Research on the Application of Green Building Materials in China

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Abstract. With the developing demand for living environment and increasing emphasis on the development of a green economy in China, using green building materials has gradually become a new opportunity for the development of our country’s construction industry. This article mainly makes an introduction about the concept, advantages of the GBM (Green Building materials), and some different types that are currently used in China, so as to have a more comprehensive and overall understanding of this kind of materials. In addition, we also elaborate on the problems in the use of GBM in this paper, and finally come up with some corresponding suggestions. We hope that through this short article, relevant researchers will have more understandings of the application of GBM, and we also hope that some references can be useful for the progress of sustainable development in the construction industry of China.

1. Forward
The report of the 19th National Congress pointed out that "we must speed up the reform of the ecological civilization system and build a beautiful China," and proposed that "We must advance green development and establish a sound economic system with a green, low-carbon cycle of development." As early as in 1996, the design of the British BRE's environment building reflected this awareness of green building materials. Since 2000, China's construction industry began to gradually increase its focus on “green”. And in 2010, when the Shanghai World Expo was convened, this concept was widely promoted. So far, China has put forward higher environmental protection requirements for development. “Green buildings” and “ecological buildings” have become the focus of attention in construction industries. Promoting the utilization of this kind of beneficial materials has become a key direction for development in the construction industry nowadays.

At present, the utilization of green materials in the construction industry is based on five major indicators, namely, they are: land conservation saving, energy saving, water saving, material saving, and environmental protection. According to the country’s emphasis on strategies, green building is bound to be the core goal of this strategy, and the adoption of the new materials will become an creative means in China’s construction industry to achieve the goal which include the reduction of energy using and pollution emissions. In the context of the new era, efforts should be made to explore the way of using the new types, and we should pay more attentions to the development trends, and push the construction industry to a new level.

2. The concept of GBM
During the first International Conference on Materials Science, the researchers firstly proposed the word “green building materials”. In 1992, the international academic community gave a definition for the green materials: recycling of raw materials, product manufacturing, application processes, and recycling after use, the least bad effects on the world's environment and human-beings. Afterwards, China has defined green building materials as follows: the use of clean production processes, the use
of advanced science and technology, no or less use of natural resources, heavy utilization of solid waste in industry and agriculture, the production of pollution-free, low-level radioactive materials and recyclable building materials; Till 2014, the MOHURD issued the "Administrative Measures for the Evaluation of GBM and Markings," and formally defined the definition of green building materials: the consumption of natural resources and the impact on the ecological environment throughout the entire life cycle can be reduced. It is a kind of building material product with the characteristics of “energy saving, emission reduction, safety, convenience and recycling ability”.

From the definition of the above-mentioned GBM, we can see that the focus of the researchers is on the production process, technology, emissions, whether it can be recycled and benefit to health.

3. The advantages of GBM

According to some authoritative studies on a variety of GBM now commonly used in China, compared with traditional building materials, they usually have the following advantages:

(1) Reduce energy consumption: Use waste slag and domestic waste as raw materials for production, or use renewable environmental protection materials to achieve the purpose of reducing the consumption of water resources and land resources, and use more advanced production technologies to increase energy efficiency, so the energy saving and emission reduction in the production process is able to realized, as well as the green environmental protection.

(2) Sustainability: Qualified materials can be used again after being produced and recycled for many times to avoid energy consumption and pollution emissions caused by repeated production or reproduction of materials.

(3) Health and harmless: Unlike traditional building materials, because of the material itself or the introduction of certain chemical substances, green building materials is not harmful for the human’s health while meeting functional needs.

(4) Good material properties: Most of the GBM have the characteristics of high strength, high water resistance, and light weight, which can reduce the cost of material handling and improve the quality of buildings.

In summary, the application of green building materials can not only improve the efficiency of the progress of production and construction quality, avoid health hazards, but also meet the requirements of sustainable development. Therefore, the state should promote the use of it and inject green vitality into the construction industry.

4. The application of China’s GBM

4.1 Current application status of GBM in China

According to a foreign research institution, the percentage of people who consider the application of green building materials in different countries is as follows:
Therefore, we can see that the attention of foreign residents put to green building materials is generally more than that of Chinese residents do.

In 2018, with the increasing attention of the construction industry to GBM, the proportion of its use has been greatly improved. The following table shows the proportion of green materials in China under different indexes.

Table 1. Application ratio of green building materials under different reference indexes

| Number | Reference Index                                                      | Percentage |
|--------|---------------------------------------------------------------------|------------|
| 1      | Increasing ratio of main business income in construction industry    | 20%        |
| 2      | Application ratio of green building materials in new buildings       | 30%        |
| 3      | Application ratio of green buildings                                | 50%        |
| 4      | Application ratio of GBM in pilot demonstration projects             | 70%        |
| 5      | The application ratio of GBM in existing building reconstructions     | 80%        |

4.2 Classification by the type of the GBM in China

For the application of this materials in construction projects, there are many ways to classify them. Overall, according to their scope of use, they can be divided into structural materials and functional materials:

1) Structural materials

In previous projects, stone, wood, steel, and concrete were commonly used as materials for columns, slabs, beams, and other structures. In the process of promoting the concept of energy conservation, bamboo gradually replaced this process. As a building structural material, bamboo has the irreplaceable advantages of wood - it has a short growth cycle, but also has the characteristics of high hardness and good toughness. Therefore, it is favored by people engaged in the green construction industry and has good potential capacity in the future.

