Research on the Design of Ecological Architecture

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Abstract. With the speeding up of the urbanization steps, along with the pathological development of cities, many practitioners begin to pay close attention to design of ecological architecture. The ecological architecture design methods are discussed in the areas such as selection of building materials, ventilation engineering, building entrances, and the underground space design. All these are considered on the basis of the elemental relation between architecture and outside environment in order to make people have a deeper understanding of ecological architecture design.

Introduction

In recent years, an outstanding architectural design is not only depend on the its functionality and appearance, the more important is the building is connected to external natural factors, and finally created the ecological architecture. Ecological building design involves many aspects; we still need to explore research continuously.

Concept and Design Requirements of Eco-building

Ecological architecture, which uses ecological perspective on the relationship between architecture and the environment, use the building itself and the related natural environmental factors of architecture to organization and design. Make energy efficient and orderly circulation in buildings and environments aims at obtaining a no pollution building environment. [1]

Ecological architecture design should make maximum use of solar, wind and rainfall to replenish energy and water needs of the inhabitants. Building should be in materials, structure, design, and construction process and so on, good for environment, conserving resources, does not have a negative effect and pollution, use of low-pollution, low carbon building materials without radioactive[2]. And should focus on microclimate created by buildings, eco-development requires building environment adapt to climate change or provide shelter to protect, to meet demands of residents. Impact of building height on urban ecological environment includes heat island effect, heat island circulation, urban wind environment, noise and other aspects. Since the high-rise buildings have a greater impact on urban wind environment, the building height in ecological urban design should be conducive to the operation of the air circulation, to effectively weaken the urban heat island effect and urban air pollutants (Fig. 1)

(a)Poor ecological environment of city building height layout

(b)Good ecological environment of city building height layout

Fig. 1 Ecological architecture design

Selection of Building Materials

Building skin materials are composed of the building elevation image directly, it is essential to reach on the environmental properties of the construction skin material. It is also an important standard to measure as the building retaining structure surfaces, no matter it realize the optimization of the resources, or reduce the construction of the environmental load.

Ecological building materials advocate the “3R” principle, namely reduce, reuse, and recycle. When people hear the ecological building materials, people will naturally think of the modern high technology [3]. Indeed, it is a very important means to use of high technology to realize the ecological building materials, but it is not the only way. The Nanhai business park is famous for its green skin (Fig. 2). Italian Museum can adjust the indoor and outdoor heat (Fig. 3).

Fig. 2 the Nanhai Business Park Fig. 3 Italian Museum Fig. 4 Alsace Museum

Ecological building materials in the design of the epidermis, the consideration of its functional are ranked in the first place. Based on today's advanced scientific and technological level, to meet the basic functions is not enough, you can also take advantage of the wind, hydro, solar and other clean energy sources, transform into the new energy for the use of construction, in order to achieve optimal use of resources. For example, the 2010 Shanghai World Expo Alsace Museum, its skin has three layers: the outer layer is the solar panels and thick glass; the middle layer is confined spaces can be opened or closed; and the third layer is the water curtain glass. Multifunctional building epidermis effective use of solar and other clean energy sources, while improving the environment, make the building to reduce unnecessary consumption of resources and energy, it also reduces the harmful pollutants (Fig. 4).

Ventilation Engineering

Natural ventilation is the study of ecological building will be necessary. From the point of view of energy conservation, for the use of natural wind, it can be divided into two aspects of wind energy utilization and natural ventilation.

Effective Use of Natural Ventilation

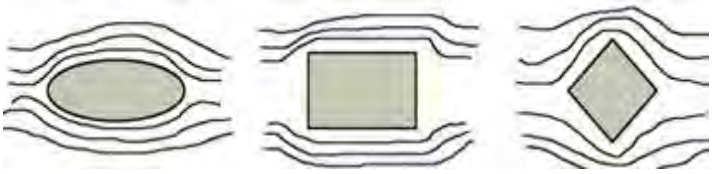

Fig. 5 Comparison of Guiding Effects on Architectural Form Fig. 6 Al Bahar Tower

High-rise building exterior body flow line has a great influence on natural ventilation [4]. In the high-rise building design, when the construction external flow line is curved flow lines, it will be able to guide the wind better and the interface of building to obtain a more uniform pressure. It will be helpful to indoor windows for natural ventilation, and its effects can also make the building

obtain maximum ventilation interface and reducing wind shadow area of behind building. However, the rectangular flow guided flow capacity is weak, the windward and leeward side form non-ventilated area, ventilation interface is minimal. If it is rotating rectangle, let the corners toward the wind, it can increase ventilation interface. Nevertheless, it is still not bigger than curved flow line interfaces (Fig. 5). This is why most of the high-rise building use curved outer flow lines (Fig. 6).

