

Research on the Application of Resilient Symbiotic Architectural Design Concept— Illustrated by the Architectural Design of Fengxian Punan Canal Floating Ceramic Cabin

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Abstract. With the increasing prominence of global environmental issues and the accelerating process of urbanization, the symbiotic theory has been widely applied in the fields of architectural design and urban planning. In the field of urban planning and architectural design, the research on the concept of symbiosis is constantly developing, but most of the research focuses on the macro direction of urban planning, and there are few relevant studies on the micro level of architectural design. Based on this theory, this paper proposes the architectural design concept of "resilient symbiosis" by optimization and improvement. Taking the architectural scheme design of Fengxian Punan canal floating ceramic cabin as an example, This paper analyzes the application of the concept of resilient symbiosis architecture design from four aspects: shape conception and evolution, modular construction, green building performance, and local materials using. At the same time, it summarizes the concept of resilient symbiosis architecture design, which provides a theoretical and practical exploration for the realization of harmonious coexistence between architecture and environment.

Keywords. Resilience, symbiosis, environmental adaptability, canal flower

1. Introduction

As an important part of the city, architecture should develop in the direction of livable, innovative, intelligent, green, humanistic and resilient. Since the symbiosis theory was introduced into the field of architectural design, it has been continuously developed through the research and practice of scholars and architects both domestically and internationally. The Japanese architect Kisho Kurokawa first proposed the concept of symbiotic architecture design. Up to now, this concept still plays an important role in guiding architectural design, especially in the aspect of environmental symbiosis. It focuses on the regional expression of architecture, and emphasizes the importance of integrating architecture with nature and culture. It has become a universally adopted guiding theory in the architectural design stage. The concept of resilient city was put

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forward at the United Nations Global Summit on Sustainable Development in 2002. Domestic research on resilient city mainly focuses on urban planning and community governance. In the field of architectural design, most of the research is from the perspective of resilient concept, such as building renovation, spatial design methods, and site design strategies [1]. The application of resilient symbiotic architecture design is of great significance to the construction of livable, green and resilient buildings and cities. We propose such a concept to guide the practice of architectural design in order to demonstrate the symbiosis between architecture and natural environment. In terms of form composition, it realizes the symbiosis between the design concept and the natural environment. In terms of construction, it uses modular assembly in response to natural disasters. In terms of green performance, it enables the resilient use of natural elements. In terms of using local materials, it realizes symbiosis with time and space.

2. Symbiosis Theory and Resilient Cities

From the 1970s to the 1980s, Japanese architect Kisho Kurokawa gradually proposed the architectural design concept of "symbiosis" from the architectural thought of "metabolism" [2]. In the field of architectural design, the symbiosis theory believes that the development of architecture and city can be connected with the principle of life, emphasizing the association of individuals to form a whole. It breaking through the dualism, believes that architecture and city coexist in the past, present and future time level. Among them, the symbiosis between history and future, man and nature, can be used as the basic concept of resilient symbiosis. For example, the use of representative materials or elements from local history in the building, it can not only convey specific historical information in the architectural space, but also enhance the uniqueness and recognition of the design.

In recent years, under the guidance of the national development strategy, the research topic of resilient cities has attracted much attention. Experts and scholars at home and abroad have a lot of interest in it. Godschalk believes that resilient cities should be a combination of sustainable physical systems and human communities, and the planning of physical systems should play a role through the construction of human communities [3]. The popularity of resilient cities in China has gradually increased since 2011. In the field of urban planning and architectural design, research on resilient cities mainly focuses on the macro direction of urban planning and the middle level of regional planning of building groups, such as the research on the planning and design strategies of village, campus, historic blocks and communities. At the micro level, the concept of resilient symbiosis is rarely studied in the architectural design [4]. We derive the resilient thinking in architectural design from the concept of resilient city, and fully consider the impact of natural disasters on buildings in the process of architectural design.

3. The Concept of Resilient Symbiotic Architectural Design

In the present and future, promoting new urban construction and improving the quality of cities will be widely concerned. In the process of architectural design, architects should not only consider how buildings can better integrate with the environment, but also need to think about how buildings can effectively cope with the impact of various

natural disasters, extreme weather and unexpected events. For example, in the case of flood damage and urban waterlogging, the design is particularly important in terms of building site, materials selection, elevation organization. Sufficient thinking and analysis of resilient concept in the design can make the building better cope with the sudden damage and impact. Another example is modular combined buildings. When these buildings are faced with emergency issues such as rapid construction, partial replacement and temporary combination after disasters, they can give full play to the advantages of modular separability, integration and easy assembly. They can respond to emergencies more quickly. From the above two examples, we can see the importance of resilient thinking in the process of architectural design. It has been optimized and improved on the basis of the theory of symbiosis between man and nature, and has formed an architectural design concept of symbiosis. From the perspective of resilience, the elements of natural and culture in which the building located are fully considered and utilized, and this is also of great significance to guide the design of high quality buildings with environmental symbiosis and resilience [5].

