Research on Green and Healthy Buildings Based on BIM Technology under the Background of Epidemic

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Abstract. The development of science and technology has changed our way of life and our understanding of nature. The concept of the architect and construction industry has entered the stage of green architecture concept due to the development of the times. The emergence of new technologies such as BIM has promoted the upgrading of the construction industry to the stage of intelligent construction, the visualization and collaborative design of the application of BIM technology, etc. The advantages of green building design analysis can solve the problems existing in traditional design. The design quality of buildings depends greatly on the analysis and decision-making in the early stage. Improving the reliability and accuracy of green building analysis and simulation can help improve the quality of green and healthy building design. Combining the BIM stage model with green building simulation analysis can provide more reliable simulation analysis results for green building design, thus improving the accuracy of design. On the basis of combining green architecture and BIM technology, the background premise of large-scale emergencies such as the epidemic is added to improve the response capacity of the construction industry under emergencies such as the epidemic at the design stage.

1. Introduction

The requirements of society for architecture have been improved. Contemporary architecture should not only meet people's functional needs for traditional buildings, but also meet the concept of energy-saving, environmentally friendly, efficient, safe and beautiful green and healthy buildings throughout the life cycle of the building. In 2020, the world was affected by the novel coronavirus epidemic, which exposed the emergencies of some buildings in the epidemic and other emergencies. The problem of insufficient coping capacity and improving the epidemic response capacity of buildings are also the only way for the development of the construction industry in the future.

BIM and other intelligent building methods can reduce construction costs and improve work efficiency throughout the whole life cycle of the building. Green and healthy buildings can reduce building pollution caused by the construction process, reduce building energy consumption and protect the ecological environment[1]. At the design stage, the BIM model is used to optimize the practical role of buildings, improve building comfort, strengthen the response and protection ability of buildings in emergencies such as the epidemic, make residential buildings safer and more comfortable, and industrial buildings in the epidemic. Quickly respond to production capacity in emergencies.
2. Overview of Related Theory

2.1. BIM technology
BIM technology turns traditional two-dimensional drawings to the three-dimensional visualization stage, opening the door of two-dimensional design to three-dimensional design. BIM technology can help integrate architectural information, integrate a variety of information of building life cycle into three-dimensional model information database, and set of BIM three-dimensional model information. The emergence and development of the concept of Chenghua and the architectural information model provide a technical platform support for all project participants to share the actual information of the project at all stages, so that many people, such as design units, construction units, facilities operation and later operation and maintenance units and owners, can work collaboratively based on the BIM 3D model. The construction method of BIM technology greatly improves the efficiency of various work, saves practical resources, reduces building costs, effectively reduces design conflicts, optimizes the traditional architectural design method to achieve sustainable development, that is, architectural information modeling. It is a complete process of information modeling[2]. It is the crystallization of technology with the continuous development of scientific and technological and digital informatization, as well as the combination of simulation and virtual technology based on parameter informatization of traditional architecture.

2.2. Green and healthy building
Green and healthy building is a more environmentally friendly, efficient, energy-saving and comfortable architectural design, construction, operation and maintenance method that fully integrates the natural environment factors and indicators around the building throughout the life cycle of the building. Apply green building design methods in the architectural design stage, improve the ability of buildings to adopt natural resources, reduce building energy consumption, adopt reasonable green building construction methods in the construction stage of buildings, and reduce environmental pollution caused by the construction process of buildings. Protecting the natural ecological environment and reducing pollution provide people with a more comfortable, healthy and efficient building living environment.

The main characteristics of green and healthy buildings: compared with traditional buildings, it has better building comfort, saves building resources, saves materials, saves energy, saves water and saves land[3]. Green and healthy buildings are the premise of green buildings. Under the premise of green buildings, buildings have been added to ensure the normal operation of buildings under major emergencies such as the epidemic. They have a good response ability, enhance the coping ability and protection ability of buildings under emergencies such as the epidemic, so that residential buildings can be safer and more comfortable, and buildings can cope with emergencies such as epidemics. Quickly return to industrial production capacity in the event.

2.3. BIM technology and green and healthy buildings under the background of epidemic
Under the influence of the novel coronavirus epidemic in 2020, the design and use problems of many buildings have been exposed. Insufficient design in water supply and drainage have led to the spread of the virus through the water supply and drainage pipeline, leading to an outbreak of the epidemic in the interior of the building. Long-term home isolation is insufficient in ventilation, sunshine, lighting, etc., leading to a long time. The comfort of living in the room decreases. So that the improvement of the emergency response ability of buildings has quickly entered the research strategy at home and abroad. Through the impact of the COVID-19 epidemic in 2020, green healthy buildings should integrate more healthy building concepts and improve their response capacity to emergencies such as the epidemic, vigorously develop new green and healthy buildings, establish a perfect evaluation standard system for green and healthy buildings, and improve green and healthy buildings in the future. Complete, safe and comfortable epidemic response ability. On the basis of intelligent buildings, combined with the analysis of BIM and green and healthy buildings, the building is optimized in the architectural design stage, improving the basic performance of the building and improving the building's epidemic response ability.
3. Case analysis

