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Design and Application of Green Buildings under the Goal of "Dual Carbon"

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Abstract: With the increasing prominence of global environmental issues, people are paying more and more attention to sustainable development and environmental protection. As one of the critical industries for resource and energy consumption, the impact of the construction industry on the environment has received growing attention. In this context, the concept of green building design has gradually emerged and has been widely applied in the industry. This article analyzes the "Dual Carbon" goal and green buildings, expounds on the importance, basic principles, key technologies, and design essentials of green building design under the "Dual Carbon" goal, introduces the application strategies of green building design under the "Dual Carbon" goal, and puts forward development suggestions for green buildings. The aim is to provide more support for realizing the "Dual Carbon" goal and offer technical support for the green and low-carbon development of the construction industry.

Keywords: "Dual Carbon" goal; Green buildings; Design

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1. Introduction

With the growing severity of the global energy crisis and environmental problems, applying the green building design concept has gradually become a significant focus in the development of the construction industry. Green buildings mainly refer to high-quality buildings that save resources, protect the environment, reduce pollution, provide healthy, suitable, and efficient living spaces for people, and maximize the harmonious coexistence between humans and nature throughout the entire life cycle of the building. Green buildings not only pursue energy conservation and environmental protection but also attach great importance to the health and comfort of residents, which is conducive to achieving the goal of sustainable development. Therefore, this article focuses on the analysis and research of green building design and application under the "Dual Carbon" goal.

2. The "Dual Carbon" goal and green buildings

2.1. The "Dual Carbon" goal and its indicator system

The "Dual Carbon" goal is proposed to solve the problem of global warming and reduce the greenhouse effect. Here, "Dual Carbon" refers to carbon peaking and carbon neutrality. The former refers to within a period of time when the total amount

of carbon dioxide emissions reaches a peak, and then gradually declines. The latter refers to absorbing or offsetting the emissions of greenhouse gases such as CO_2 to make the net emissions "zero." Overall, the "dual carbon" aims to promote sustainable economic growth and ensure that greenhouse gas emissions are controlled within a sustainable range through technological innovation, industrial structure adjustment, and resource utilization. The evaluation indicator system of the "Dual Carbon" goal covers multiple aspects, such as the adjustment of the energy structure, the upgrading of industrial production, the improvement of transportation, carbon sink construction, and the energy conservation and greening of buildings.

2.2. Overview of green buildings

"Green building" is to effectively use the surrounding environmental resources in line with the concept of sustainable development during the design, construction and operation of the building, so as to minimize the impact and impact on the surrounding environment, so as to provide a healthy and comfortable indoor environment for the majority of residents. Specifically, "green buildings" have the following characteristics: First, optimize the energy system to minimize energy consumption. Second, pay attention to environmental protection performance and reduce pollution to the surrounding environment. Third, rationally develop, utilize, and manage water resources. Fourth, we should focus on providing residents with a healthy and comfortable indoor environment to improve their living quality and quality of life. At present, green building design has been widely applied and promoted around the world. Many countries and regions have also formulated green building evaluation standards and certification systems, such as BREEAM in the United Kingdom and LEED in the United States. In China, despite the late start of research on green buildings, it has developed rapidly. National regulations such as the "Administrative Measures for the Use of Green Building Labels," "Green Building Evaluation Standard" (GB/T 50378), "Green Industrial Building Evaluation Standard" (GB/T 50878), " and "Evaluation Standard for Green Retrofit of Existing Buildings" (GB/T51141) have made specific provisions for the design, construction, and operation of green buildings, which have effectively guided the development of green buildings in China.

3. The importance of green building design under the "Dual Carbon" goal

3.1. Mitigating global climate change

In the process of continuous development of industrialization and urbanization, a large amount of greenhouse gases is generated, which has caused the problem of global warming. According to data from the International Energy Agency, the energy consumed by the construction industry and its operation and management accounts for 40% of the global total carbon emissions. The green building design emphasizes the energy conservation and environmental protection of the building itself, and pays attention to the organic integration of renewable energy such as solar energy and wind energy which is one of the essential ways to achieve energy conservation and emission reduction. It is also conducive to reducing the dependence on traditional carbon-emitting fossil energy and improving the energy utilization rate of buildings.

