

# Application of Ecological Architecture Design in Library

Fengrui Tian

School of Civil Engineering and Architecture, Wuhan University of Technology, Wuhan 430000,  
China

2230439642@qq.com

**Abstract.** Under the background that people pay more and more attention to ecology, the application of ecological design in architecture is becoming more and more common. This paper introduces the application of various contents of ecological building design in library buildings, summarizes the development of domestic library ecological concept, analyzes the feasibility and infeasibility of ecological design methods in libraries, and looks forward to the future of more ecological and green library design.

**Keywords:** Ecological building design; library building.

## 1. Introduction

As an important part of the public cultural service system vigorously promoted in China, its development can not be ignored. Ecological buildings and green buildings are in line with the national environmental protection policy of "green water and green mountains". On this basis, a number of public buildings such as libraries are becoming more and more ecological. Many newly built libraries pay special attention to ecological architectural design. Therefore, learning and summarizing the application and time of various ecological architectural designs and technologies in the library field can help us better carry out library design, and make the library better serve the public under the principles of ecology, green and environmental protection, which is the inescapable responsibility of architectural designers.

## 2. Concepts

### 2.1 Introduction to ecological architecture

Under the background of the destruction of the environment, the gradual shortage of resources and the continuous reduction of green, the ideological trend of ecology has gradually swept the world. The concepts of respecting nature, saving and regeneration have increasingly become the mainstream principles of life and production. From the concept of ecological architecture proposed by Italian architect Paul Soleri for the first time to the main principle of ecological architecture design in China, the concept of ecological architecture is constantly being better interpreted. These ideas are very important for China's rapid development.

### 2.2 Ecological concept of Library Architecture

As the palace of people's knowledge, library needs to set an example in today's increasingly severe environmental problems.

#### 2.2.1 Water saving

The shortage of water resources in China is a problem that the government has paid special attention to since the founding of the people's Republic of China. Through the South-to-North Water Transfer, the construction of water conservancy projects and many other measures, the water problem of residents has been alleviated to a great extent. Even so, we should not ignore the current situation of insufficient water resources. In architecture, the utilization of water resources is mainly reflected in efficient irrigation, reclaimed water recovery, rainwater utilization, sponge city and so on.

### 2.2.2. Land saving

Therefore, the location of libraries is mostly the "golden area" of cities and blocks. How to make full use of excellent land is the first consideration, which is particularly important in the urban area with increasing shortage of land resources. Secondly, the construction of the library should minimize the change and damage to the ecological environment inside and around the base.

### 2.2.3. Material saving

In library construction, recyclable building materials should be used as much as possible. Indoor and outdoor decoration materials, such as formaldehyde free, pollution-free and radiation-free, ensure no impact on the surrounding environment and indoor air freshness and environmental protection. At the same time, the selection of building components such as doors and windows also affects thermal insulation, air ventilation, daylighting, etc., which is related to energy consumption. In addition, sound insulation and noise reduction measures shall be carefully considered in the architectural design of the library, and sufficient sound-absorbing materials shall be set in the building. For example, the use of carpet or decorative fabric, absorbent floor coating, glass wool board, sound insulation partition wall composed of gypsum board and glass wool, sound insulation perforated brick and other sound-absorbing structural materials can significantly reduce noise pollution and create a quiet and comfortable reading environment. Moreover, the applicability and economic principles of architecture are also deeply affected by it.

### 2.2.4. Energy saving

Energy saving mainly refers to saving electric energy. The first is to make full use of natural lighting. Ingenious daylighting design can make sufficient light shine indoors and reduce lighting power consumption. The second is the collection of solar energy. Solar energy meets the concept of sustainable development. The use of solar power in large buildings such as libraries can reduce the dependence on external power supply to a certain extent. Finally, save electricity. Under the condition of meeting the lighting specifications, fluorescent lamps and light controlled lamps can be used in the library. At the same time, sufficient natural ventilation will reduce the power consumption of air conditioning, ventilator and other equipment.

The application of these technologies can make the library become an ecological building with low carbon, low energy consumption and no pollution.

## 2.3 Development of domestic ecological library

In the 1990s, there were only more than ten libraries with an area of more than 20000 square meters, such as the National Library and Peking University Library. In recent years, the domestic library industry has invested a lot and developed rapidly. By the decade of this century, there were more than 20 large public libraries with an area of more than 20000 square meters.

The focus of Library Construction in the 21st century lies in ecology. The completion of Shanghai Library in 1997 pioneered the domestic ecological library. Nowadays, more and more ecological libraries have been built. The library of Shandong Jiaotong University, designed by the school of architecture of Tsinghua University, is one of the best libraries in China based on ecological concept. However, there are some phenomena in today's library construction, such as the pursuit of luxury and blind worship of foreign affairs.

