BILINGUAL PUBLISHING CO.

Frontiers Research of Architecture and Engineering
https://ojs.bilpublishing.com/index.php/frae/index

REVIEW

Discussion on the Intelligent Design of Ultra-Low Energy Consumption Passive Buildings

Xin Tong[1*] Xiaolin Yang[1] Xiao Ma[2]

1. Graduate Students Brigade, Logistics University of People's Armed Police Force, Tianjin, 300309, China
2. Logistics support Department of the Armed Police Logistics College, Tianjin, 300309, China

ARTICLE INFO

Article history
Received: 26 March 2019
Revised: 1 April 2019
Accepted: 23 April 2019
Published Online: 30 April 2019

Keywords:
Ultra-low energy consumption
Passive buildings
Intelligent design

ABSTRACT

With the continuous development of science and technology and the gradual improvement of modern building technology, people pay more and more attention to the introduction of advanced technology in architectural design, such as the application of intelligent technology. With the increasingly severe environmental situation, people are increasingly demanding the environmental performance and green performance of buildings. The establishment of ultra-low energy consumption passive buildings has become one of the key construction contents of construction projects. This paper mainly analyzes the design points and architectural forms of related buildings from the perspective of intelligent control.

1. Introduction

With the continuous development of economic construction and the continuous improvement of people's living standards, people's requirements for the built environment are getting higher and higher. The current environmental damage and energy shortages are becoming more and more prominent. The total energy consumption and energy consumption intensity of buildings are significantly improved due to the increasing volume of buildings. The concept of energy conservation and emission reduction is deeply rooted in the hearts of the people. It is important to pay attention to the green design of the building and to promote the transformation of the building towards a green and low carbon type. Establish passive buildings, use advanced scientific and systematic architectural concepts to improve and transform related buildings, give full play to the advantages of energy-efficient buildings, and provide people with high-quality architectural design.

2. The Overview of Ultra-Low Energy Consumption Passive Buildings and Related Design Points

2.1 The Definition of Ultra-Low Energy Consumption Passive Buildings

The ultra-low energy consumption passive buildings differ from ordinary buildings mainly in that they can adapt to natural conditions and climatic characteristics, and can maintain a structure with better thermal insulation

**Corresponding Author:*
Xin Tong,
Graduate Students Brigade, Logistics University of People's Armed Police Force, No. 1 Huizhi Ring Road, Dongli District, Tianjin, 300309, China;
E-mail: 578036446@qq.com.

DOI: https://doi.org/10.30564/frae.v2i2.681

performance and airtight performance. The use of high-efficiency fresh air heat recovery technology to minimize the energy consumption of buildings during use and make full use of renewable energy, which can provide residents with a comfortable indoor environment and a new type of building that can meet the energy saving and emission reduction effects. The construction concept of passive building has a wide range of applications in the current construction field. It is the most advanced low-carbon energy-saving building in the world. It has the advantages of scientific principles, advanced concepts, complete research and testing, and mature technology models. Energy-efficient buildings have high cost advantages and technological advantages. Passive buildings maximize the use of renewable energy and the natural environment, greatly improving the air tightness and thermal insulation of buildings, which allows buildings to reduce energy consumption for heating and cooling, and to reduce the energy use of buildings during use, which allows natural resources such as natural ventilation, day lighting and solar radiation to be fully utilized during the operation of the building to minimize the need for energy consumption, to save energy and reduce emissions and protect the environment.[1]

2.2 The Design Points of Passive Buildings

2.2.1 Set the Air Barrier and Insulation Layer

In the design work of ultra-low energy consumption passive buildings, the first thing to complete is the design of the building's airtightness and insulation layer, the air barrier and the insulation layer of the building can be separated from each other or overlap each other. In the design of the passive building space, the space including the air barrier and the insulation layer is required. The air barrier can be installed inside the insulation layer, but the air barrier cannot pass through the insulation layer. Both designs should be as simple as possible to avoid complex changes. Buildings can be wrapped in the bedroom, dining room, living room, bathroom, study, kitchen, stairwell and other areas to fully play the role of the insulation layer. However, in order to further control and reduce the cost, the air barrier can be installed in some areas with good air permeability, such as stairwells, unit halls and outdoor corridors. These places can also be tested without air tightness to reduce the cost of production and construction.[2]

In the process of placing the insulation layer and the air barrier, it is also necessary to separately and centrally arrange the relevant equipment space and living space according to the current building layout and related spatial characteristics, so as to better complete the installation and processing of the equipment, the length of the relevant pipeline is reduced as much as possible. For ultra-low energy consumption passive buildings, it is generally necessary to install integrated ventilation equipment that uses pipes to transfer wind resources to various areas of the building. Ventilation equipment is typically placed between equipment or bathroom ceilings to minimize heat loss during transport. In the spatial layout of the equipment, the centralized equipment space layout should be selected first, and the laying length of the pipeline should be reduced as much as possible to improve the air supply efficiency of the ventilation system and reduce the heat and loss during the air supply.[3]

