The Application of Green Energy-Saving Technology in Building Design—Take Zhejiang Water Control Museum architectural design as an example

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Abstract: The fundamental purpose of green building design is to protect the environment, reduce pollution and save energy. Among them, energy-saving design is the most concerned one of green building. In this paper, the architectural design of Zhejiang Water Control Museum is selected as a case study, and the optimization design of energy conservation is carried out in the aspects of building orientation design, natural wind application, roof energy conservation design, renewable energy utilization and water resource utilization. This paper comprehensively monitors the energy consumption of the whole building by combining with the building intelligent management system, and dynamically displays the current energy saving effect, emission reduction sewage and sunshade effect. We hope to establish demonstration green buildings through this project research and strengthen the application and promotion of green building energy-saving technology.

1. Introduction
The ratio of building energy consumption accounts for the whole society terminal in our country has increased from 10% in 1978 to the current 27.5%. And the process of construction operation caused a great deal of energy and resources consumption, so developing green building energy saving technology, advocating energy conservation and emissions reduction, reducing building energy consumption and greenhouse gas emissions are of vital significance in dropping the carbon dioxide emissions[1].

The project is located in Hangzhou City, Zhejiang Province. In terms of climate characteristics, it is an area with hot summer and cold winter. Among the five building thermal design zones in China, the area with hot summer and cold winter is the only one that has a long time requirement for heating and air conditioning. In these regions, the temperature of each season varies relatively large in a year. The temperature in winter reaches or is close to 0℃, while the temperature in summer can stay above 35℃ and last for a long time. In order to maintain comfortable indoor environment, buildings are often at the cost of high operating costs, energy consumption and pollution emissions[2]. Therefore, according to the climate characteristics of this region, green energy saving technology is applied comprehensively in the architectural design.

2. General layout of the building
Zhejiang Water Control Museum building base is located in Hangzhou Water Expo Park lakeside, adjacent to the China Water Museum, is the gateway of Xiaoshan New City. Covering an area of about
60,000 square meters, the plan is to build 20,000 square meters, 15,000 square meters above ground and 5,000 square meters underground.

The layout of the building is as close as possible to the lake in the southeast of the site. Through the diversified exhibition space inside and outside the building, the audience can fully understand the past, present and future of water control in Zhejiang Province. The popular science exhibition content forms a good complementary relationship with the China Water Conservatory Museum. The whole plane function is mainly divided into three areas: collection exhibition area, public communication area, management and security area. The exhibition area runs through the whole building, and the different exhibition Spaces are linearly combined through the logic of spatial and chronological narrative. The public exchange area, located in the middle of the building, serves as a rest and communication area for the audience. There are academic exchange halls, coffee and tea houses, viewing platforms and other functional Spaces. The area has a good view of the water park lakeside scenery. The management and security area is located in the northeast side of the building. There is a separate entrance and exit on the first floor, which is mainly equipped with functional Spaces such as the collection warehouse, collection storage, academic research room, administrative office and staff canteen.

Part of the building volume is cantilevered and elevated, so that the lakeside landscape penetrates into the interior of the building, forming a multi-level, infiltrating and blending space. At the same time, through the multi-path design on the ground and the roof, visitors can pass through the water control museum to other scenic spots in the park with great interest.

3. Green energy-saving design
The architectural design integrates passive energy-saving measures and active ecological technologies to effectively reduce building energy consumption and comprehensively improve the demonstration role of the museum building in ecological environmental protection in Hangzhou.

3.1. External wall energy-saving and roof energy-saving
In addition to using the building’s own shape to shade the sun, the museum minimizes the amount of window space that opens against the unfavorable orientation[3]. The skylight at the top of the museum's large space exhibition hall is designed to allow only north diffused skylight to enter the interior, so as to satisfy the interior lighting while avoiding the adverse effect of direct sunlight on the interior exhibits. The building facade adopts adjustable bamboo louvers, which can flexibly adjust the demand for sunshine in different seasons in areas suitable for hot summer and cold winter. In addition, vertical and roof greening are adopted inside and outside the building, which not only echoes the theme of sustainable development of Water Expo Park, but also creates a pleasant micro-environment for users.

The roof of the museum has a large area of green garden in the air, which not only provides an excellent viewing platform for tourists, but also increases the insulation performance of the roof, thus helping to reduce the energy consumption of indoor air conditioning.

3.2. Utilization of renewable energy
In the building roof and indoor reserved installation of solar photovoltaic system conditions, the use of solar photovoltaic power generation. At the same time, outdoor solar lamps are widely used in the site. Taking the renewable energy consumption as the standard to meet 15% of the total electricity consumption of the air conditioning system, part of the air conditioning system adopts the lake water source heat pump system. And the central cooling and heating sources, air conditioning equipment, elevator, office equipment, etc. are all designed with sub-metering electricity meters. The electricity meter data is fed back to the central controller and recorded into the database through the BA control system. Some of the ecological technologies set separate measurement measures to monitor the energy consumption of the ecosystem.
3.3. Water saving and utilization of water resources

