Research on Integrated Design Strategy of Campus Buildings Under the Concept of Green Ecology

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Abstract: In recent years, the problem of social ecological environment deterioration caused by high energy consumption has attracted widespread attention. How to integrate the integrated design strategy of green campus buildings will be deeply discussed in this paper. Starting from the concept of green ecology, the paper analyzes the current situation of green ecological campus, and believes that through optimizing the selection of building materials, improving building energy efficiency, introducing renewable energy systems, and rational layout and spatial planning, it explores and practices a building design scheme that not only meets the needs of education functions but also realizes the goal of energy conservation and emission reduction. Based on the integrated practice of campus architecture in a certain place, the paper proves that the integrated design strategy of campus architecture under the concept of green ecology has great practical significance from the aspects of building site planning, energy saving technology and so on, and hopes to provide reference for similar campus projects.
***Keywords*:** green ecology; Campus buildings; Integrated design

1. Introduction

With the implementation of the strategy of rejuvenating the country through science and education, the scale of running schools in China continues to expand. In order to meet the needs of educational infrastructure, campus buildings in colleges and universities have also received unprecedented development, but at the same time, the impact on the environment is also increasing, and the appearance of "energy consumption" in campus building projects has caused the reflection of relevant industry personnel[1]. Foreign scholars began to study the green ecological campus from the 20th century, from the overall campus planning to school building energy conservation and many other aspects of practice, put forward a lot of effective measures. In recent years, with the further emphasis on higher education in China, the relevant documents such as "Notice on building conservation-oriented schools" and "green campus Evaluation Criteria" have been issued successively, which put forward the concept of green campus construction and provided the basis for the construction of green campus[2].With the proposal of the concept of "green campus", some developed countries in the world have started the plan of green ecological campus. Whether it is the design of new campus or the green ecological transformation of old campus, the system and guiding rules established for green campus are relatively mature. For example, Harvard University vigorously promotes campus energy conservation plans and a series of green Cup activities, and the University of Tokyo has formulated long-term and near-term plans for the construction of a green and low-carbon campus[3]. Compared with these green campus construction abroad, the construction of green ecological campus in China started relatively late, and the implementation scale has certain limits. At present, there are still many problems in the construction of green ecological campus in China as a whole[4]. For example, there are contradictions between site selection and function, poor overall ecological coordination of the campus, the surface of the green campus, the lack of systematic planning and research, the variety and total amount of energy consumption, and insufficient attention to the application and expansion of sustainable ecological technology. Based on this, we will discuss the integrated design strategy of campus buildings based on the concept of green ecology.

2. Ideas and principles of integrated construction of green campus buildings

2.1 Construction Ideas

Throughout the current situation of campus construction in China, there are still many problems in the construction of green ecological campus in China, such as the contradiction between site selection and function, the lack of understanding of environmental protection and energy conservation concepts, the poor overall ecological coordination of the campus, the surface of the green campus, the lack of regional and cultural perspectives, the lack of systematic planning and research, and the insufficient attention to the application and expansion of sustainable ecological technology.

Considering the particularity of our campus architecture and environment, in the green campus design, The architect's controllable design contents mainly include architectural modeling, old building utilization, building envelope, sound insulation of envelope structure, sound insulation of equipment, underground space, sound insulation of building layout, outdoor environment and comfort, reducing heat island effect, barrier-free design, material selection, light pollution space, three-dimensional greening, shading and heat insulation, etc.

The main design contents are indoor air pollution source control, indoor air temperature and humidity control, building structure optimization, indoor ventilation, comprehensive utilization of energy, renewable energy utilization, etc. Therefore, in the process of campus design, architects should give full play to their own role, practice design with a holistic and dynamic idea, not only consider the existing architectural needs, but also focus on dealing with the multi-party connection between the whole and the environment, the whole and the part, according to local conditions, flexibly consider the potential needs of the campus for a period of time in the future, and create a suitable green campus.

