

The Applications of Materials, Framework, and Designs in Green Buildings

Peiran Dong *

Department of Northeast, Forestry University, Harbin, China

*Corresponding author: 2019213221@nefu.edu.cn

Abstract. Facing environmental pollution and resource waste, the green building becomes more and more popular. This study analyses the advantages and future trends of green buildings from the green building materials, framework, and design. Green buildings were proposed in the 20th century and slowly developed into the dominant architectural model today. The application of green building concepts in architecture focuses on three components of green materials, green frames, and green design. Green materials are the basis for the implementation of the green building concept, more and more high-performance, environmentally friendly green materials have been developed, effectively reducing environmental pollution and harm to the human body. The green framework is an integral part of the implementation of the green building concept, and the green framework composed of green materials can effectively use natural energy to replace or convert it into advanced energy, effectively reducing energy consumption and environmental pollution. Green design is the specific performance of the combination of the green building concept and the building, both improving building beauty and the environmental quality. It indicates that the concept of the green building makes better use of energy to create personalized buildings that are harmless to the environment and better use energy, providing residents with a more comfortable environment.

Keywords: Green Building, Green Material, Green Framework, Green Design, Environment.

1. Introduction

In the 1960s, the American architect Paul Soleri proposed a new concept of ecological architecture. In 1980, the World Conservation Organization for the first time put forward the slogan of "sustainable development", while the energy-saving building system was gradually improved, and it was widely used in developed countries such as Germany, Britain, France, and Canada. In 1992, the "United Nations Conference on Environment and Development" popularized the idea of sustainable development, and green building gradually became the development direction; More and more green environmental protection materials are being applied to the construction of modern civil engineering.

In the whole building life cycle, the green building saves resources, protects the environment, reduces pollution, provides people with healthy, suitable, and efficient use of space, and maximizes the harmonious coexistence of man and nature [1]. It is a kind of high-quality building, which can better handle the relationship with nature under the premise of being people-oriented, maximizing the protection of the environment, and meeting people's pursuit of a better life. It mainly refers to a building that can coexist with the natural environment under the premise of not causing adverse impacts on the environment and can make full use of the natural resources of the environment to maintain the original balance of the surrounding environment as much as possible [2].

In recent years, the number of green buildings has shown a spurt of growth, more and more green building materials are also being developed. With the promulgation of green environmental protection policies, green buildings are becoming more and more popular. This study analyses the advantages and future trends of green buildings from the green building materials, green building framework, and green building design.

2. Green building materials

Materials of green buildings commonly include high-performance cement concrete, light high-strength concrete, hollow brick, composite brick, etc. These new green materials are mainly

comprised of coal gangue, fly ash, slag, and other industrial waste slag synthesis. This study mainly discusses three new green materials in detail: ecological cement, high-performance concrete, and a new type of ecologically protected ceramic permeable brick.

Ecological cement refers to the use of municipal garbage incineration ash and sewer sludge as the main raw materials, which are formed by water and hard cement material. It is conducive to environmental protection with five characteristics. First, it has raw materials to save natural resources. Second, the production and use of the process are beneficial to environmental protection. Third, its waste can be reused resources. Fourth, it is conducive to human health. Finally, it has good performance with the basic characteristics. The development and practice of ecological cement technology are not only conducive to curbing the evil of the ecological environment, but also promote the recycling of incineration ash and sludge in sewers. For cement companies, especially in large cities, the production of cement from industrial waste and municipal waste is not only necessary but also technically feasible. The cement industry in large cities should change its concept and establish a new concept based on the disposal and utilization of municipal waste, supplemented by the production of cement [3].

High-performance concrete materials are a new type of green and environmentally friendly building materials, and the emergence of such materials has effectively filled the material gap in the construction industry. Ordinary concrete raw materials in the actual utilization process have higher energy consumption, resulting in serious pollution. In order to avoid such problems, it is necessary to increase the importance of high-performance concrete and strengthen the effective use of high-performance concrete in the actual construction process. This high-performance concrete has many application advantages, such as the use of modern technologies, which can improve the strength and durability of concrete. Its doping part of the industrial waste residue can reduce the use of clinker cement. The overall strength of the concrete structure is strengthened, thereby reducing the pollution of the surrounding environment and the harm to the human body [4].