2.2.2 Carry out the Design and Calculation Work of the Thermal Bridge

Ultra-low energy consumption passive building design requires the use of a heat-free bridge design. The thermal bridge coefficient needs to be reduced to a sufficient extent within the building envelope, paying attention to the heat dissipation and the amount of infection in different areas. For example, for the position of the reinforced concrete ring beam in the outer wall, the heat transfer amount of these places is much larger than the main part, and the temperature of the main body is also much lower than the temperature of the inner surface. Therefore, in the process of designing the boom node, it is necessary to fully understand and analyze the relevant structure and related equipment of the building, then mark all possible thermal bridges in the building, and use professional software to calculate the parts where heat bridges may exist to determine the relevant thermal bridge coefficients. When the calculation result indicates that the thermal bridge coefficient is high, the relevant designer needs to re-design the thermal bridge construction node and recalculate the relevant thermal bridge coefficient until the standard requirement is reached.[4]

2.2.3 Carry out the Design Work of the Kitchen Ventilator

The setting of the kitchen ventilator is also a key project for the ultra-low energy consumption passive building. During the setting process of the kitchen ventilator, it is necessary to complete the setting work of the self-contained fume purification device and part of the system. In the case that the kitchen usage rate is relatively low and the soot is relatively small, the fresh air ventilator and the kitchen ventilator unit can be combined to use the fresh air ventilator unit air duct to complete the fume removal work. With the kitchen ventilator's own fume purification

 DOI: https://doi.org/10.30564/frae.v2i2.681

device, for some kitchens with low usage rate, the purification efficiency should be higher than 98%. For the daily cooking situation where the kitchen application is frequent and the soot is relatively large, an independent air supply system needs to be established, and the supplemental air is directly introduced from the outdoor, and the related insulation measures and sealing measures need to be taken into consideration.[5]

3. The Intelligent Design Work of Ultra-Low Energy Consumption Passive Buildings

3.1 The Integrated Design Work

With the continuous development of science and technology and the arrival of the information age, the application of intelligent technology in various industries has deepened. Applying intelligent technology to the control and management of buildings during the construction and use of buildings can effectively reduce the energy consumption of buildings, achieve good resource and energy distribution, and achieve better energy saving and emission reduction effects. In the design process of ultra-low energy consumption passive buildings, it is necessary to design according to the passive priority and active optimization design principles. The performance- oriented design principles that aim at energy consumption are designed throughout the design. First of all, the overall design work needs to be completed. After fully understanding the passive building-related functions and the local climatic environment, local natural light, natural ventilation, and building heat storage and shading measures can be used to better meet the spatial functional requirements and design aesthetic requirements of the building. Control the construction cost of the building, and at the same time reduce the cost, apply various intelligent means to better control the building system. The application of intelligent technology can provide better energy optimization solutions for the system to more effectively utilize various natural resources such as geothermal energy and solar energy, and reduce the consumption of fossil energy, which ensures that in the design process, every design step can reflect the details of energy saving and emission reduction, and create intelligent buildings.

3.2 Reasonable Space Design and Layout

The rationality of the space design of the building is directly related to the energy consumption of the building during operation. In the design process of ultra-low energy consumption passive buildings, under the premise of satisfying the function of building use, the layout of the building plane and space should be reasonably carried out, and the intelligent design of the building orientation, window opening form, body shape coefficient, lighting and sunshade area should be reasonably set according to the characteristics of different areas. The shape of the relevant building needs to be regular and compact, avoiding irregular changes and excessive decorative components, and controlling the building shape coefficient to a lower range. To reduce the area of the building's outer protective structure, the flat design of the building should be more conducive to natural ventilation and winter sunshine. The arrangement of the building door and window openings and the organization of the relevant space should be conducive to the passage of the wind, so as to achieve natural ventilation in summer, reduce the need for air conditioning use and the time of air conditioning use, and reduce energy consumption. The orientation of the intelligent building needs to adopt a north-south or near-north-north direction. According to the sunshine situation in China and the corresponding seasonal changes, the room should avoid the dominant wind direction in winter.

According to the lighting conditions and related ventilation conditions, the regional planning is reasonable, and the relevant designers can reasonably arrange the gaps and spacing between the buildings according to the local climate characteristics, so as to avoid the hindrance of the building sunshine in the back row. At the same time, it is also possible to prevent the rear buildings from being attacked by the cold wind in winter, and to set the high-rise buildings to the position facing the winter wind direction, thereby contributing to the reduction of winter heating needs. The area ratio between the relevant building windows and the wall is optimized and calculated through the performance design method. From the perspective of climate change and temperature throughout the year, the area ratio between the window walls is reasonably set to meet the heating function demand of the building. Under normal circumstances, in order to better achieve the insulation effect of the building, the outer window generally adopts three-layer glass, and the outer door and the household door are insulated and sealed. In addition, the design of the pipe arrangement of the building should be carried out, according to the layout of the building and the layout of the space. It is necessary to be able to design an optimal pipeline line to facilitate the installation of equipment, promote cost reduction, reduce resource consumption during installation, and save energy and reduce emissions.