2.2 Guiding Principles

(1) The principle of energy conservation and consumption reduction, the production and transportation of building materials will consume a lot of energy, produce construction waste, and ultimately cause inevitable damage to the environment[5]. In the design of campus buildings, in addition to ensuring the normal function of the building and ensuring the safety of the structure, low energy consumption and recyclable building materials should be selected.

(2) People-oriented principle, the campus building unit area accommodates a large number of students, such as the class in the classroom generally more than 30 students, dormitories are also mostly 6-8 rooms. Therefore, in the design stage, it is necessary to fully consider the rationality of the design content of the internal thermal environment, ventilation environment, electricity safety and noise environment, and carry out adaptive design around the main body of students to improve the rationality of the design content of campus buildings.

(3) The principle of practicality: the design of green ecological buildings should proceed from reality, and it is not possible to ignore the actual needs and blindly copy the designs of others in order to achieve green ecology. Ecological building design should be carried out according to the actual situation, and a variety of factors should be comprehensively considered for overall planning, so as to improve the practicality of the design results.

3. Campus architectural design strategies from the perspective of green ecology

3.1 Design strategy based on site regional environment

The objective analysis of the site environment is the basis and premise of passive building design. In order to realize the sustainable application of the environment, it is necessary to objectively analyze the environmental conditions and climate conditions of the building, and then determine the orientation of the building, the building shape coefficient and the green layout of the site. It is necessary to pay special attention to building spacing, building layout and building orientation, rationally organize natural lighting and ventilation, give full play to the utility and potential of natural energy, make natural resources serve the building to the maximum extent, and realize the sustainable development of the building and site environment.

3.2 Design strategy for controlling the form of single building

The single form of a building has a direct relationship with building energy saving, and is the main factor considered in passive energy saving design. The shape of a single building is affected by the coefficient of shape, structure and spatial organization. For buildings with the same volume, the larger the body shape coefficient, the larger the building heat dissipation area, the more unfavorable to energy saving, and reasonable control of the building body shape coefficient is conducive to reducing the energy consumption of buildings. In addition, the physical design and spatial organization of the building can not only create a comfortable internal environment but also maximize the requirements of indoor ventilation and lighting.

3.3 Design strategy suitable for the selection of building energy saving technology

Building energy saving technology includes passive energy saving technology and active energy saving technology. Active energy saving technology is the use of mechanical and electrical equipment as the main energy saving means to achieve building energy saving technical means, can be converted into renewable energy in nature into electricity, heat and other building use, that can save energy and reduce building energy consumption. The passive energy saving technology and the active energy saving technology adopt different energy saving means, mainly from the building body design, site planning and design, building monomer design and environmental configuration and other design methods to create a comfortable indoor and outdoor environment, maximize the use of the natural environment around the building, so as to achieve low

carbon environmental protection of the building.

Building first through the analysis of environmental factors to determine the appropriate passive energy-saving technology, reasonable single building design and the selection of enclosure materials, the use of air conditioning equipment in summer and winter heating equipment has played a decisive role. Secondly, different building types have different building functions. Under the premise that passive energy saving technology cannot fully meet its functional requirements, active energy saving technology is used to optimize and supplement and improve efficiency.

4. Practical Application

4.1 Project Overview

This project is a vocational and technical college with a rectangular terrain, green campus landscape on the north side, teaching buildings on the southeast side and reserved open space on the west side. The project is mainly for teaching functions, including ordinary classrooms, laboratories, offices, computer rooms and multi-function halls.

4.2 Building site planning and design

First of all, a good building layout can not only improve the comfort of outdoor personnel activity space, but also use the wind pressure difference of the building to provide favorable conditions for the natural ventilation of the building. Considering the use function of the project and the surrounding environment, there is a need for public activity space, so the building chose a courtyard building layout. After the initial determination of the building layout form and the splicing relationship between the buildings, CFD was used to simulate and compare the overall layout of the building. The summer is mainly southeast wind, and the winter is mainly southwest wind, so a building is designed on the south side of the project base, the volume is slightly shorter than and lower than the north volume, not only can introduce natural wind into the middle of the two buildings, but also can block the cold wind in winter, forming a group form suitable for natural ventilation.

