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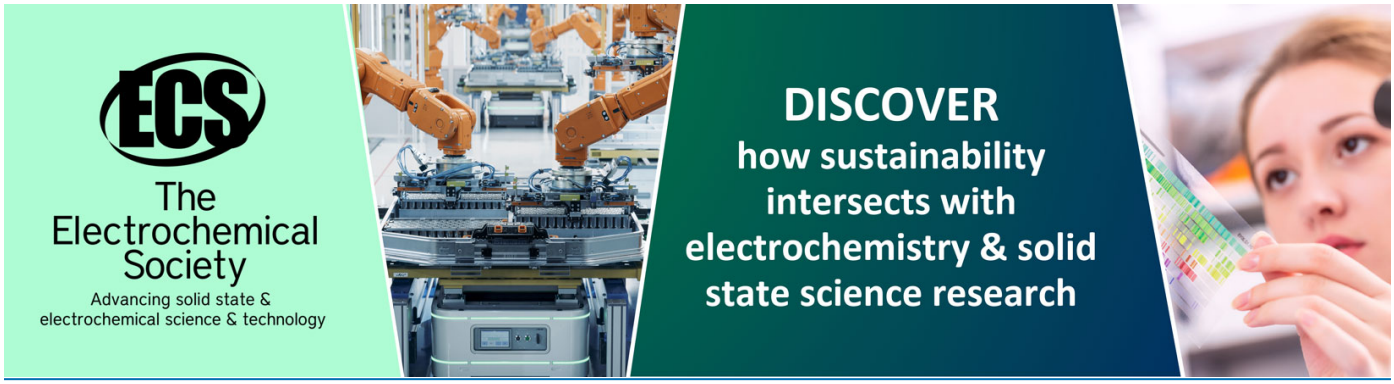

Application method of natural light in architectural design

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Abstract. Based on the purpose of improving the architectural design, we will make a simple discussion around the application of natural light, propose the use of natural light, and make a simple discussion. First, the article analyzes the requirements of architectural design. Secondly, it analyzes the use of natural light with examples. Finally, the strategy of using natural light is summarized. According to the analysis of architectural design practice, improving the utilization rate of natural light will play a positive role in reducing the consumption of energy and resources, and has the value of promotion and application.

1. Introduction

According to data released by the Bureau of Statistics, clean energy consumption in 2019 accounted for 23.4% of total energy consumption. According to preliminary calculations in the report, the total energy consumption for the year was 4.86 billion tons of standard coal, a year-on-year increase of 3.3%. Coal consumption increased by 1.0%, and electricity consumption increased by 4.5%. Energy consumption continues to increase, which has a greater impact on the climate and brings great environmental challenges to people's lives. In the context of increasing energy consumption, how to reduce energy consumption in various industries has become the focus of research. The construction sector is a major energy consumption subject and is the focus of attention. Buildings account for about 40% of energy-related greenhouse gases, but the industry as a whole has not reversed its contribution, and must actively explore to effectively reduce the use of resources related to buildings. In recent years, building construction standards have been continuously improved, and construction requirements and standards for low-carbon buildings and green buildings have been proposed. In the practice of building design, new energy sources are widely used, such as solar energy and wind energy. Energy-saving design reduces energy consumption and meets the requirements of green environmental protection.

Based on the background and requirements of sustainable development, the following architectural design requirements are proposed: First, zero-carbon building. It means that the building does not consume non-renewable energy such as coal, oil and electricity, and the entire year's energy consumption is provided by the renewable energy generated by the site. Zero-carbon buildings advocate passive energy-saving design of building envelopes, and at the same time encourage the active shift of building energy demand to renewable energy. For example, solar energy, wind energy, and shallow geothermal energy provide solutions for the sustainable development of mankind and the harmonious development of buildings and the environment. Second, green buildings. This type of building refers to saving resources as much as possible during the whole life cycle of the building, achieving environmental protection, reducing environmental pollution, providing a healthy and comfortable space for humans, and achieving harmonious symbiosis with nature. The greenness

mentioned here is not simply afforestation, but advocates the full use of resources, and puts forward the concepts of sustainable development of buildings, ecological buildings and energy-saving and environmentally friendly buildings. From the whole process of architectural planning, design and construction, the pursuit of harmony between buildings and resources, such as daylight utilization and air circulation, creates a livable environment and reduces energy consumption. Generally speaking, in the face of new standards and requirements for building construction, comprehensive control must be done when building design, and new technologies and methods for energy conservation and environmental protection must be actively integrated.

2. Analysis of application examples of natural light in architectural design

2.1. Case overview

Taking a project as an example, the total area of the building is designed to be 3316.3 square meters, the body form factor is set to 0.04, and the window-to-wall ratio is set to 34%. The residential area of the 1-5 floors of the building is designed to be 2433.7 square meters, the storage room area is designed to be 560.1 square meters, the top floor area is designed to be 322.5 square meters, and the height of the entire building is designed to be 19.7m. The building is located without obstructions, and the terrain is flat. The structural safety level of the building is designed to be level two, and the design is designed according to the service life of 50 years; the seismic intensity level is set to 7 degrees, and the basic seismic acceleration is 0.15g. The fire resistance rating of this building is designed to be level 2; the roof waterproof is set to level 3. In the building envelope structure system, the outer wall is designed as a composite wall with a thickness of 240mm; the household wall of the inner wall is 240mm, and the partition wall is 240mm. Now combine the lighting design of this building for analysis.