In addition, a new type of ecologically protected ceramic permeable brick (EPCPB) is developed and used in the construction of roads. It has a length of about 210 mm, a width of 110 mm, and a height of 55 millimeters. In the process of use, there needs to be a gap of about 3 mm between the two bricks, which is conducive to the retention of water from the middle and can be applied to the construction of roads inside the city. The surface of the permeable brick is covered with pores when encountering rainy weather, the water could flow into the underground sewer through the pores, avoiding the formation of a large amount of water on the road surface. It has the characteristics of good water permeability, good water absorption, and heat absorption, good ecological and environmental protection performance, and good anti-freeze and anti-slip properties. EPCPB also has an important practical value, with good permeable ecology is good, and its application in the construction of urban roads can effectively avoid the formation of water on the road and facilitate traffic[5].

3. Green building frame

The natural foundation is a natural soil layer that can meet the requirements of bearing all the loads of the foundation in the natural state. It does not require human reinforcement, saving construction time and engineering costs. With its characteristics of economical, efficient, and environment friendly, it has gradually received attention in recent years, and its application scope is no longer limited to multi-story buildings, small high-rise, and even high-rise buildings. However, the application of natural foundations has some limitations. The major one is that it is difficult to find a suitable geological condition to build the natural foundation. Moreover, it often causes greater waste in order to guarantee soil uniformity. When dealing with the foundation, it is needed to improve the shear strength, permeability, and dynamics of the foundation soil, and reduce the compressibility of the foundation soil.

The energy-saving glass curtain wall is composed of metal structure and plate, which has positioning and shifting ability relative to the main structure, or has a certain deformation ability, and does not bear the load and role of the main structure. At present, there are two commonly used sealing materials for energy-saving building glass curtain walls, namely rubber sealing strips and silicone weatherproof sealants. Both materials have their advantages, the former has high elasticity, and can effectively resist the strong irradiation of ultraviolet rays and long-term deformation. Therefore, the rubber sealing strip is often used between the building curtain wall and the profile. The contact surface between the rubber sealing strip and the glass curtain wall is usually a wavy line to prevent air from entering. In addition, the silicone weatherproof sealants have characteristics of good sealing effect, strong ultraviolet radiation resistance, pollution resistance, weather resistance, and water resistance. It is often applied to the sealing caulking between glass curtain walls, making the curtain wall structure more tightly. With the good sealing effect, the energy-saving glass curtain walls could reduce construction pollution, heating, geothermal energy, air conditioning equipment energy consumption index, and optimize the thermal insulation performance of buildings. It, thus, plays a great role in energy conservation and emission reduction. Furthermore, it also has aesthetics and low-carbon economic benefits. When designing energy-saving glass curtain walls, it is necessary to pay attention to three principles: energy conservation and environmental protection, scientific, and practical principles. Doing a good job in the design of energy-saving curtain walls is one of the development directions of green buildings in the future [6].

Compound parabolic concentrator - concentrating photovoltaic (CPC-CP) system mainly includes a water collection tank, CPC, photovoltaic panels, thermal insulation layer, rectangular aluminum pipe, and water pump (Figure 1). Each part of the CPC-CP system has its functions. For example, the grooves composed of CPC and photovoltaic panels can effectively collect rainwater, and the water collection tank could store water resources. The rectangular aluminum pipe as a substrate is only attached to the back of the photovoltaic panel, and the left, right, and bottom sides of the rectangular aluminum pipe are the insulation layer. The photovoltaic panels, rectangular aluminum pipe, and the thermal insulation layer are as a whole, embedded in the outer surface of the building roof grooves. CPC layout on both sides of the photovoltaic panels. The internal part of the rectangular aluminum pipe is a cooling channel with cooling water. Water pumps are used to drive the flow of water. The cost of the CPC-CP system increases with the increase of concentrating multiples. When the concentration multiple is 1 to 3, the cost-effectiveness ratio is 0.05~0.11 yuan / (kW·h). The increase in the concentration multiple reduces the cost-effectiveness ratio of the CPC-CP system. Compared with the traditional building roof, the CPC-CP system greatly avoids the heat of the building caused by direct sunlight on the roof surface, effectively reduces the indoor cooling load, and obtains high-grade electric energy. Furthermore, rainwater collection is a very important green water-saving measure, and it can be used for environmental greening, road cleaning, landscape water, etc. If the temperature of the cooling photovoltaic cell is appropriate (such as the use of circulating flow), it can be used for the replenishment system of domestic hot water [7].