Policies and regulations are also the basis of library construction and development. It provides a policy basis for the construction of public library. In addition, it has defined higher library construction standards, explicitly stipulated the use of renewable resources, and encouraged the use of new materials in new libraries, which provides laws and regulations and scientific basis for the construction of ecological libraries.

### 3. Cases

At the beginning of the construction of the library of Shandong Jiaotong University, the design team first considered two principles: first, balance the contradiction between technology and economy, deeply consider the impact of technology, and cannot copy the technology and practices of developed countries. Second, formulate a scheme in line with the characteristics of Jinan, comprehensively analyze the local natural conditions, and adhere to the design principles of simplicity, applicability, high efficiency and economy.

#### 3.1.1. Land saving

Shandong Jiaotong University is located in the northwest of Jinan City. Due to the massive mining of ore and rock, the uneven surface was first formed. In addition to the 4-5m high garbage landfill, the site has formed a bad geology of weathered rock and garbage mixing. In the low-lying area in the north of the site, there are ponds supplied with rainwater and surface water, with weeds and reeds. Through pond reconstruction, garbage cleaning, soil backfilling and other measures, the site environment has been completely transformed and more than 7000 square meters of land has been opened up.

#### 3.1.2. Energy saving

The air conditioning design index of the library is the application of technologies such as natural ventilation, atrium and side atrium ventilation, sun shading, efficient thermal insulation of peripheral protective structure and pool cooling, which makes its energy consumption lower than that of ordinary school buildings by more than 45%. Hollow plastic steel glass is used for doors and windows to meet the latest energy-saving design standards of public buildings.

#### 3.1.3. Water saving

Due to the transformation of the pond in the north, the water resources in the pond are used for building cooling and irrigation, so as to achieve the effect of recycling. At the same time, it is equipped with water-saving sanitary ware to minimize the consumption of water resources.

#### 3.1.4. Material saving

Plain concrete surfaces such as walls and columns play a decorative effect in basement and interior decoration. The outer wall brick is used to paste the inner wall of the atrium, which reduces the material cost to meet the economic principle.

#### 3.1.5. Construction status

The internal unified modular design makes the load uniform and the column grid regular, and can also meet the use of different functional rooms, so that different load areas can be changed flexibly and the internal streamline can be optimized. It can also provide a comfortable and healthy indoor environment on the premise of energy saving. Under a series of economic and energy-saving construction, the final construction and installation cost is 2150 yuan / m<sup>2</sup>.

#### 3.1.6. Energy saving

(1) Night temperature improved. The heat storage at night is up to 90kw, and the hot pressure ventilation effect can be realized at 2.5-3.5 times / h under the support of natural ventilation at night, with a temperature drop of more than 1.5 °C.

(2) Tunnel wind effect is obvious. Tunnel air can bear 90% of the load of fresh air, and the external temperature of 30 °C can cause the cooling effect of 8 °C, which greatly reduces the power consumption of air conditioning.

(3) The cooling effect of the pool is remarkable. The cooling capacity of a single chiller is 604kw, up to 130% of the customized cooling capacity, and the heat transfer coefficient of pool water cooling water can reach 137kw / K, making the air conditioner operate well at the maximum load in summer.

Without copying Western technologies and practices, the architect team uses ordinary materials and project integration technology suitable for local natural conditions and site status, does not increase economic expenses, and can realize the ecological construction of the library. Moreover, the effect is remarkable, the cost is low, and the new technology is worthy of extensive promotion

### **3.1 Practice of new ecological Architecture technology -- Reconstruction and expansion of Sun Yat-sen Library of Guangdong Province**

Guangdong Provincial Zhongshan Library was founded in 1912 and located at No. 213, Wenming Road, Guangzhou. Its phase I project has a reconstruction and expansion scale of 68900 m<sup>2</sup>

#### **3.2.1. Energy saving technology of low energy consumption envelope**

The enclosure structure has an obvious impact on the energy-saving and thermal insulation effect of buildings. In this project, measures such as adding thermal insulation layer, thermal insulation layer, using single-layer (partially hollow) coated glass aluminum window with excellent thermal insulation performance, special treatment of cold bridge, roof thermal insulation and greening have been taken for the enclosure structures such as exterior walls, doors, windows and roofs of reconstruction projects and new projects, and good results have been achieved.

Roof: 30 mm thick extruded polystyrene board insulation layer is added on the existing building roof, and then 500 mm thick plant greening; 25 mm thick extruded polystyrene board insulation layer is also used on the roof of new buildings, and 500 mm thick plant greening is carried out; The composite foam board can not be used for greening, and its main thermal insulation material is polystyrene foam (thick 35mm).

Exterior wall: 20 mm thick polystyrene particle thermal insulation mortar is added on the surface of the existing building exterior wall. Aerated concrete blocks are used for new buildings, and 20 mm thick polystyrene particle thermal insulation mortar is used for the exterior wall. External windows: the existing buildings have replaced the original single-layer ordinary glass aluminum alloy windows with single-layer (partially hollow) coated glass aluminum alloy windows with excellent heat insulation performance, and the new buildings adopt single-layer (partially hollow) coated glass aluminum alloy windows with excellent heat insulation performance.