2.2. Climate analysis

The area where the building is located is a hot summer and cold winter climate zone. The nationwide plan is divided into 5 types of light climate zones. This project is located in a type IV light climate zone. The critical illuminance value of natural light outside the building is 4500lux, and the corresponding light climate coefficient value is selected as 1.10. This project is designed in accordance with the relevant regulations of "Architectural Lighting Design Standards" (GB/T50033). The standard values of daylighting coefficient and natural illuminance for each key position of the building are as follows (side lighting): 1) Living room, bedroom, study and kitchen. The lowest value of daylighting coefficient is 1.0%; the critical illuminance of indoor natural light is 50lux. 2) Toilets and halls, stairwells and dining rooms. The lowest value of daylighting coefficient is 0.50%; the critical illuminance of indoor natural light is 25lux.

2.3. Analytical method

Build a BIM architectural model, and use the model's functions to perform daylighting analysis. When carrying out daylighting effect analysis, according to the daylighting coefficient standard and light climate coefficient of the building construction area, the value of the regional daylighting coefficient is obtained. The lowest value of daylighting factor for living rooms, etc. of this building is 1.1%; the lowest value for bathrooms, etc. is 0.55%. Use Ecotect software to analyze the natural lighting level of typical building floors and carry out simulation calculations. According to the design coordinates, select a 0.8m horizontal plane from the ground as a reference evaluation work surface. At the same time, select the indoor lighting coefficient and lighting intensity to carry out the analysis and evaluation of the lighting level.

2.4. Light environment analysis results

Using BIM software to analyze the building light environment, the analysis results are as follows:

- Daylighting factor[1]. The installation of building doors and windows promotes the improvement of natural lighting in the building. The daylighting coefficient of this building near the doors and windows is larger than the daylighting coefficient of the internal space, but the difference is not significant, so it will not cause significant contrast between light and dark, which can effectively avoid the appearance of glare. The lighting coefficient of the living room and bedroom in the building is in the range of 5.6-9.5%; the lighting coefficient of the restaurant and bathroom in the building is in the range of 0.6-5.5%, which can meet the design standards.
- Illumination analysis. According to the analysis result, the illuminance analysis result is similar to the daylighting coefficient simulation result. The installation of building doors and windows promotes the improvement of the building's indoor natural lighting level. The daylighting coefficient of this building near the doors and windows is larger than the daylighting coefficient of the internal space, but the difference is not significant. However, the overall distribution of indoor lighting is relatively uniform. The illuminance value range of the living room and bedroom in the building is 210- 450lux; the lighting value range of the restaurant and bathroom in the building is 60-175lux, which can reach the design standard.

2.5. Light environment analysis conclusion

In the practice of building construction design, setting up doors and windows can play a positive role in increasing indoor natural lighting. When designing, it is necessary to integrate the shape and orientation of the building as well as the distance between the buildings to ensure the rationality of the design and ensure that the natural lighting of the building meets the standard. Generally speaking, there is no significant difference between the daylighting coefficient and daylighting results of the typical floor indoor and near the doors and windows, which can effectively avoid the contrast of light and dark and prevent the generation of glare[2].

3. Summary of application strategies of natural light in architectural design

3.1. Do a good job in master plan architectural design

When carrying out architectural design, the main content is the general layout design, which affects the quality of the entire design plan, so strict control must be done. Designers must do a good job in the investigation and analysis of the construction site, master the statistics and analysis of the on-site lighting, have a comprehensive grasp of the overall lighting situation, and ensure that the organic combination of the building and natural light can be achieved at the architectural design level to ensure the realization of natural lighting and improve The overall quality level of the architectural design. To carry out daylighting design, we must adhere to the principle of scientific rationality, organize the design work in accordance with the current system and norms, grasp the overall design style, and be rigorous and reasonable. The spacing of the buildings should be controlled within an appropriate range to avoid shading problems. At the same time, it is necessary to prevent the occurrence of waste of land resources or insufficient lighting to ensure the quality of the design plan to the greatest extent. In addition, it is necessary to pay attention to the lighting inside the building to realize the effective complementation of natural lighting and lighting, create a comfortable environment for people, meet the needs of sunlight, and enhance the overall lighting effect[3].

3.2. Reasonable use of natural light materials

In the practice of architectural design, natural light materials should be selected reasonably in the design of natural light. The commonly used materials are as follows:

- Transparent material. Generally speaking, transparent materials are inseparable in the practice of architectural design, which is an important part of natural light design. In order to meet the requirements and standards of natural light, the materials need to be adjusted accordingly. Actively promote the use of translucent glass, realize natural light design, ensure the quality of design work, and show the overall beauty of architectural design. In addition, improve the quality level of the design.