3.2. Promoting the sustainable development of the green economy

Green building design can improve the air quality of the surrounding environment, reduce dependence on traditional energy, promote the development of the green economy and the recycling of renewable energy. This is because, with the continuous promotion and financial support of the national government for green building-related policies, the construction industry, material manufacturers, and related enterprises are paying more and more attention to the development and utilization of green technology and environmentally friendly materials which can create new growth points for social and economic development and is also conducive to better driving the construction industry to achieve green transformation and development.

4. The main design principles of green buildings under the “Dual Carbon” goal

4.1. The principle of energy-saving design

Energy-saving design is a key principle of green building design which aims to reduce energy consumption by optimizing building design and using energy-saving technologies[1]. For example, by insulating the exterior walls, roofs, windows, and other parts of the building, the heat loss of heating in winter can be effectively reduced, and the energy loss of air-conditioners in summer can also be reduced. Additionally, in architectural design, through reasonable layout of the spatial structure of the building, the location of doors and windows, the instruction of natural wind and natural light can be maximized, which is conducive to reduce the reliance on artificial lighting and further lowers the building’s energy consumption.

4.2. The principle of environmental friendliness

The principle of environmental friendliness is an important part of green building design. Its primary purpose is to reduce the negative impact of buildings on the surrounding natural environment[2]. On the one hand, when choosing the location and planning of a building, we should select areas with minimal damage to the natural environment as much as possible and avoid ecologically sensitive areas such as wetlands, woodlands, and cultivated lands to maintain the balance of the natural ecosystem. On the other hand, in the selection of building materials, we should prioritize green and environmentally friendly building materials, such as renewable resource materials, low-emission materials, and recyclable materials, to reduce the pollution caused by building materials during production and use.

4.3. The principle of health and comfort

The principle of health and comfort is an essential part of green building design. Its primary purpose is to provide a healthy and comfortable living and working environment for residents. On the one hand, the design of green buildings should follow ergonomic principles. By reasonably arranging the spatial layout and optimizing the design details, users’ comfort can be improved. For example, when designing a green building, we should comprehensively consider the placement of indoor furniture and equipment to ensure the user experience and safety. On the other hand, the design of green buildings should be based on improving indoor air quality. Using effective ventilation systems and air-purification devices to keep indoor air fresh and clean, so as to reduce the harm caused to human health. In addition, in green building design, we should also use natural light as much as possible, such as introducing more natural light into the interior through large-area windows and light pipes, so as to achieve the purpose of energy saving, emission reduction and improve the psychological comfort of residents[3].

5. Key technologies for green building design under the “Dual Carbon” goal

5.1. Energy-saving technologies

Energy-saving technologies aim to reduce energy consumption and improve energy utilization efficiency, playing an important role in green building design. Specifically, common energy-saving technologies mainly include two aspects: First, the heat-insulation technology of building envelopes. Using high-performance insulation materials, double-or multi-layer glass windows, insulation coatings, etc., to reduce the heat loss in winter and the heat gain in summer, so as to achieve the purpose of energy conservation and emission reduction. Second, natural ventilation and natural lighting technologies. By optimizing the orientation and layout design of buildings, the maximum amount of natural wind and light can enter the indoor space, reducing the reliance on artificial lighting and air-conditioning equipment. At the same time, strengthen the application of high-efficiency energy-saving equipment, such as LED lighting and energy-saving appliances, and actively introduce intelligent control systems to automatically adjust indoor temperature, lighting, and other data parameters. This is not only an intelligent management of green building energy but also an important manifestation of energy-saving technologies. In addition, actively utilizing renewable energy sources and giving full play to the advantages

of technologies such as solar photovoltaic power generation systems, wind power generation, and energy recovery and utilization is also an important part of energy-saving technologies in green building design.

