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Research on the Application of Environmentally Friendly Intelligent Materials in Civil Engineering

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Abstract:

This paper mainly focuses on the study of environmentally friendly intelligent materials. In this paper, optical fiber, intelligent concrete, piezoelectric materials, shape memory alloy (SMA), ecological cement materials are introduced. The principle, characteristics and application of these four kinds of environmental friendly intelligent materials in civil engineering are introduced in detail. The research shows that these materials have many advantages at the same time. First of all, for optical fiber sensing intelligent concrete, its advantages are high sensitivity and high flexibility, and resistance to high pressure and high temperature, so it is suitable for detecting the load inside the concrete. Secondly, SMA has the characteristics of high strength and high flexibility, which can be used for strengthening buildings and other aspects, effectively extending the service life of concrete. Piezoelectric materials have the characteristics of fast response speed and high precision, which can be used for safe control and evaluation of material repair ability. Finally, as an energy-saving and environmentally friendly intelligent material, the development of ecological cement materials helps to reduce carbon dioxide emissions and better protect the environment. At the same time, the development direction of environmentally friendly intelligent materials in the future is given to provide reference for its application in civil engineering.

Keywords: Environmentally friendly intelligent materials; shape memory alloy (SMA); fiber sensing Intelligent concrete.

1. Introduction

Climate change is a very serious challenge facing mankind today. With the development of industry, more and more carbon is emitted, which leads to global warming. Therefore, global warming began

to become a concern of the world. As people's awareness of environmental protection becomes stronger and stronger, in order to reduce carbon emissions, environmentally friendly materials are gradually studied. At the same time, due to the development of artificial intelligence, people's lives are becoming more and more convenient and the quality is getting higher and higher. Therefore, researchers try to combine environmentally friendly materials and intelligent materials together, and environmentally friendly intelligent materials are gradually invented. Environmentally friendly intelligent materials refer to new functional materials that can sense external stimuli, judge and appropriately handle them, and implement them on their own, while effectively reducing energy consumption. Environmentally friendly intelligent materials are making great contributions in many different fields. First, environmentally friendly intelligent materials are conducive to reducing energy consumption, which is due to their environmentally friendly features can provide the ability to recycle. With the development of human beings, resource consumption has become a major problem in the world, and this recyclability is a good feature to alleviate this problem. Secondly, because of its intelligent function, it also provides a great help in construction, workers can start to observe the data on the screen, and the data is very fine, the efficiency of workers is significantly improved, which means that the cost of the company will be reduced. This not only improves the ability to protect the environment, but also reduces the cost of the company. Therefore, environmentally friendly intelligent materials will become an important factor in the development of civil engineering.

2. Building Environmentally Friendly Intelligent Materials

2.1 Optical Fiber Sensing intelligent Concrete

Optical fiber is a fibrous optical communication media material, as shown in Fig. 1. Because of its higher optical signal efficiency than metal, it is more widely used than metal. The optical fiber is dual construction, the core part is high refractive index glass, and the surface part is low refractive index glass or plastic. The internal structure of the construction will change with the change of the external environment, so that the light in the fiber changes, it can feel the change from the sensor, and judge the performance of the building material at this time.

Fig. 1 Optical fiber [1]

Fiber sensing intelligent concrete is to bury fiber sensors in the key parts of the concrete structure to detect the internal stress of the concrete during the loading process, and to monitor the deformation, cracking and other damage generated during the loading process. The role of this type of concrete is to detect the changes inside the concrete during the loading process. The fiber itself is highly sensitive and flexible, so it has the characteristics of being able to withstand high temperatures and pressures well. In real life, optical fiber sensing intelligent concrete can be applied to many buildings, such as bridges. However, in order to be able to carry out the inspection smoothly, workers must also be arranged according to the requirements, so as to maintain the accuracy of the data. However, optical fiber intelligent concrete is still unable to be laid over long distances, which means that researchers need to further study the long-distance transmission of light information to improve the practical use of this material in daily life [1].

2.2 Shape Memory Alloy (SMA)

SMA is a material consisting of more than two metallic elements that have shape memory effects through thermoelastic and martensitic phase transitions and their inversion. SMA is the best material with shape memory performance. The purpose of SMA is that when materials are squeezed or bent, they can be heated back into their original shape. It has a shape memory effect. In order to recover the original shape, the alloy has high strength properties. It also has pseudo elasticity, shock resistance and adaptability properties. SMA can be used to strengthen buildings or repair and shock absorption function, effectively extend the service life of building concrete. Therefore, it has a great help for construction. At present, many countries have used SMA for the seismic function of many buildings. At the same time, there are also examples used in the field of building earthquake resistance, such

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as SMA shape memory effect, large resistivity and other characteristics of building structure concrete cracks can be inspected. At the same time, the change of resistance value can reflect the size of the crack, so that corresponding measures can be taken. Such behavior can prevent the further development of cracks and damage, thus effectively extending the service life of the material [1].

2.3 PiezoelectricMaterial

Piezoelectric material is crystalline material that has a voltage between the two ends when subjected to pressure, as shown in Fig. 2. It is a material that acts as a result of the piezoelectric effect. The principle of the piezoelectric effect is that when pressure is applied to a piezoelectric material, it creates a potential difference. If the pressure is reduced, more voltage is released, creating mechanical stress. Piezoelectric materials can produce electric field due to mechanical deformation, and can also produce mechanical deformation due to electric field action. This inherent electromechanical coupling effect makes piezoelectric materials widely used in engineering. Piezoelectric materials have the characteristics of fast response speed and high precision. Today, piezoelectric materials and technology have been used in many aspects of civil engineering, such as the control of sound generation, the control of safety, and the evaluation and repair capabilities of materials. When piezoelectric materials are added to civil engineering, the efficiency of work can be significantly improved [1].

