber to aeolian sand concrete, Xie Guoliang et al. [13] used a self-made falling weight device to study the value of the impact resistance index. Through five different volume fiber content, the results show that when the volume content is 0.1%, the impact resistance performance index curve reaches the maximum, indicating that the impact resistance of concrete is the best at this time. This research provides a certain basis for cement concrete such as pavements to bear dynamic loads and lays the foundation for subsequent road development.

In summary, it can be seen that the impact resistance test of fiber concrete is mainly carried out through the drop weight test and SHPB rod test, which mainly reflects the impact resistance through impact toughness and ductility, crack changes and energy absorption. Researchers not only studied the impact resistance of various fiber concretes, but also studied the impact resistance of concrete from aspects such as length and diameter.

3. Numerical simulation and theoretical research on impact resistance of basalt fiber concrete

In the process of studying the impact resistance of concrete, since the impact resistance belongs to dynamic properties, material dynamics tests are chosen in most cases. However, before conducting tests, some numerical and theoretical analyzes are usually performed, so more and more people usually choose finite element or numerical analysis to analyze the impact resistance of concrete.

Finite element analysis is the use of finite element methods to analyze a physical object or physical system, whether it is static or dynamic. Finite element analysis is a good method when we want to analyze physical changes in a part or whole. Finite element simulation is a very powerful simulation software that can be of great value in many aspects. Since the selection of the fiber concrete model and the setting of its attributes are troublesome when simulating it, there must be higher requirements for the constitutive model during the simulation process.

Yoshikuma et al. [14] used separate Hopkinson rods to study the impact resistance of hybrid fiber high-strength concrete, and used finite element software to simulate some situations during the impact test. The results showed that hybrid fibers can improve the impact resistance of concrete. performance.

For basalt fiber concrete, Wang Song et al. [15] also conducted impact tests on basalt fiber concrete through separate Hopkinson rods. Since fiber concrete has relatively high requirements for the model, some parameters need to be corrected before the simulation can continue, and then simulate the HJC constitutive model after correction. The test results show that the impact resistance of basalt fiber concrete is improved compared to plain concrete.

Li Weimin et al. [16] established a constitutive model of basalt fiber concrete by using the finite element software ANSYS/LSDYNA to verify the accuracy of the data. The results show that the impact resistance of basalt fiber concrete is stronger than that of plain concrete, and it can still maintain a relatively complete whole after simulation.

Chen Pengfei [17] conducted a numerical simulation of a concrete wall mixed with basalt fiber through finite element analysis. By modifying the parameter changes of the fibers, the damage pattern of the fiber-incorporated concrete wall is significantly lower than that of plain concrete, which shows that the impact resistance of basalt fiber concrete walls is much better than that of plain concrete walls.

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In the process of numerical analysis, Zhan Shizuo [18] conducted a numerical analysis on the toughening effect of basalt fiber concrete, and then calculated the average distance between fiber centers when the amount of basalt fiber was optimal. The results show that when the basalt fiber content is 0.11179%, the average distance between the fiber centers of each group is closest, and the impact resistance of concrete reaches its optimum.

Yu Yong [19] et al. mixed basalt fibers with two different lengths and five different volume amounts into concrete to make basalt fiber concrete, and used Weibull distribution for statistical analysis of the test results. The results show that, under the premise of the same failure probability, the impact resistance of short-fiber concrete is better than that of long-fiber concrete by comparing the natural logarithm of the number of impact times for initial cracking and final cracking.

In addition to finite element models and other numerical simulations, there are other software and mathematical methods that can simulate fiber concrete. I hope that other scholars can find the best way to simulate fiber concrete in the future to build better models. Study the impact resistance of fiber concrete.

4. Development and prospects of basalt fiber concrete

Due to the development of society, fiber materials have been greatly used in various fields, not only widely used in industry, but also in military, metallurgy, aviation and other fields. For example, basalt fiber concrete is a relatively common type of concrete and can be seen in many places.

At present, the "Design and Construction Specifications for Basalt Fiber Composite Bars and Basalt Fiber Concrete" has been compiled in society, which is the prerequisite for the development of basalt fiber concrete. Basalt fiber can enhance the high temperature resistance of concrete [20-22]. If it can be widely used in buildings, it will be a good method for fire protection. However, because fire is a very complex scene, most of the current research only studies the compressive and flexural strength of basalt fiber concrete under high temperature. If a breakthrough can be achieved, it will undoubtedly be a major breakthrough in the field of materials.

Others are studying the corrosion resistance of basalt fiber concrete. Researchers [23-24] placed basalt fiber concrete test blocks in sodium sulfate solution. After 90 days, the test results found that the corrosion resistance of basalt fiber concrete has been improved. Of course, this must be done when the basalt volume content is 0.1%. If it continues to increase, the corrosion resistance will not increase but decrease. Therefore, basalt fiber concrete does have relatively good corrosion resistance, but this is only under the premise of one corrosion factor. It remains to be seen whether this ability will still exist under two or more corrosion factors. Go and research.

With the continuous development of society, the development prospects of fiber are getting better and better in our country. Not only are there more and more types, but they are used in more and more fields without having to bear too much cost. There are also more and more application scenarios of fiber in construction, machinery, chemical industry, etc. With the emergence of fiber concrete, various construction industries have higher and higher requirements for the building itself, and people are becoming more and more skilled in its use. Fiber concrete will definitely become the trend of future development, and the development prospects of fiber concrete engineering materials are very promising.

Since many fiber concrete components are studied from the aspect of impact resistance, when studying the impact resistance of concrete, it is necessary to study more from the fiber fracture mechanism and to study the internal structure of fiber concrete in different environments. how they interact.

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In short, fiber concrete, as a new type of composite material, not only promotes progress in materials, but also takes a big step forward in the industrial development of society. However, there are still many theoretical and application issues that require further research and development in the future. For example, in terms of funds, we cannot invest blindly, but must consider the use of various expenses. There is also the issue of whether it is suitable based on the performance of the material itself. I believe that fiber concrete will definitely play its value in my country's construction industry and other fields, and will continue to play a more critical role, and the application prospects of fiber concrete in future society will also be further expanded.

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