Secondly, the building size coefficient has a direct relationship with the building energy consumption, the smaller the building size coefficient, the smaller the building surface area, the smaller the building heat dissipation area, the more energy saving the building. Therefore, the “L” shaped building and the “one” shaped building are connected and enclosed by the corridor to form a courtyard space, and the height difference of the buildings is used to create a visual sense of uneven height and meet the needs of the public activity space of the project. The building form is simple, the building size is compact, the shape coefficient is small, and the surrounding buildings and the environment coexist harmoniously.

4.3 Passive energy saving technology

First of all, the building envelope structure is the main part of the building space, and is the main component of heat exchange with the indoor and outdoor, so the selection and construction of the envelope structure materials are crucial. Considering that the project is located in a cold area, the temperature difference between day and night is large, the summer is hot, the winter is cold. Therefore, the measures of heat insulation in summer and heat insulation in winter are the key to reduce energy consumption. (See Table 1) as the design of the building external protection structure performance.

Table 1. Maintenance structure outside the building

Structural position	Construction practice	Heat transfer coefficient/[W/(m·K)]
wall	300mm thick aerated concrete block, 80mm thick composite rock wool insulation board	0.43
roofing	Insulation layer 150mm thick rock wool insulation board, waterproof layer 2 3mm thick paste must be BAC self-adhesive waterproof coil	0.28
Exterior window	Cut-heat aluminum alloy low radiation hollow glass window	2.3

Secondly, the solar radiation intensity of the city where the project is located is large, and the exterior shading design of the building can well improve the indoor thermal comfort and light environment quality, and reduce the dependence on air conditioning to reduce energy consumption. Manual sunshade roller blinds are installed inside the building, and the user can adjust the position of the roller blinds according to the change of the height Angle of the sun, reducing the influence of the light environment and the thermal environment on the interior. According to this design, the shading coefficient of east and west is 0.65. The combination of different shading forms can not only effectively reduce the solar radiation entering the room, but also enhance the change of light and shadow, enrich the outline of the building, and form an appealing and expressive building facade.

4.4 Conclusion

In summary, starting from the construction of green ecological campus, the integrated design of buildings should be based on the quantitative analysis of building functions, local climate conditions and natural resources, including building layout, shape, functional organization, envelope structure and shading based on numerical simulation, so as to meet the requirements of natural ventilation and lighting of campus buildings to the maximum extent. At the same time, the optimization is combined with appropriate active energy-saving technology, which can not only create a comfortable indoor and outdoor environment, but also reduce energy consumption. It can be seen that appropriate design strategies can, on the one hand, improve the applicability of architectural design content and improve the operability of design schemes; On the other hand, it can effectively improve the utilization efficiency of building resources and provide students with a better learning environment and living environment.

References

[1] Ying X U , Qing-Ping Z .The ecological transition analysis of urban green space construction—a case study on the 2010 World EXPO in Shanghai[J].Journal of Nanjing Forestry University(Natural Sciences Edition), 2010, 34(6):144-148. DOI:10.3724/SP.J.1238.2010.00474.

[2] Sun, Zhen K .Research on the Design for Sustainability and its Green Building Materials[J].Advanced Materials Research, 2012, 479-481:2279-2282.DOI:10.4028/www.scientific.net/AMR.479-481.2279.

[3] Wu X , Kong W , Chen R ,et al.Investigation and Analysis on Development Strategy of Integrated Energy Service Digital Platform[J].IEEE, 2021.DOI:10.1109/CEEPE51765.2021.9475731.

[4] Raharjo E P , Pradana A , Sasue R R O .The Design Concept of Integrated Pedestrian Sidewalk with Solar Plants as a Form of Green Campus Development at the Bali Land Transportation Polytechnic[J].IOP Publishing Ltd, 2024. DOI:10.1088/1755-1315/1384/1/012035.

[5] J Cárdenas, Osma G , Caicedo C ,et al.Building energy analysis of Electrical Engineering Building from DesignBuilder tool: calibration and simulations[J].IOP Conference Series: Materials Science and, Engineering, 2016, 138(1):012013 (6pp).DOI:10.1088/1757-899X/138/1/012013.