Effective Use of Wind Energy

Due to the block of buildings, wind speed of town generally is smaller than suburban city. But surrounding buildings may also appear locally strong wind area. In the cracks of building or mouth parts, since the cross-section of the air flow suddenly becomes small, funneling effects appear to form a strong canyon wind or drafts. At the same time, according to the properties of vertical wind, as the height goes up, the wind speed also increase (Fig. 7). In general, the wind being blocked by the many buildings in the city, wind direction and wind speed will generate uncertainty. Since top of the high-rise buildings are blocked by other buildings, wind speed and direction as a suburban areas situation [5]. Therefore it can be a very suitable place for wind power. According to the characteristics of high-level wind environment, wind power installations are generally placed in a building roof of low air resistance or strong wind speed of cave as well as hole (Fig. 8).

Fig. 7 Vertical Variation of Wind Speed

Fig. 8 Building with Wind Power

The Buffer Space of Architectural Entrance

The entrance as a climate transition space between the architecture and the natural environment is a very important Part of ecological building design. The ecological construction entrance is not only to meet the human beings enjoy comfortable and healthy living environment, but also to coordinate between human beings and the environment for sustainable development.

The entrance is the prelude of the architecture. It is a reflection of the building's character, on the other hand, it contact with people directly, it gives a psychological suggestion, and so it guides human behavior. For most buildings, the existence of "gray space" provides an excellent climate buffer conditions. Regional climate have a huge impact on the architecture, buildings in different climatic zones often presents a completely different form. The same building entrances must adapt to the local regional climate, in order to make better use of natural resource.

Hot-summer and Cold-winter Zone

Hot-summer and cold-winter zone are characterized by hot and dry. For the entrance process, shade is paramount, the entrance should be located in the shady side, deep overhangs, porches and vegetation shade can be used. And vegetation and pool should be applied to increase the humidity and lower the temperature of entrance area .To reduce the impact of outdoor to indoor, the use of the brick, stone, concrete and clay blanks and other materials with high thermal compatibility should be adopt to the door interface, and glass should be reduced. The area of the enclosed courtyard should not be too large, in order to block external hot air, and to provide a comfortable entry environment.

Hot-summer and Warm-winter Zone

Hot-summer and warm-winter zone characterized by hot and humid and rainy, the entrance area should be ventilated and sunshade. So entrance should be located in the shade and ventilation area,

sun visors, sun porch and vegetation should be used. The best type of vegetation is that the combination of lawn, garden and tall trees, avoiding planting tall bushes to influence building ventilation. Try to use the envelope of wood, bamboo and other materials, which have voids in the soil, help keep the airflow. These practices in the building had a strong contrast of real and imaginary, light and dark, which rich architectural expression of the body, always exhibit the characteristics of light and transparent.

Moderate Climate Zone

For moderate climate zone, entrance design should pay attention to summer sun and winter cold, he entrance can be set in both north and south, north to use in the summer, and south to use in the winter, in order to adapt to the change of seasons.

Cold Climatic Zone

Cold climatic zone characterized by cold and dry in winter, in order to get more sunshine, the entrance should be located in the southern slope, avoid the areas where is dark and the high speed of the wind will be produced. When have to set entrance toward the dominant wind in winter, can change entrance direction by adding the door bucket, thus effectively avoiding the cold wind blowing straight. The door can be used the dark material to increase the radiant heat absorption.

Extremely Cold Climate Zone

Entrance in extremely cold climate zone is same to cold regions, in addition, can be set up double doors, enhanced sealing of buildings to improve thermal capacity. In order to prevent the winter cold wind blowing straight, windshield wall is set up in the front of entrance, which can reduce wind speed and cold air infiltration.

Underground Space Design

It is an important content for the intensive utilization of land in the ecological urban design .For the efficient use of land, urban underground space utilization is very important. The level of development and utilization of underground space, some foreign developed countries has reached 40%~60%, but in our country, are just starting out or are scattered construction, rarely forming underground space integrated system. In the design of ecological city, to strengthen the utilization of underground space became more significant [6].

Underground space environment need to take into account its comfort and safety. The earth ecological elements such as trees, sunshine can be bring into the underground space, forming the integration of ecological space overground and underground, and ensure the safety requirements in fire evacuation and other aspects of the underground space. Underground space should be design of the system. It means that underground traffic facilities, underground municipal facilities and underground commercial service space can be built systematically and cosmically, in this way, to save the use of land, to diversion of ground traffic, and underground commercial space also bring some benefit. For example, the underground space construction in Montreal Canada is developed, its contact the city's 80% Office Area and commercial area is equivalent to the total area of the city's business district 35%, its total construction scale more than 3.6 million square meters. (Fig. 9)

Fig. 9 Montreal

Summary

Ecological architecture is destined to be the future direction of building development, our country is still in the primary stage of the construction of ecological architecture, but if we have the courage to explore, effectively learn from the advanced experience of other countries, and have scientific understanding of architecture and environmental issues, we must be able to contribute to the ecological architecture design.

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