3.3 The Energy Consumption Monitoring of BAS System

The BAS system can effectively manage and control the

DOI: https://doi.org/10.30564/frae.v2i2.681

whole process and full parameters of the building energy consumption system, and realize the optimization and monitoring of the energy-saving operation system. The system can monitor the temperature changes in various areas of the building in real time, especially for the related lighting energy consumption, socket energy consumption, heating energy consumption, etc., thereby the relevant energy consumption data can be collected in real time and transmitted to the management center. The management center uses intelligent technology to conduct comprehensive analysis and statistical work on relevant energy consumption data, upload it to the energy consumption monitoring center, monitor abnormal energy consumption power in time, find out the cause of the abnormality, and solve it in time. In the real-time monitoring and network management of indoor temperature, pay attention to the selection and application of temperature sensors, finely manage the use of central air conditioners, and control the time and temperature control of central air conditioners. Carry out real-time monitoring of related door and window status, avoiding the use of heating equipment and air-conditioning equipment when opening windows and opening doors, reducing unnecessary loss of energy. The application of intelligent technology in buildings can also be embodied in the intelligent lighting control system. The intelligent lighting control system can monitor the brightness of the room in real time, adjust the brightness of the light according to the law of the human body, and control the opening and closing of the light, which avoids the situation that the light is still on after the person walks, reduces the waste of electric energy, and the intelligent home control system in the ultra-low energy consumption passive building can control the opening and closing work of the curtain in real time. It is also possible to remotely control related electrical equipment, thereby minimizing the consumption and waste of energy resources, and reflecting the effect of energy saving and emission reduction.

3.4 Intelligent Monitoring and Control of Fresh Air System

With the continuous development and intelligence of science and technology, technology has been deepened in furniture applications, and high-efficiency fresh air systems have been widely used in new buildings. The system is capable of building control with intelligent technology to provide a comfortable and comfortable indoor environment for the building. Efficient heat recovery fresh air delivers fresh air to the room, while also providing heating, cooling, dehumidification and humidification. The intelligent control system can control the air outlet speed and the outlet air temperature of the heat recovery fresh air. The heat recovery of the fresh air equipment filter can reach 90%, providing a comfortable and healthy indoor environment for the occupants. Compared with the traditional air supply system, efficient heat recovery fresh air system can increase heat recovery efficiency by 75%, which greatly reduces the energy consumption of heating and cooling, and effectively improves the indoor health and comfort. The control system is implemented in accordance with relevant national standards and building requirements, and can ensure that the indoor environment can effectively meet the residential needs and health needs of the residents.

3.5 Intelligent Technology Construction Points

Applying the skills technology to the building field has become one of the important goals of the current building development. With the continuous development of China's construction industry and the increasing number of construction companies, relatively speaking, the development of the construction industry has reached a bottleneck, and the competition between construction companies is also increasing. In order to ensure the vitality and vitality of construction enterprises, it is necessary to reform the traditional construction plans and construction methods of construction enterprises, and arm construction techniques with the latest technology, so that construction projects can better meet the needs of current society and people's development. First of all, we must improve the construction and quality control of the ultra-low energy consumption passive building field. We will focus on solving the problem of no-heat bridge construction, air tightness system and equipment installation. According to the actual situation and the requirements of the residents, the design drawings should be properly adjusted. In the construction plan, it is necessary to pay special attention to ensure the integrity of the building airtightness. The cross-section and plan view of the relevant design plan should be able to clearly mark the position and orientation of the air barrier, and write a patented construction plan according to the relevant construction requirements.

4. Conclusion

The construction of ultra-low energy consumption passive buildings in the current construction field can effectively reduce the energy consumption of buildings during operation, promote the ecological civilization construction of the city, and have a good environmental protection effect. This paper mainly studies the intelligent design of ultra-low energy consumption passive buildings, and points

 DOI: https://doi.org/10.30564/frae.v2i2.681

out the specific application of intelligent technology in the passive building design process, hoping to provide some reference for related industries.

References

[1] Xiaoxia Han, Tiangang Fan, Guqiang Wei, Congchuan Hu. Analysis of renewable energy application scheme for ultra-low energy consumption passive buildings[J]. Building Energy & Environment, 2016(35):12-13. (in Chinese)

[2] Kan Zhu, Xiaojing Liu, Chao Xu. Application analysis of ultra-low energy consumption passive building technology in Jiangsu province[J]. Building Energy Efficiency, 2016(44):10-11. (in Chinese)

[3] Lei Liu, Zhigang Zhang. Waterproof construction technology in building construction engineering[J]. Social Sciences (Digest), 2016(10):182. (in Chinese)

[4] Haiyin Cheng, Guodong Lou, Zhongmin Fang. Semi-reverse construction technology of a basement of a engineering podium in Wuhan[J]. Construction Technology, 2014, 43(7):22-25. (in Chinese)

[5] Gang Li. Underground railway concrete waterproof engineering construction technology[J]. Architecture Technology, 2015, 46(8):707-709. (in Chinese)

DOI: https://doi.org/10.30564/frae.v2i2.681