5.2. Environmentally friendly materials and technologies

Applying environmentally friendly materials and technologies in green building design can significantly improve the overall performance of buildings and effectively reduce the negative impact of buildings on the surrounding natural ecological environment[4]. Specifically, the commonly used environmental protection materials and technologies are mainly manifested as: first, the selection of environmental protection materials. In the design of green buildings, we can not only choose renewable resources such as bamboo and wood to reduce the waste of resources, but also choose low-emission materials such as low-VOC coatings to reduce the emission of harmful substances, so as to achieve the purpose of protecting the health of residents. Second, the selection of recycled materials. In green building design, we can choose materials such as recycled concrete and recycled steel, which can not only reduce waste generation but also save resources while ensuring the quality of building products, embodying the concept of green circular economy development. Third, building waste treatment technology. In the process of green building construction and operation, various construction wastes are often generated during construction and demolition. By establishing a relatively complete building waste management system, we can classify and collect and treat these wastes, which is conducive to reducing the pollution impact of waste on the surrounding environment, so as to maximize the value of waste.

5.3. Water resource management technologies

As an important part of green building design, applying water resource management technologies can effectively reduce the damage of buildings to the surrounding ecological environment and improve water resource utilization efficiency. First, a rainwater collection and reuse system can be used. By installing specific devices, rainwater from courtyards and rooftops can be introduced into cisterns. After secondary treatment, it can be used for greening and flushing toilets. Second, a greywater reuse system can be used. Greywater refers to wastewater generated from daily life, such as laundry water and bath water. After systematic treatment, it can also be used for greening and flushing toilets. With this system, the consumption of tap water can be greatly reduced and the installation of household water-saving equipment can effectively improve the utilization of water resources. Finally, an AI water management system can be added. Through the association with AI technology and equipment, real-time monitoring and management of the overall building water consumption can be realized, and system faults can be found and repaired promptly, so as to reduce the waste rate of water resources and achieve the purpose of protecting water resources.

6. Design essentials of green buildings under the “Dual Carbon” goal

6.1. Site selection and layout

Green buildings are different from traditional buildings, it needs to consider multiple factors. Take site selection as an example. If the plot is in a mountainous area, a traditional building only needs to purchase land and ensure that the soil meets the construction requirements. In addition to considering land use rights and geological stability, green buildings also need to understand whether the building plot has been recorded as a debris flow, landslide and other disasters, and take corresponding preventive measures; If the plot is in an urban area, traditional buildings are often simply connected to the transportation network, while green buildings will actively implement the concept of “TOD”. “TOD” stands for Transit-Oriented Development, which simply means that buildings and bus stops are seamlessly connected, making it easier for people to get around, reducing congestion and carbon emissions, and increasing traffic flow.

In terms of ventilation design, a “hot aisle curtain wall” or “breathing curtain wall” system should be added on the basis of the north-south orientation design. By docking with the intelligent control system, the system can open and close the ventilation holes according to the outdoor and indoor air temperature and wind speed to achieve the effect of air flow

exchange and heat release.

In terms of lighting design, designers can use methods such as lighting zoning, reflector shading, and side wall lighting to reduce the dependence of building users on air conditioning systems and artificial lighting, which is not only energy-saving and comfortable, but also reduces the adverse impact of building operations on the surrounding ecology.

6.2. Selection of building materials

The choice of building materials is also a top priority for green buildings. Designers should clearly stipulate the specifications and characteristics of materials, such as giving priority to materials with excellent performance, good quality and low pollution (decorative boards with less formaldehyde content, green and non-toxic materials), so as to effectively protect the life and health of building users. For example, in the selection of window glass materials, we can choose some materials with low solar heat gain coefficient and high visible light transmittance, so as to realize the organic combination of aesthetics and functionality of green buildings. At the same time, recyclable materials and resources are also the first choice for green buildings, such as recycled bricks made from construction waste, solar water heaters, solar photovoltaic curtain walls, etc. Through the use of recyclable materials and resources, it can not only reduce environmental pressure and construction costs, but also meet the daily life needs of building users while ensuring low energy consumption, and realize the sustainable development of green buildings.

