Energy saving and ecological exploration of buildings

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Abstract. In the context of increasingly serious environmental problems, construction, the main factor that is unfavorable to the environment, has drawn significant attention. This has allowed green and sustainable buildings to be developed. China is now entering the 21st century and experiencing a stage of rapid development. The construction of urban environments is a key issue because of the complex background and various restrictive factors. Truly green building must be well-regulated from the initial design stages, material procurement, construction and operation. The article summarises and explores the goals, energy conservation, technology, and management involved in green building development.

Keywords: green building; energy-saving design; technology development.

1. Design concepts, principles and goals of green buildings

Green building has become the mainstream of research and practice in the world's architectural community as its response to environmental problems. In China, although the introduction of the concept of green or sustainable building is more recent than that in Europe and the United States, the theoretical research and design practice of domestic green building has also become a hot issue in the industry [1]. To plan for the future, people are constantly exploring how to design energy-saving and environmentally friendly buildings that consume a large proportion of energy. This paper will also compare and summarise past, present and future building development and the entire green building life cycle from several aspects.

The whole life cycle of green buildings refers to saving resources, protecting the environment, reducing pollution, providing people with healthy, appropriate and efficiently-designed space, and maximizing the harmonious coexistence between man and nature within high-quality buildings. In general, the factors that need to be considered in green building design are "four sections and one quality", namely land, energy, water and material conservation and indoor environmental quality [2]. The "four sections" are as follows: (1) Base: In the selection of bases, the first consideration should be given to controlling pollution caused by construction activities, and avoiding soil erosion, air pollution and the use of high-quality arable land because of its scarcity; (2) Water resource utilization: Reclaimed water or rainwater should be used and drinking water avoided, and the building or site should be designed to collect rainwater; (3) Energy use: reduce the use of non-renewable energy and encourage the use of renewable and clean energy; (4)) Building materials: It is best to choose building materials that cause little pollution from production to final disposal or reuse, or renewable natural materials.The background of China's development of green buildings: urbanization is accelerating, building energy consumption is high, land and water resources are scarce, urban pollution is serious and carbon emissions are large.

2. Analysis and design of outdoor environments

Since people are committed to creating a green building in which people and self-heating coexist in harmony, the concept of green building is not only applied to the building itself, but to research and explore a series of external environments such as the surrounding site from the early stage of its planning and design.

In cities, the urban heat island phenomenon is particularly common; this is the phenomenon in which the temperature in the urban center is significantly higher than that in the outer suburbs. There

are three factors that produce the urban heat island effect. One is that most of the ground surface is covered by buildings and roads, and many hard materials absorb heat, warming their surface; another is that building equipment, road traffic and lighting facilities consume the energy and heat dissipation is significant; third, air pollutants are highly concentrated in urban areas, preserving heat. The impact of the urban heat island on the city is reflected in the heat island circulation and the urban background wind will be affected. This makes it difficult for heat in the city to be blown away by the wind, and precipitation and air humidity in the city are reduced. More, less cold. Hard building materials and the use of colours with strong sunlight absorption are the main culprits that cause the urban heat island effect. Therefore, building materials with higher reflectivity can be used to reduce its impact.

3. Indoor environment and its control technology

3.1 Indoor acoustic environment

China's civil building sound insulation and noise reduction design standard divides building noise reduction into special, first, second, and third grades [2]. At the same time, China's "Acoustic Environment Quality Standard" also sets the environmental noise limit in different acoustic environment functional areas with different thresholds in the morning and evening. Category 0 is for convalescent and high-end villa and hotel areas; Category 1 is for residential and cultural and educational institutions; Category 2 is for residential, commercial, and mixed industrial areas; Category 3 is for industrial areas, and Category 4a is for road two. Category 4b is suitable for both sides of the new railway trunk line.

3.2 Indoor light environment

A good indoor light environment quality requires an appropriate illuminance level, preferably between 1,500 and 3,000 lx, and also requires a reasonable illuminance distribution, the colour table and temperature of the light source [1], the amount of lighting, the directionality of the light, and the prevention of glare.

3.3 Adjustment of heat and humidity environment

3.3.1 Passive technology

Passive technology uses the building itself and natural energy to ensure the quality of the indoor environment [3]. Solar radiation can be controlled by: ① using energy-saving glass windows; ② using canopies that introduce visible light into the building while blocking direct sunlight in the surrounding areas; ③ using ventilation window technology to introduce the air-conditioning return air into the double layer. The window interlayer space can take away the convective heat caused by the increase in the temperature of the middle louver caused by sunlight; ④ using the atrium of the building to introduce daylight into the building and secure the heat outside, and ⑤ setting the sunshade outside the building or combining it with solar cells, which reduces the air conditioning load and provides supplementary energy for indoor lighting [4].

3.3.2 Active technology

Active environmental control technology relies on mechanical, electrical and other equipment that requires additional energy to adjust the indoor environment. They are heating, mechanical ventilation, and air conditioning.