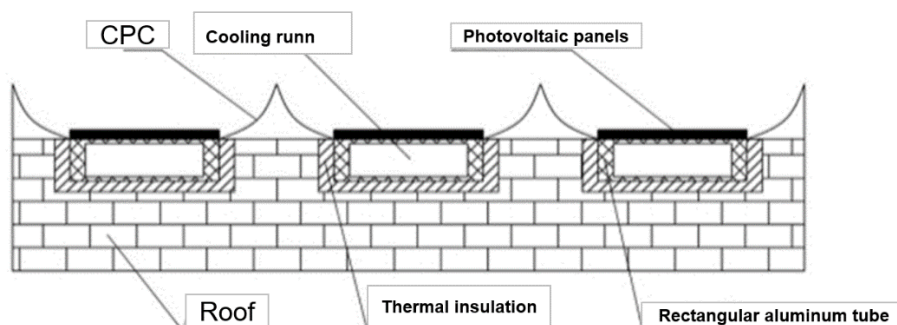


Figure 1. CPC-CP system [7]

4. Green building design

4.1 New house designs using natural air

In order to improve the comfort and experience of residents and achieve the effect of energy-saving and environmental protection, the air conditioning system can be replaced by using natural air throughout the design of the house.

The tube house was created by the famous Indian architect Koria, which is a narrow and long flat residential model of 3.6 m wide and 18. 2m depth (Figure 2). The sidewall is closed, with the front and back opening, and the internal space is a cavity that runs through the front and back. When the wind comes from the front, the impedance generated by the extremely high penetration space in the room is very small, which can effectively strengthen natural ventilation. There are many jumps inside it, and the height difference accelerates the indoor airflow, leading to the wind pulling effect of hot pressure ventilation and reducing the room temperature. This tube house design is also applied in high-rise buildings. The interior space of the building is a cavity that runs through the front and back, which produces a wind pulling effect through the way of split layers, to strengthen natural ventilation and take away the humid and high-temperature air in the room and improve the comfort of living under the premise of saving energy.



Figure 2. Tube House [8]

The atrium space, which is a form of architectural space, refers to the courtyard space inside the building. Its biggest feature is the formation of an "outdoor space" located inside the building. The core atrium is generally used for larger buildings, and the atrium is surrounded by other rooms on all sides. Its spatial height forms temperature layering, generating bottom-up airflow and taking away the heat generated in the room. Air intakes are usually windows on each floor, but there are also air purification devices that use to introduce clean and cool air from the basement. This design is used in the MATSUSHITA Electronics Building in Japan (Figure 3).

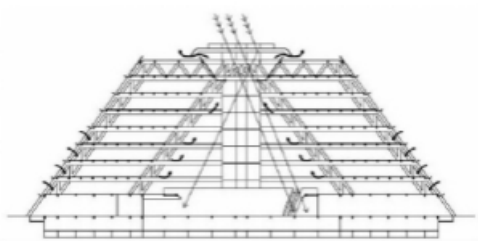


Figure 3. MATSUSHITA Electronics Building in Japan [8]

The overhead courtyard, unlike the ground floor overhead, can be built on any floor of the building. Because the occlusion of the upper building creates a lower air temperature in the overhead courtyard, it creates a bottom-up airflow that takes away the heat generated by the crowd activities inside the building. Combining the creation of natural elements such as water bodies and greenery, the overhead courtyard forms a comfortable semi-outdoor activity space. Therefore, the overhead courtyard is one of the common design techniques of modern architecture. The most famous example is the Daimler-Benz company building, which not only acts as good ventilation and creates a comfortable office environment, but also the greenery in the atrium is pleasing to the eye [8].

4.2 The roof landscape design

The landscape design inside the building is also the current development direction of many green buildings, and there are already a large number of application examples in modern buildings. The roof garden is one of the most landscape designs.

The roof garden requires a large area, with a relatively wide field of view. It should take into account the aesthetics and practicality, and have the function of improving the ecological environment. Especially in areas with relatively large winds, the selection of roof garden plants should take into account their wind resistance and drought tolerance. Considering the watering of plants on the roof, it is necessary to avoid roof leakage (Figure 4) [9].