6.3. Energy conservation and emission reduction

In the general trend of green and sustainable development, energy conservation and emission reduction have become the main direction of the development and transformation of the construction industry. Through energy conservation and emission reduction, it can not only reduce the negative impact on the environment during the use of buildings, but also bring environmental, social, economic and other benefits.

As one of the main tasks of green buildings, energy conservation, and emission reduction should be considered throughout the entire life cycle from design to construction, operation, and maintenance. In the design stage, tasks such as building orientation and layout should be appropriately carried out. In the construction stage, high-performance materials should be actively used. For example, insulation materials with good heat-insulation performance can significantly reduce the heat transfer between the inside and outside of the building and reduce the energy consumption of air-conditioners. At the same time, make the most of natural light and wind. For example, a natural ventilation system can effectively replace the air inside and outside the building by skillfully installing ventilation openings and ducts, improving indoor air quality, reducing the growth of bacteria and odors, and reducing the use time of air-conditioners and fans, thus making a positive contribution to global warming.

6.4. Water resource management

Water resource management is an important part of green building design. In water resource management design, the following aspects can be considered: (1) Build an ecological wetland. Establishing a wetland system can not only purify sewage but also serve as a building landscape, enhancing the overall environmental quality of the building. (2) A rainwater collection system. This system can effectively collect rainwater outside the building and concentrate it for non-drinking water scenarios (irrigation, flushing toilets), achieving the goal of water conservation and reducing the workload of the urban drainage system. (3) The secondary utilization of greywater. Greywater, that is, wastewater from daily life (laundry water, bath water), can be used for car washing, watering flowers, etc., after secondary treatment, significantly improving the utilization efficiency of water resources and reducing the reliance on groundwater.

6.5. Overall optimization

Green building design should follow the principles of integrity and systematicness. This means that designers need to have a comprehensive perspective and good thinking ability to grasp the overall design of green buildings and make full

and effective use of the geographical, climatic, and cultural conditions of the building's location. For example, in hot or cold regions, special shading devices and ventilation systems can be designed and installed. In ethnic minority areas, local patterns and colors can be added to the appearance of green buildings, which can not only achieve the perfect integration of the building with the local environment but also enhance the sense of belonging and identity of users and inherit traditional culture.

7. Application strategies for green building design under the "Dual Carbon" goal

7.1. Design stage

7.1.1. Adopt a comprehensive design plan

In the initial design stage, designers should consider environmental protection, health and comfort, and energy conservation, and use BIM technology (Building Information Modeling) to assess the environmental impact and energy consumption of the building throughout its life cycle.

7.1.2. Reasonable layout design and site selection

A good layout design can make the most of the surrounding environment, reducing building energy consumption and environmental damage.

7.1.3. Do a good job in collaborative communication.

Designers should not only be good at theoretical design but also need to communicate with staff in various links, pool their wisdom, jointly optimize the design plan, continuously improve the work and living quality of green building users, achieve the "Dual Carbon" goal, and extend the service life and improve the use value of green buildings.

7.2. Construction stage

During the construction stage, the formulation and implementation of various reasonable strategies directly affect the final level and quality of green buildings. Common green construction strategies mainly include applying advanced construction technologies, strengthening on-site management, regular staff training, effective noise control, dust prevention, and improving the construction evaluation mechanism. Among them, the application of low-emission, low-noise construction equipment, reclaimed water reuse technology, solar photovoltaic power generation system and other advanced technologies is critical, which can significantly reduce the damage to the environment and energy damage caused by construction; In construction management, managers must formulate a strict management system and a detailed construction plan, strengthen the monitoring and management of green environmental protection materials, and ensure the "green environmental protection" of the construction process. At the same time, special personnel should be arranged to clean up the on-site waste materials promptly to reduce the hidden dangers of environmental pollution caused by on-site landfills.