3.1. Project overview
A residential district building is located in Chengde City, Hebei Province. It has two floors underground and 18 floors above ground. The building type is shear wall structure, with a total land area of 40620.7 square meters and a total building area of 124501.0 square meters, including 103244.24 square meters above ground and 90711.99 square meters of residential area. The first phase building is 36018.4 square meters, and the second phase building is 54693.59 square meters. In addition, Commercial and supporting building is 12532.25 square meters, underground building is 21256.76 square meters. The volume ratio is 2.54, the building density is 25%, the green rate is 35%, the building height is 57.7 meters, the total number of households is 853, and the total parking spaces are 550, including 149 above-ground parking spaces, 301 underground parking spaces and 100 commercial parking spaces. Combined with the actual situation, the green building optimization of the building is carried out by using BIM technology and green analysis software. The flow chart of green building software analysis is shown in figure 1.

![Flow chart of green building software analysis](image)

Figure 1. Flow chart of green building software analysis

3.2. Optimization of lighting and sunshine design of buildings under epidemic and other emergencies
Significance: Natural light source is a long-term and comfortable light source condition for people. According to various studies, the visual effect of all kinds of light sources is better than artificial light source under the same irradiation conditions, which is more conducive to people's daily work, life, improve labor and production efficiency, and more protect people's eyesight. As a consequence, making full use of natural light sources in architectural design is of more significance for creating good lighting conditions, saving building energy consumption, protecting the natural environment and building a green building system.

3.2.1. Daylighting optimization. The indoor lighting effect of the building is affected by both the interior and the exterior of the building. The reflectance of the inner surface of the building is one of the important internal factors, the sunshine of the sky brightness is an important external factor, and the reflection of the outer surface of the building is also an important factor affecting the effect of daylighting. The interior and exterior wall finishes of the building, the interior floor of the building, the materials used in the building, and the reflectance corresponding to the color are different. They bring different lighting effects to the indoor lighting environment. The position, size and shape of the windows will have different effects on the indoor lighting effect of the building. The light transmission performance of the light transmission components used is also closely related to the effect of building lighting.

3.2.2. Design optimization. The actual sunshine trajectory map of the building project (see figure 2) and the annual sunshine trajectory map (see figure 3) are made by using Revit combined with the design
situation, location, sunshine time, sunshine area and actual sun trajectory data of the project. In addition, the three-dimensional model of BIM is combined with the green building analysis software and the environment and sunshine data are used. Besides, we simulate the actual windowsill height and window height of the building and the indoor lighting and sunshine conditions of the building in different seasons, use the simulation method, formula method and formula expansion method to calculate the lighting, change the size, shape and location of the window outside the window to change the indoor lighting coefficient. Moreover, we make a reasonable window layout according to the different lighting coefficient required by different functional rooms. Appropriate reflective and light guide materials are used to change the light transmission coefficient and then change the lighting effect. The reflector is arranged at a reasonable position and angle in the indoor room where the lighting coefficient is too high, and the reflection part of the light source makes the lighting effect the best. The light guide is arranged in the appropriate position to increase the indoor lighting coefficient in the room with low lighting coefficient. In addition, all these analysis and optimization methods are applied to obtain the ideal lighting effect so as to improve people's comfort for the use of natural light sources. The utility model reduces the use time of the artificial light source, reduces the electricity consumption of people, and reduces the energy consumption of the building.

3.2.3. Optimization of response to epidemic situation. The living conditions of long-term homes were not taken into account in the design of traditional buildings. In addition, the indoor lighting problems of related buildings were exposed under the influence of COVID-19’s epidemic situation in 2020, which
led to the reduction of living comfort of buildings where people lived in isolation for a long time. The building optimization combined with BIM and green and healthy building technology, natural light sources were used to optimize different functional rooms to the greatest extent. Windows with different materials and different light transmission coefficients are used to place daylighting windows at appropriate locations and heights to meet the needs of different functions, to increase the living comfort of buildings that are isolated and lived for a long time, and to achieve the best feeling in daylighting and vision. Combined with the analysis report and data derived from the daylighting and sunshine analysis software, the height and position of the building windows and the window materials are modified on this basis. The light guide pipe is arranged in the room with lower lighting coefficient, and the reflector is arranged in the room with higher lighting coefficient. As a result, different rooms can meet the lighting requirements and make full use of indoor lighting. The comparison of the daylighting design of the first floor of the building with BIM technology and green healthy building concept before and after optimization is shown in figure 4. It is concluded that the lighting design combined with BIM and green health building is more suitable for people's living needs.