4. Building energy-saving design and technology

4.1 Building energy-saving design

4.1.1 Construction layout

Building layout is generally divided into parallel, staggered, peripheral, hybrid, free and other centralised forms.

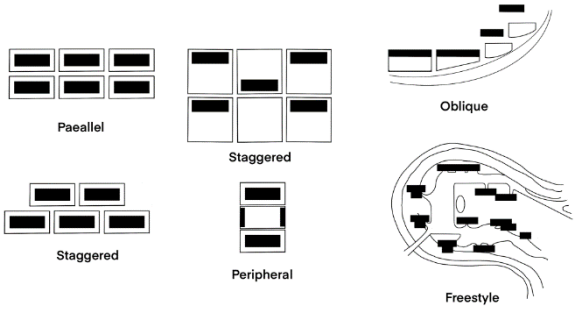

Fig. 1 Construction layout forms

(source: Jiaping Liu, Shijun Sun. A Introduction to green building [M]. Beijing: China Construction Industry Press. 2021.1)

The determinant means that the buildings are arranged in rows and can strive for the best orientation. Many living rooms can get good sunlight and are conducive to ventilation. Peripheral type refers to the arrangement of buildings along the surrounding streets. This arrangement can enclose an open courtyard for arching greening and rest, but it may lead to poor sunlight and natural ventilation in many rooms. Generally, it is suitable for cold northern regions. Hybrid refers to the combination of determinant and some peripheral forms, which can combine the advantages of various layout methods [2]. Free style refers to a flexible and reasonable layout that reflects the characteristics of the terrain when it is complex. It can make full use of the terrain, and it is convenient to use a variety of plane forms and combine high and low blocks, which helps to avoid mutual blocking of sunlight and is beneficial to sunlight and natural ventilation.

4.1.2 Building shading

According to the arrangement of building shading [5], shading can be divided into four types: horizontal, vertical, comprehensive and baffle shading. ① Horizontal sunshade, set a certain width of sunshade above the window, can block the sunlight from above the window with a tall angle, and apply to all windows facing south and nearby. ② Vertical sunshade. Large sunshades with a certain width and vertical direction are set on both sides of the window, which can block the sunlight that is obliquely received from both sides of the window with a relatively small height angle. It is used for windows facing in all directions. ③ Hybrid shading is the basic combination of the above two visors, which can block the sunlight received from above the window with a relatively tall angle, and that which is received obliquely from both sides of the window with a relatively small height angle. The shading effect is relatively obvious. It is suitable for most windows facing south, southeast and southwest. ④ Baffle sunshade uses a large sunshade perpendicular to the parallel direction of the window at a certain distance in front of it, which can effectively block the sunlight received from the front of the window with a small height angle.

Fixed shading devices [6] include a variety of horizontal overhangs, vertical shading, or a combination of the former and the successful lattice grille. Shutters and vertical shading can be angled with sunlight control.

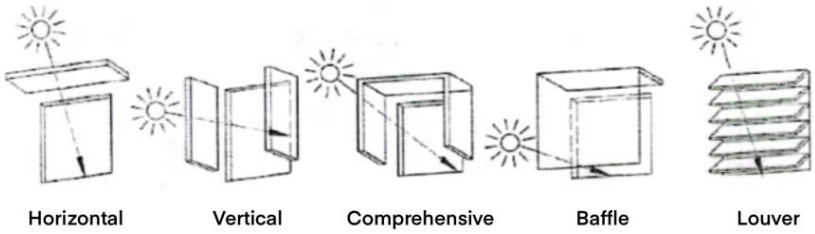

Fig. 2 Fixed shading example

(source: Meng Cui. Research on energy saving and environmental protection design of architectural decorative glass curtain wall [J]. Sichuan Cement. 2020(09))

4.2 Solar energy utilization technology

Solar photovoltaic system. The application of solar photovoltaic cells, power storage, inverter, control, grid connection and other equipment constitutes a solar photovoltaic system. The main advantage of photovoltaic cells is that they can be used in combination with external decorative materials and do not generate noise and exhaust gas during operation [5].

Solar Photovoltaic Utilization Technology. The solar photovoltaic utilization system is composed of photoelectric conversion device, connecting device, AC/DC converter, electric meter and installation fixture.

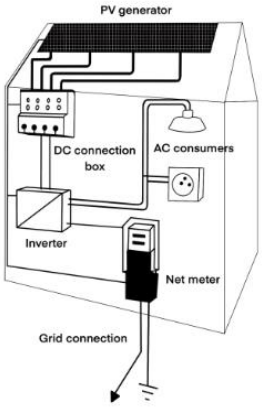

Fig. 3 The composition of photoelectric utilization system

(source: Jiaping Liu, Shijun Sun. An Introduction to green building [M]. Beijing: China Construction Industry Press. 2021.1)

5. Design and Technology of Effective Utilization of Water Resources

Water resources are not abundant in China. Based on its current large population, water resources per capita are far lower than the world average. Therefore, the water content is very important for us and even the world. It is precious, so people need to take certain effective measures to deal with this problem.