The roads in this project are all permeable ground. Permeable paving materials are laid to absorb rainwater through the pores of permeable bricks, and a filter layer composed of gravel, gravel and sand is laid under the permeable bricks to allow rainwater to penetrate into the ground to increase the natural infiltration of rainwater and replenish groundwater resources. Natural water circulation is perfect, and natural wetlands play an important role in this cycle. Due to the participation of human activities, the natural water circulation has been damaged. Rainwater is collected and discharged rapidly by hardened pavement and urban pipe network system, and the underground water can not be fully supplemented. This system has brought a series of ecological problems. In the site design of this project, the constructed wetland rainwater self-purification system is used to repair the damage of ecological water circulation system caused by human activities, which is also the trend of the further development of green buildings. The system is mainly based on rainwater control, supplemented by utilization. During the designed rainfall recurrence period, on the premise of ensuring the safety of the base, the rainwater should be properly and economically reused, without any further treatment or other measures[4]. Add pervious ground, such as base greening, and the hard pavement is mainly permeable concrete; Try to ensure that before and after construction, the local block water circulation does not change greatly.

In the design, the ability of constructed wetland to purify sewage is fully exploited. All building domestic sewage (mainly refers to the sewage discharged from office building toilets) is collected and treated in a unified way to meet the water quality requirements of "Urban Sewage Recyclation and Urban Mess Water Quality" (GB/T 18920 -- 2002), and all of them are used for building flushing and greening water. Zero discharge of domestic sewage. At the same time, according to the requirements of green building, the leakage of pipe network should be monitored. The leakage monitoring system of automatic pipe network based on bus system can meet this requirement, and it can not only monitor the water system, but also read the electricity system and gas system, so as to achieve the purpose of monitoring the energy consumption of the whole building.

3.4. Material saving and utilization of material resources

This project starts from the requirements of resource saving and environmental protection, and on the premise of ensuring safety and durability, the architectural structure system with low resource consumption and environmental impact is selected. High-tech dimming film + 3D holographic projection technology is adopted in the facade along the lake of the building to solve the problem of shading the facade through the variable light transmittance of dimming film, and at the same time, the building skin becomes the carrier of multimedia display of museum contents. The outer skin of the building is made of LOW glass, clay plate curtain wall, bamboo and wood louvers and other ecological and environmental protection materials. The unique structure gives the building facade a rich visual effect. In the daytime, the Water Control Hall floats by the lake of the Water Expo Park like a light and elegant "green dragon", while in the night, the building facade turns into a huge multimedia display platform, showing the unique charm of modern water control technology.

3.5. Indoor environmental quality

Actively improve the interior environment of the building through design. The building ground floor is partially overhead, forming a microclimate with good convection ventilation. At the same time, an automatically opened ventilation window is set on the top of the indoor atrium to enhance the natural ventilation effect in the building through the indoor "heat and pressure effect", so as to effectively reduce the use of air conditioning in the transitional season of the museum and reduce the building energy consumption (as shown in Figure 1).
The application of natural lighting is fully considered in the building. Through simulation analysis, the main functional rooms of the building are determined to meet the lighting coefficient standard value and the work requirements of the management personnel in the "Architectural Lighting Design Standards". Fixed shading louvers are set on the square skywindow at the top of the building. Through effective shading treatment, only north diffused skylight is allowed to enter the room. While meeting the indoor lighting requirements, the adverse effect of direct sunlight on indoor exhibits is avoided.

3.6. Intelligentized management system

The water source heat pump air conditioning system and solar photovoltaic power generation system of this project all have their own equipment control system. The system is designed with input and output equipment, which can realize the control of each system by a central controller[5]. The automatic building control system also designs the lighting control system, the shading control system and the ventilation louver control system. The control is also implemented in the central console (Figure 2).
Building lighting can be divided into four categories according to its functions: exhibition area lighting, office lighting, public area lighting and floodlight lighting. Automatic control of lighting, realize the automatic management of lighting system according to the working season, work and rest time, illumination changes, all meeting rooms realize intelligent on and off lights, timing on and off all kinds of lighting equipment, to achieve the best energy saving effect, and according to the needs of users can be arbitrarily modified each lighting loop.

We all around the building palisade structure, set up multiple temperature sensor in the indoor setting temperature, humidity, CO2 sensor, in the solar photovoltaic, ground source heat pump exchanger setting data acquisition equipment, combined with the building intelligent control system software, green monitoring system is able to run on the construction of the whole system energy consumption to conduct a comprehensive monitoring, And provide various subsystems presentation board through the electronic display screen display, real-time display the current working status of each system, and through the simulation calculation and experimental data analysis, displays the current sewage and shading effect of energy saving and emission reduction, etc., have to green energy-saving building monitoring, data analysis, set up a remote mobile monitoring system at the same time, Mobile monitoring and dynamic display of all data.

4. Conclusion
In the design of Zhejiang Water Control Hall, we take measures such as summer air conditioning refrigeration, winter air conditioning heating and electric heating to improve the indoor environment. At the same time, we also take into account environmental protection and low carbon, such as the use of renewable energy, the use of water resources and solar thermal, photovoltaic, ground source heat pump and other energy saving design.

In general, the domestic green construction industry is developing in a good direction. In the process of development, it is inevitable that there will be some predictable problems or deficiencies. We hope to have more and more people to consider more comprehensively and realistically the problems that arise at the present stage of development from the perspective of society, the whole life cycle of the building and the climate characteristics of different regions, Instead of being limited to purely technical research. And we hope to establish demonstration green buildings through this project research and strengthen the application and promotion of green building energy-saving technology.

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