- Opaque material. Commonly used materials include cement and wood, etc., which are widely used in architectural design practice to obtain good shading effects. However, although the use of opaque materials can keep warm in winter, it is difficult to receive sufficient natural light in summer, which affects the overall quality. Based on this, when carrying out architectural design, natural light, metal materials and building concrete should be reasonably matched to enhance the overall effect[4].

3.3. Reasonable use of natural light

According to the summary of past practice, the application of natural light is as follows:

- The collection and storage of light and heat. Using the heat storage wall method, by applying a dark color on the outer surface of the wall, the effective absorption of sunlight is realized. With the help of the vertical heat collecting and storage wall on the south side, the effective absorption of sunlight passing through the glass lighting surface is realized. And radiation and other methods to effectively transfer heat to the room. At present, the more commonly used heat collection and storage walls include solid heat collection and storage walls and fast heat collection walls. In addition, use natural light conversion devices to provide the energy required for building operation, build a building system with "0" pollution and "0" emissions, promote the sustainable development of buildings, and create ecological buildings[5].
- Heat transfer. The heat energy transfer measures adopted are convective heat transfer, that is, heat energy is transferred from one place to another in a liquid or gas. The entire thermal energy transfer is mainly due to the change in the position of the particles so that the temperature is close to a uniform state, achieving thermal energy transfer, but it will also cause heat conduction. Generally speaking, convection heat transfer is divided into natural convection and forced convection. Make full use of the solar collector device to realize the collection of solar energy.
- Light pipe method. Using the light pipe method, the natural light collected by the solar laser is effectively transmitted to the parts that need lighting, supporting the development of indoor dining and reading under the sun. Generally speaking, windowless factories and underground buildings often use this method to collect natural light. With this method, in addition to meeting the demand for light, it can also prevent skin darkening or sunburn.
- Prism multiple reflection method. Use daylighting device for daylighting, use prism multiple reflection method to realize the effective transmission of natural light and send it to the place where daylighting is needed, meeting the daylighting needs of underground buildings or windowsless buildings[6].

3.4. Do a good daylighting analysis

Everything and everything have a "degree" of harmonious coexistence. The lighting requirements in the building have a certain degree. Too much or too little lighting does not meet the requirements of architectural design. When carrying out architectural design practice, it is necessary to do a comprehensive analysis of daylighting, actively explore effective methods, and formulate a complete plan to ensure that the daylighting needs are met to the greatest extent. At present, there are many available technologies and software in architectural design, such as BIM technology and other daylighting analysis software, etc., which can efficiently complete daylighting analysis in practical applications, evaluate whether the daylighting plan is reasonable, and propose optimization and improvement measures and suggestions. Ensure the rationality of the architectural design plan, and ensure the effect and benefit of the later use of the building. Use modern software and technology to simulate the changing conditions and environment of sunlight, analyze the lighting conditions of each space inside the building under different sunlight environments, grasp the problem of insufficient lighting, carry out a comprehensive analysis, optimize and improve lighting, and realize the value of natural light And effect [7]. Designers must have the awareness of daylighting analysis, actively explore effective analysis methods, do a good job in the overall control of building natural light design, propose high-quality daylighting design plans, and guide the development and implementation of construction work.

3.5. Expand the role of natural light

From the analysis of architectural design practice, the role of natural light is as follows:

- image construction[8]. Buildings mainly rely on natural light to achieve the effect of being visually perceived. If the scientific and rational use of natural light can be realized, the overall three-dimensional sense of the building can be enhanced, and good artistic effects can be obtained.
- Structure space[9]. Reasonable use of natural light, forming a contrast effect of light and dark, showing the sense of spatial hierarchy of the building, can promote the enhancement of the spatial effect. Combining the characteristics of people's psychological feelings and the artistic sense of architecture, the value and function of light are brought into play to promote the overall effect.
- Render the atmosphere. Use the strong and weak characteristics of light to change people's inner feelings and realize the rendering and setting off to the overall atmosphere. Through the contrast of natural light, the overall artistic effect is enhanced. Artificial light sources with better color rendering effects are used to create a relatively authentic natural environment, so that people can have a good experience in this space. The application of natural light in architectural design can play a positive role and effect and play an important role. In fact, the application of natural light, in addition to lighting, can also achieve heating, etc. Designers should combine actual needs and requirements, actively expand the scope of use of natural light, innovate the application of natural light, achieve efficient use of resources, and improve the overall quality of architectural design , To ensure that buildings meet low-carbon and green requirements, and to promote the sustainable development of buildings[10].

4. Conclusion

In summary, the full use of natural light in architectural design practice can achieve good results and play a positive role. Based on architectural examples, the article analyzes its light environment design, understands the value and effect of light design, and proposes reasonable use of natural light, good daylighting analysis, and expansion of the role of natural light. Through comprehensive and complete control, the daylighting and lighting of the building can meet the requirements to the greatest extent.

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