7.3. Operation stage

7.3.1. Improve the maintenance and management mechanism.

Operators should develop a complete operation management plan and establish a regular equipment inspection mechanism to detect and handle equipment problems in a timely manner, ensuring the long-term and efficient operation of various systems in green buildings.

7.3.2. Add an intelligent management module.

By connecting the artificial intelligence system with the energy and water systems of green buildings, real-time monitoring and management can be carried out, making better use of the energy and water systems.

7.3.3. Establish an operation management evaluation mechanism.

Through the summary and analysis of the index data of various systems by artificial intelligence devices, operators can timely understand the working conditions of the existing system management plan and optimize and adjust the operation strategy in combination with the work expectations to ensure that various energy-saving and environmental-protection measures meet the government's green building implementation standards and requirements.

8. Development suggestions for green buildings under the "Dual Carbon" goal

8.1. Formulate and improve green building incentive policies

The "dual carbon" goal and the implementation of green buildings are inseparable from the support and encouragement of government policies. The government should emphasize the "Dual Carbon" goal, clarify the green building standards, and assume that the annual energy consumption of traditional buildings is 200 kWh/m², the annual energy consumption of green buildings must be less than 100 kWh/m². In terms of policy incentives, the government should give certain tax exemptions and subsidies, open up green finance channels, and reduce the risks and costs of enterprises building green buildings. In addition, as a new type of building, the government should unify the standards and procedures in terms of approval process and review standards to "escort" the reliability, quality and technical application of green buildings.

8.2. Encourage technological innovation and R & D investment

To further promote the sustainable development of green buildings and achieve the implementation of the "Dual Carbon" goal, the government should formulate a green building innovation incentive mechanism and establish a special green building fund to encourage more construction enterprises to invest in the field of green buildings. At the same time, the government should take the lead in establishing an open green building development platform to deepen cooperation and communication among the political, construction, and academic circles. Through the joint participation and development of multiple stakeholders, it can provide strong support for the upgrading and innovation of green building application technologies, practice the "Dual Carbon" goal, and give full play to the advantages of green buildings.

8.3. Establish a data monitoring and evaluation mechanism

Data monitoring is an important means to ensure the normal operation of green buildings. Through the real-time collection and monitoring of various data of the building energy system and water resource system, the operation personnel can grasp the "health status" of the building in time and make adjustments to the operation strategy. At the same time, establish a scientific evaluation mechanism to conduct in-depth analysis of the collected data. For example, check whether the utilization rate of renewable energy meets the standard and whether the energy efficiency complies with the energy-saving specifications, so as to realize the practical implementation of green buildings from the design concept to the actual operation.

In addition, through a scientific evaluation mechanism, problems caused by the bad behavior habits of building users and the low-efficiency operation of equipment can be solved, providing a basis for the optimization and upgrading of green buildings (such as optimizing the building space layout and adjusting the equipment operation parameters). In this process, the following two systems can be established: (1) Establish a data collection system. This system will actively record and monitor the values of indicators such as carbon emissions, energy consumption, and resource utilization. (2) Improve the index evaluation system. This system is mainly used to evaluate the performance and effectiveness of green buildings, such as the LEED evaluation system and the DGNB evaluation system.

9. Conclusion

The construction industry plays a crucial role in the development process of China's "Dual Carbon" goal. It is urgent to strengthen the promotion and application of green building design. Therefore, every practitioner in the construction industry should actively explore how to integrate green, ecological and low-carbon concepts into green building design on the basis of mastering the principles, key technologies, and design essentials of green building design under the "Dual Carbon" goal, to better provide residents with a good living and living environment and ultimately promote the realization of the "Dual Carbon" goal.

Disclosure statement

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