#### **3.2.2. Solar photovoltaic system technology**

Through sufficient demonstration and technical analysis, the project has installed a solar photovoltaic grid connected power generation system with a peak power of 181kw. The system uses solar photovoltaic modules to convert solar energy into DC energy, and then reverses the DC into 230 V / 50 Hz single-phase AC or 400 V / 50 Hz three-phase AC through grid connected inverter. The output end of the inverter is connected in parallel with the low-voltage side of the transformer in the substation through the distribution cabinet to realize low-voltage grid connection.

The efficiency of grid connected inverter is not lower than 92%. It has the protection functions of input reverse connection protection, input undervoltage protection, input overvoltage protection, input overload protection, output short circuit protection, lightning protection, overheating protection and so on to ensure the safe operation of the system; At the same time, it is equipped with RS485 / RS232 communication interface to connect with the computer for long-term data acquisition and real-time display of historical total power generation of the current system, voltage, current, output power of real-time system power generation, carbon dioxide reduction and other data indicators.

The project has been running for two years since the acceptance, and the effect is good. After the transformation of existing buildings, the building energy saving rate reaches 60%, and the overall energy consumption level of the project meets the national green building requirements, especially the successful application of the project, which plays a good reference and guidance role for the energy-saving transformation of public buildings and the promotion of renewable energy application.

### **3.2 Large area outdoor garden and natural lighting -- Hubei Province Library**

#### **3.2.1. Building retreat and greening**

By virtue of the geographical location and natural environment of the Sand Lake Park in the north and the Sand Lake in the city, a good outdoor environment has been built by planting trees, flowers and plants in a large area around the museum area and greening the garden. At the same time, take advantage of the graded retreat platform in the north of the building to build an air garden. A 3955 square meter roof garden is built on the fourth floor roof. Readers can take a walk in the terrace courtyard, overlook the distant and near natural scenery, stretch their muscles and bones, eliminate fatigue, and read and communicate on the green under the shade of trees. 1800 square meters roof garden will be built on the sixth floor roof. Staff can come to the courtyard in their spare time to breathe fresh air, relieve mental pressure and improve work efficiency.

#### **3.2.2. Daylighting is mainly supplemented by lighting**

The indoor is mainly natural ventilation and natural daylighting, supplemented by artificial light. Try to use fluorescent lamps and desk lamps with low power consumption to make up for the lack of light from natural light sources in the library, or use light controlled lamps to control the strength of indoor lights through the strength of sunlight, so as to combine sunlight with lights to achieve the purpose of comfort and energy saving. The atrium and its top adopt openable skylights to pull out the wind. There are more than 5000 windows that can be opened in the whole building, which can realize effective natural ventilation and daylighting.

## **4. Methods and Materials**

Through the above cases, it is not difficult for us to get some commonly used ecological library design methods and building materials.

### **4.1 Method - using natural resources**

For large buildings such as libraries, whether increasing natural lighting or improving natural ventilation can save a lot of energy consumption. If the library is close to rivers and lakes, water, a material with large specific heat capacity, can also be used for efficient heat exchange. In recent years, planting flowers and trees inside buildings to create ecological space has become a trend, and libraries are no exception. Using the physiological characteristics of plants can also create a pleasant indoor environment

### **4.2 Materials - creating a liveable environment**

Hollow walls can greatly reduce heat exchange and play a great role in hot summer and cold winter areas. If the hollow wall is not suitable, the thermal insulation layer composed of thermal insulation mortar and aerated concrete can be used. For doors and windows, we should not only complete the task of thermal insulation, but also play the role of light transmission and daylighting. Therefore, single-layer glass aluminum alloy window or double-layer hollow glass window is a good choice.

### **4.3 Equipment - Construction information system**

Using computer system to manage hydropower HVAC in buildings can not only reduce labor costs, but also avoid mistakes to a great extent, making buildings more intelligent. The application of information system in library can well solve many problems from architectural design, construction, and then use management.

## 5. Conclusion

The ecological building technology used by ecological library is limited, but it has met the basic requirements of ecological building design. Many of the above ecological buildings are worth popularizing and applying. However, it is absolutely undesirable to use it blindly, not according to local conditions and without considering economic cost. It is hoped that the listed groups of technologies can be used as a reference for architects.

From the basic energy-saving, water-saving, power-saving and land-saving, to the application of advanced photovoltaic and high-efficiency glass, ecological building technology has maintained the ecological environment and saved natural resources to a great extent. Under the condition of meeting the building economic conditions, make the best use of ecological building technology, so that whether libraries or other buildings can achieve low energy consumption or even complete self-sufficiency, people can obtain a better living environment, and better create "Golden and Silver Land" while protecting "Green Water and Green Land".

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