2) Functional materials

The functional material differs from the structural material, because it possesses certain characteristics and also includes various functions of the new material, such as nanotechnology, intelligent materials, and superconducting materials. At present, we have witnessed a big success in the China's science and technology. New types of materials combined with matching scientific and technological means will surely shine in the industry. At present, there are some of the construction projects start to try to using nano-alumina during the construction process. Because of its high heat resistance, good moldability, strong surface acidity, and a certain surface alkalinity, it is widely used as a catalyst and catalyst carrier. Such as new green materials, it can be widely used in paints, waterproof materials, effectively playing a role in the construction process to help the deposition of powder, while
improving the quality of the waterproof materials.

4.3 Classification by the use of GMB in China

The new materials can be divided into new types of wall materials, waterproof sealing materials, green decorative materials, thermal insulation materials as well. According to different uses. At present, many countries at home and abroad put their time and money into the research of green building materials. Currently, the most widely used green materials in construction are the following:

(1) Green vacuum glass
   The main channel for building lighting is glass. The glass used in traditional buildings is not insulated in winter and not insulated in summer. At the same time, the refractive index of harmful light such as ultraviolet rays is too high. The successful development of green vacuum glass has the advantage that traditional glass cannot match. It not only improves the shortcomings of traditional glass, such as poor thermal insulation and high refractive index, but also has a long life cycle, good heat insulation and sound insulation. The use of natural light to adjust the room temperature achieves the effect of energy saving.

(2) Ecological Cement
   In the traditional building, cement and concrete are indispensable materials in the building materials. However, in practical applications, the cement also has shortcomings and defects, such as a large amount of waste of mineral resources, as well as huge pollution to the environment during the production process. As the science technology in our country develops quite rapidly and the promotion of low-carbon and green countries is in a fast pace, ecological cement has been successfully developed. Its performance is similar to that of cement, and it can blend in with the environment. Ecological cement is produced from wastes such as steel slag and volcanic ash as raw materials. Compared with traditional cement and concrete building materials, carbon emissions have been greatly reduced, and resource consumption has also been reduced.

(3) Wall materials
   The production of green wall materials in buildings can use concrete hollow fast, fly ash, slag ash and other materials as raw materials. This green wall material has the advantages of high hardness, light weight, good energy-saving effect, recyclability of materials and so on.

In addition to the above-mentioned three widely used green building materials, there are many green decorative materials, such as deodorant sanitary ware, new ceramics, etc. These decorative materials are not only beautiful in appearance, but also have powerful functions. It can be seen that these are the advantages that traditional building materials do not have. New green functional materials meet the green requirements while also improve the performance of the building. Therefore, they should be more widely used and applied, and the construction industry in our country will be taken to a new step by using GBM.

5. Problems and countermeasures

The utilization of GBM in construction projects is extremely beneficial from a social and personal point of view as well as from a corporate perspective. Green building materials will certainly be promising in the future. Compared with foreign countries, China’s green building materials have developed relatively slowly. From the real situation, there are some problems still left to be solved in the future :

(1) There is a large amount of waste in China each year and comprehensive recycling of resources is not realized, and the overall rate of utilization is quite low. It will directly lead to the lack of supply of raw materials for the production of GBM and will also leave some bad effects on the production of materials.

(2) The technological input and raw material costs in the production of GBM are relatively high, and they are unfavorable to the cost control of products. Products lack price advantages, and they also affect the enthusiasm of social capitalists.

(3) In addition, there are few supporting policies as well as market forces, and our government
fails to keep pace with market propaganda, resulting in its influencing power not being widely spread, and forming a greater resistance to the development and promotion of GBM.

Therefore, in light of the above problems, combined with the actual application, this paper proposes the following improvements:

1) The state needs to strengthen the management of comprehensive utilization of resources to ensure that factory waste can be smoothly distributed to the production of the material.

2) We must increase capital investment in production technology research and development and raw material procurement, or use subsidies to reduce the cost of finished products, thereby increasing the price competitive advantage of products in the market and ensuring that more green building materials flow into the market.

3) At the same time, the relevant national authorities must issue relevant encouragement policies for the use of green building materials and increase their publicity efforts to arouse the attention of the industry, increase the enthusiasm of the capital, and the recognition of green building materials, so as to realize the full use of green building materials and make its role in the construction project more unshakable.

6. Conclusion
Based on the above discussion, this paper generally describes the concept, advantages and different types of materials of GBM. It also describes the obstacles encountered in the development of green building materials, and proposes corresponding countermeasures. I hope the study of this paper can help to promote the sustainable development of the construction industry to a certain extent.

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