3.3. Optimization of ventilation and thermal comfort design of buildings under epidemic and other emergencies

3.3.1. Building ventilation. In addition, the basic purpose of building ventilation is to remove indoor pollutants and ensure to meet the needs of indoor personnel for fresh air. Modified building ventilation provides the main breathing and cooking for residents to provide the necessary oxygen to prevent the production of polluting gases caused by excessive carbon dioxide in the building. As the indoor air is in the state of people's breathing, the indoor air will be polluted in any case[4]. As a consequence, the ventilation design of the building can change the fresh air in time. The window size and shape of the building, the height and area of greening around the building, etc, the upwind and leeward pressure of the building and the average wind pressure difference of the building window are derived by software drop calculation through the analysis of the physical information of the building combined with the surrounding environment of the building(see figure 5 for the building wind pressure cloud map). The overall layout of the building in the project is optimized by combining the speed distribution and the wind speed distribution (the cloud map of the horizontal wind speed magnification factor of 1.5 meters of the building is shown in figure 6). Analysis report of wind speed amplification factor, out-of-limit area and building ventilation around buildings in the area and thermal comfort of buildings is calculated. In addition, we optimize the design of the building, modify the distribution of the building and the position, size and shape of the window, so as to make the ventilation meet the standard requirements of the green building. The wind pressure difference between the outdoor surface and the indoor surface of

Figure 4. Comparison of daylighting design of the first floor of the building before and after optimization
the building is greater than 0.5Pa when 50% of the outer windows can be opened. All the buildings can open the outer windows and the difference of wind pressure between the outdoor surface and the indoor surface of the building can meet the standard requirements of green buildings.

![Figure 5. Building wind pressure cloud map](image1)

![Figure 6. Cloud map of magnification factor of horizontal wind speed of 1.5 meters in building](image2)

3.3.2. Thermal comfort of building. The comfortable thermal environment can prevent residential discomfort caused by warm feeling and moist skin to a certain extent. The main factors that ensure the thermal comfort of indoor personnel affect the thermal comfort of the building are indoor temperature, air velocity and water vapor pressure. On the basis of the ventilation standard, combined with the annual outdoor average temperature map of the actual location of the building (see figure 7) and the coefficient of material thickness, thermal conductivity, heat storage and thermal resistance of the building itself, the indoor thermal comfort of the building is analyzed by software[5]. We modify the size, nature and location of the window in the building room where the indoor temperature is lower in the thermal comfort zone. In addition, by the analysis of the actual indoor temperature of the building, we modify the materials used to control the thickness of building materials, heat conductivity, heat storage, thermal resistance and other coefficients to improve the thermal comfort of the building.

Good building ventilation design and thermal comfort can provide people with better living comfort in home isolation. It is consistent with the design concept of the new green building in 2020. On the one hand, it provides people with good living thermal comfort and indoor oxygen content, and isolates a large number of viruses in the ability to deal with the epidemic, which is conducive to epidemic prevention and control. On the other hand, maintaining a proper indoor and outdoor wind pressure gradient can effectively eliminate indoor pollution and odor. Besides, the green building concept of isolating a large number of viruses and "healthy and comfortable, environmentally livable" is in line with the current prevention and control measures of COVID-19.
3.4. Optimization of building water supply and drainage design under epidemic situation and other emergencies

Under the influence of the epidemic of COVID-19 in 2020, novel coronavirus caused the virus to spread inside the building through the water supply and drainage pipe due to the insufficient design of building water supply and drainage or the lack of water seal design of building water supply and drainage. As a result, it led to the spread of the virus inside the building and aggravated the impact of the epidemic.

Combined with BIM 3D modeling (see figure 8 for building water supply and drainage model), the electromechanical water supply and drainage model is established to ensure the connectivity and tightness of the water supply and drainage pipeline in the software. The BIM model is used to carry out the construction in the actual construction process. The problem of water seal in epidemic prevention and control leads to the spread of the virus in the building indoor. In the design, according to the actual water consumption combined with the pipeline layout location, we increase the design height of the water seal to ensure that the virus does not spread through the water supply and drainage pipes in the building in case of an epidemic and other emergencies. In addition, we increase the prevention and control ability of buildings under the epidemic situation, making sure that the water appliances are closely connected with the drainage system through the water seal, and block the contaminated gas and some viruses inside the sewer pipe from entering the room through the water seal (see figure 9 for the water seal model).

4. Conclusion

People's ideas are moving forward rapidly in the design of contemporary buildings. There is an urgent need to develop green and healthy buildings combined with the background of the epidemic on the
premise of ensuring the safety and quality of buildings. In addition, the promotion of the technical concept of green and healthy buildings is carried out steadily. The development benefit of green and healthy building is very obvious. The key assessment index of green building has been upgraded from "four sections and one environmental protection" to the performance standard of green building of "safety and durability, resource conservation, livable environment, health and comfort, and convenience of life" under the influence of the epidemic situation of COVID-19 in 2020. The measures for prevention and control of COVID-19 come down in one continuous line. From the perspective of future development, the birth of green and healthy buildings has produced "epidemic-free" and "safe" green and healthy buildings. The development of green and healthy buildings in the future is conducive to the construction of complete, safe and comfortable building epidemic response capacity. In addition, it contributes to improve building epidemic response capacity and building comfort and practicability in building ventilation and air-conditioning operation, building thermal comfort, building water supply and drainage facilities management and indoor and outdoor environment and other aspects.

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