5.1 Reclaimed Water Utilization Technology

5.1.1 Basic Concepts of Reclaimed Water Utilization

"Zhongshui" means relative to "upper water" and "lower water". Among them, "Shangshui" refers to urban tap water, that is, fresh water that has not been used; "Xiashui" refers to sewage in the city, and "reclaimed water" refers to water that will be used and reused. Construction water refers to the collection of domestic sewage in civil buildings or building communities, or the sewage and rainwater discharged from domestic production activities, and then reused in civil buildings or building communities after treatment to meet certain water quality standards It is used for water supply systems

for residential greening, landscape water, car washing, cleaning buildings and roads and indoor flushing toilets.

6. Green building materials and construction equipment

6.1 Definition of Green Building Materials

Green building materials are healthy, environmentally friendly and safe. They are also known as "healthy building materials" or "environmentally friendly building materials" internationally. Safety" character evaluation. In foreign countries, green building materials have been applied and popularised earlier, while in China, they have been only a mere formality and have just started. More green building materials need to be brought into the homes of ordinary people.

6.2 Green building materials direction

There are three major directions for the development of green building materials: resource-saving, energy-saving, and environmentally-friendly green building materials.

6.2.1 Resource-saving green building materials

China's land resources are seriously insufficient [2], and the production of traditional building materials will lead to a large amount of resource consumption and a series of adverse consequences such as acid rain. Develop resource-saving green building materials to achieve the purpose of saving resources.

6.2.2 Energy-saving green building materials

Energy-saving green building materials not only refer to low energy consumption in the manufacturing process of the material itself, but also to those that help reduce the energy consumption of buildings and equipment during use.

6.2.3 Environmentally-friendly green building materials

The traditional cement production process generates a large amount of carbon dioxide, sulfur dioxide and dust, which pollutes the environment. Therefore, it is important to develop environmentally-friendly green building materials to reduce the emission of smoke, dust and harmful gases during production.

6.3 Classification of green building materials

It is developed on the basis of traditional building materials, mainly including wall materials, thermal insulation materials. Waterproof sealing materials, ceramic materials, new chemical building materials, decoration materials and comprehensive utilization of various industrial waste residues [3]. At the same time, in terms of materials, it can also be divided into: structure, function, and decorative materials, of which functional and decorative materials are the main green building materials.

7. Operation management and maintenance of green buildings

The principles of building equipment operation management include three aspects: control of indoor air quality and thermal comfort and energy conservation and emission reduction.

7.1 Reasonable determination of indoor temperature, humidity and wind speed

Indoor temperature is usually controlled at approximately 16℃during the heating period and 27℃ during the cooling period [4]; the humidity is guaranteed to be above 30% during the heating period and below 70% during the cooling period. The wind speed is controlled at 0.2 m/s during the heating period and during the cooling period it is below 0.3 m/s.

7.2 .Intelligent property management

The management of green buildings should adopt intelligent property management, which is an improvement in the content of traditional property management services [5]. The first is the management of energy, water and material saving and environmental protection, followed by the use of intelligent technology in security, fire protection, and parking management. Then the network and informatization of management services, and finally the application of information systems for property management, using quantitative methods to achieve the design target value. This realises simultaneous development of green building construction and management.

8. Examples of green building design

The selected example is Yunnan Tengchong Tuofeng Airport Terminal. It is an intensive mixed-use model, a breathing and regional landmark.

Fig. 4 Building's appearance and sections

(source: Tang Wenjian. The application of ecological green building in airport terminal[J]. Building energy saving and green building, 2014.09.039: 118-119)

8.1 Intensive Complex Model

Since the project is located on the mountain, to minimise the amount of earthworks and retain more native vegetation, the design does not adopt the conventional method to occupy the terminal, freight, air traffic control, and tower each on their own and set them up independently. Combining them closely together avoids the dispersion of bases and brings convenience to the construction of the project in the mountains.

8.2 A breathing building

Saving energy and resources: Through the flat layout and low-skilled building structure, the environmental comfort requirements can be met at the lowest cost, saving energy and creating self-breathing ecological buildings [7]. To ensure the window opening rate, the glass curtain wall uses a framed curtain, rather than the frameless one used in most public buildings, and uses the upper and lower sections to allow glass louvers to help pull the wind.

Return to nature: The exterior of green buildings should emphasise the integration with the surrounding environment to protect the natural ecological environment. The indoor and outdoor decoration materials use natural volcanic rocks from the local area as much as possible, which not only saves costs, but also highlights the regional characteristics of the building.

9. Summary

For green buildings, high-quality construction materials are very important. In the design of green buildings, it is necessary to select the corresponding construction materials, colours and other characteristics according to the surrounding environment [8]. It is also necessary to pay attention to the environmental protection of building materials, such as the use of renewable resources, the environmental protection of the production process of construction materials, and the volatility of harmful substances in the use of construction materials.

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