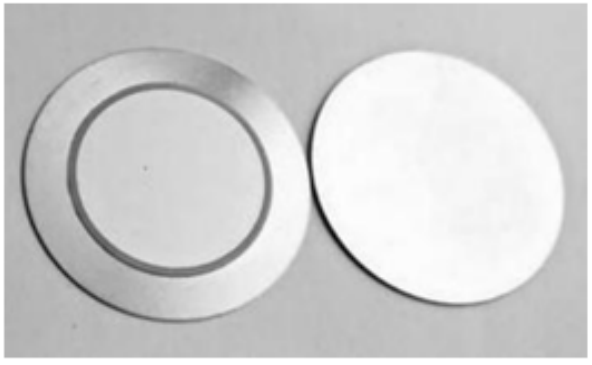

Fig. 2 Piezoelectric materials [2]

2.4 Ecological Cement Materials

Ecological cement refers to the hydraulic cement material formed by burning municipal waste into powder form after incineration. The biggest feature of ecological cement is energy saving, it consumes a lot of industrial solid waste, and gradually transition to the consumption of a lot of domestic waste. This product is not only of high quality and strength, but also can transform environmental pollution into environmental protection. It has many features, can make the waste regenerated and recyclable. The product is not dangerous to human health. It has good performance and can meet the needs of various construction. These characteristics make it make great contributions to the construction, for example, when making the foundation, the ecological cement will not only pollute the environment, but also its strength is very high, which shows its strong application ability. Ecological cement as a representative of energy saving and environmental friendly building materials, it can effectively reduce carbon dioxide emissions in the production process, so as to achieve environmental protection. In the construction project, cement as an important material, the demand has not been low. However, during its preparation, harmful gases can have a great impact on the environment. The emergence of eco-cement alleviates this situation. Ecological cement is not only helpful for environmental protection, but also can be used for low-level strengthening treatment because of its short setting time and high strength [3].

3. Future Development of Environmentally Friendly Intelligent Materials

In the development process of civil engineering, the characteristics of building materials are crucial, such as environmentally friendly, lightweight and high strength characteristics. The development of environmentally friendly intelligent materials can follow the following directions:

(1) Intelligence: With the development of science and technology, AI has begun to become a welcome object for people. In this case, the idea of incorporating intelligent functions into building materials was born, and such materials can also be reused, such as self-healing concrete.

(2) Environmental protection: With the enhancement of people's awareness of environmental protection, harmful materials are excluded, people gradually reduce the frequency of the use of harmful materials and begin to use environmentally friendly and harmless building materials. Therefore, in the development of this area, people can invent materials that can automatically degrade after being discarded, such as special concrete that will automatically degrade after feeling concrete is discarded.

(3) Versatility: In order to save costs, the function of each material can be considered to develop and increase. Therefore, the development of environmental friendly and energy-saving materials should be accompanied by the increase in function, not only to meet the characteristics of traditional building materials, but also should have environmental protection, intelligent and other modern functions.

(4) Saving resources: This mainly involves in the process of mining, development and use of materials, people need to reduce the consumption of resources as much as possible. At the same time, these materials are recycled and reused to reduce the impact on the environment, such as intelligent glass [4, 5].

4. Conclusion

In the development of civil engineering, the environmental protection, lightweight, high strength and other characteristics of building materials are essential. In this paper, the environmental friendly intelligent materials in the field of civil engineering are studied, and the following conclusions are drawn:

(1) Optical fiber sensing intelligent concrete, as an environmentally friendly intelligent material, not only has the characteristics of less pollution, but also is higher than traditional materials in terms of efficiency. Therefore, optical fiber sensing intelligent concrete has made a great contribution to the development of civil engineering.

(2) SMA has environmental friendly characteristics, so the harm to the environment will be effectively reduced. It also has impact resistance and pseudo-elasticity. Therefore, in terms of architecture, SMA has a great contribution, such as strengthening the building structure.

(3) Piezoelectric materials as a intelligent material, high efficiency is an obvious feature. Secondly, because it is generated by pressure, it also has characteristics such as pressure resistance, and it learns specific internal characteristics through pressure resistance. Therefore, piezoelectric materials can be used for the control of sound generation, can be used for the control of safety, and can also be used for the evaluation and repair capabilities of materials.

(4) The birth of ecological cement not only reduces carbon dioxide emissions, but also has the characteristics of short solidification time and high strength. Therefore, in terms of strengthening the foundation, ecological cement can play a role.

With the development of environmental friendly intelligent materials in the field of construction, various intelligent environmental friendly materials have been applied in civil engineering because of their own characteristics and advantages. This means not only improved civil engineering, but also more opportunities for people to study more novel buildings. In addition to civil engineering, the general improvement of buildings not only makes people's lives more convenient, environmental friendliness has been effectively improved, and the ability to resist natural disasters has also been improved. At the same time, major industries have more opportunities to develop new products. However, in order to ensure that intelligent, environmentally friendly materials can function effectively, the construction industry must have a deep understanding of the role of materials. In the future, researchers also need to improve the material to improve its shortcomings, so that environmentally friendly intelligent materials play a greater role in engineering.

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