In order to reflect the ornamental effect of the roof garden, its seasonal characteristics are important. The selection of plants in the roof garden can be divided according to the season, with plants of the corresponding flower season. Because the roof is thinly planted, in order to prevent the root system from causing corrosion to the building structure, it is necessary to choose a shallow root system that is resistant to barrenness. When the rainy season or typhoon days, wind and rain will cause damage to plants. However, due to the thin planting layer of the roof, the soil water storage capacity is insufficient, there may be a problem of water accumulation if it rains heavily. Therefore, it is necessary to consider the plants that are resistant to wind, not easy to lodging, and resistant to standing water, and the load-bearing capacity and drainage system of the roof. In addition, the roof is the fifth façade of the building, and the fundamental purpose of creating a roof garden ecological landscape is to increase the green area and delight everyone's body and mind. In order to make the garden more colorful, some evergreen plants and seasonal flowers should be planted to achieve the effect of spring in all seasons [10].



Figure 4. Roof Garden

4.3 Indoor decoration

The concept of green building can not only be applied to the outdoor building surface but also can be applied to indoor decoration, perfecting a complete set of building systems. It is necessary to scientifically select design schemes for interior decoration. It mainly refers to the overall layout and structural material design of the interior, specifically the floor material, wall wallpaper or paint, household materials, size, etc., which have an impact on the quality of the decoration. Therefore, when carrying out indoor decoration activities, it is noted to consider the scientific matching of decorative materials, space carrying capacity, and indoor fresh air volume. For example, if only one material is selected, the ground material accounts for a relatively large proportion of the total decoration material, leading to the problem of harmful substances of a single material in the indoor air exceeding the standard.

When carrying out interior decoration design work, full consideration should be given to issues such as resource utilization and energy saving. Choose energy-efficient materials whenever possible and make full use of natural light to reduce energy consumption. It is strictly forbidden to use processes with a high degree of pollution [11].

5. Conclusion

This study analyses the advantages and future trends of green buildings from three aspects of green building materials, green building framework, and green building design.

This study mainly analyzes three kinds of green building materials, namely ecological cement, high-performance concrete, and ecological protection ceramic permeable brick. These three materials have their characteristics, ecological cement can save resources, help reduce the harm of building materials to the environment, and can be recycled many times. High-performance concrete plays a very important role in reducing energy consumption during construction, effectively improving the strength and durability of concrete, and reducing the harm to the environment and the human body. EPCPB is used in the construction of roads to avoid a large amount of water formed after rainy days, anti-freeze and anti-slip in winter, and facilitate traffic. The development of green buildings is inseparable from materials, and it can also be said that the development of green buildings is the development of green materials.

This article discusses three types of frames, natural foundations, energy-saving glass curtain walls, composite parabolic concentrators - concentrating photovoltaic systems. Natural foundations save construction time and costs, and have developed rapidly in recent years and are widely used on construction sites. Energy-efficient glass curtain walls make a great contribution to reducing pollution and energy consumption. This curtain wall can optimize the thermal insulation performance of the building very well, and slowly become one of the main directions for the development of green buildings in the future. The CPC-CP system is composed of multiple parts, each with its unique function. After absorbing solar energy, the surface of the system is converted into heat energy, which not only obtains a high level of electrical energy, but also effectively reduces the load of indoor cooling. When the temperature is right, it can also be used as a supplement to domestic hot water. The green framework is not only beneficial to the protection of the environment, but also makes better use of the performance of materials, which is one of the manifestations of the green building concept.

Green design is the combination of ecological concepts and environmental protection with the building, so that the building is more beautiful, and the residents live more comfortably and healthily. This article mentions three design concepts, the use of natural winds, the combination of landscape design and architecture, and green decoration. The use of natural air instead of the design of the air conditioning system can improve the resident's sense of experience, more energy-efficient than the air conditioning system, many famous examples, such as tube houses, atrium spaces, overhead courtyards. The most well-known design of the combination of landscape and architecture is the landscaped roof. A good roof garden has a good aesthetic effect, achieving the effect of spring all year round, which can please the body and mind of the residents. The concept of green decoration is increasingly applied in indoor decoration, compared with ordinary decoration, the release of harmful substances in green decoration is greatly reduced, and the health of users can be guaranteed, but it is necessary to pay attention to the process and prohibit the process with a high degree of pollution. Green design is the main direction of future architectural development.

Since the concept of green building was proposed in the 20th century, it is becoming the mainstream direction of architectural development. It means that the concept of the green building combined with more advanced technology and more materials will continuously create a more environmentally friendly, more unique, and beautiful building in the future.

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