4. An Application Case Analysis of the Resilient Symbiotic Architectural Design Concept -- Fengxian Punan Canal Floating Ceramic Cabin Architectural Design

4.1. Background of Architectural Design

Fengxian Punan Canal Floating Ceramic Cabin is a small building that can be floating and assembled in the design competition "Meet Punan, Feel Punan, Experience Punan - 11 and 12 point planning scheme design of Punan Canal, Fengxian District, Shanghai". The work participated in the third "Shanghai Beautiful Village Youth Creative Design Competition Fengxian sub-division of Punan Canal Design Competition" and won the second prize. Figure 1 below is the master plan of the entries.

In the project, we sorted out the positioning of the Punan Canal plan. The purpose of this planning is to create a leisure and recreation function area along the canal, which can reflect the Fengxian culture and the characteristics of the canal. In particular, it is necessary to design a kind of small floating buildings that relied on the natural environment of the canal to enrich the leisure and recreation functions. Thus, the design concept of "Flower of the Canal" came into being. Figure 2 below is the floating ceramic cabin "Flower of the Canal".



Figure 1. Master plan of the design .



Figure 2. Floating ceramic cabin.

4.2. Analysis of the Building Environment

4.2.1. Analysis of the Natural Environment-Resilient Symbiosis with Canal System

The project site is located at the intersection of Puxing Highway and canal. Its natural environmental elements include an annual average temperature of 16.5°C and good sunshine conditions. The project site is rich in natural vegetation along the river, and there are many farmlands and woodlands in the northern part of the plot. On the south bank of the canal, there is a nursery forest on the east side of Puxing Highway, and a public green space on the west side. Among the natural environment elements of the project, the most prominent one is the Punan Canal. The total length of the canal is about 38.7 kilometers. It passes through Zhuanghang, Nanqiao, Qingcun, Fengcheng, and other towns. The canal can form a symbiotic relationship with floating buildings, and it can be used as a natural environment element carrying the floating building to create a functional space for leisure and recreation. At the same time, the canal is closely related to the urban flood control system, it plays an important role in the urban ecosystem of diversion, drainage, storage and water resource dispatching. This also puts forward the resilient requirements for the design of floating buildings to cope with natural disasters.

4.2.2. Analysis of Cultural Environment-Resilient Symbiosis with the "Xian Culture"

Fengxian has profound cultural heritage and rich intangible cultural heritage, such as rolling lamp, Fengxian local paper art, etc. It is said that even the name "FengXian" is concerned with the legend of Confucius' disciple Yan Yan, he has given lectures here for a long time, so that people named it "FengXian" with the meaning of "respecting the sages". Fengxian's "Xian culture" is not only a spiritual vision, but also a kind of cultural confidence. We seize the "Xian culture" from so many local cultural elements, and integrate "Xian culture" elements into the architectural design, so that the spiritual vision can be reflected in the building and the cultural confidence of thousand years can be well inherited.

4.3. Application of the Resilient Symbiotic Architecture Design Concept

The design concept of the architectural shape is inspired by falling flowers. We were inspired by a lilac tree that growing quietly along the water bank during our site reconnaissance. Falling flowers floating on the water remind us of the harmonious coexistence between architecture and environment. In conceiving the architectural form of this temporary building on the water, we hope that it can coexist with the natural environment like lilacs floating on the water. We have abstracted the form of the lilac flower to capture its unique and elegant outline. Then, through the elaboration of the form, these lines are refined into the elements of the building in order to make each part of the building emit the charm like lilacs. In the process, we not only consider the aesthetics of the building, but also pay attention to its practicality and integration with the environment. Figure 3 below is the form process of the floating ceramic cabin. This building is like a blooming lilac flower that floats quietly above the canal and blends in with the surrounding nature.

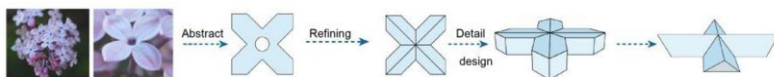


Figure 3. Architectural form design.

The construction form of the building is modular assembly. As a natural water system, the water level and flow of Punan Canal are not stable under the influence of seasonal changes and climate factors. This is a great challenge to the safety and stability of building in such a natural environment, and the adaptation and response to various storm-flood situations must be considered in the design. By using the concept of resilient symbiosis, we consider to design a flexible and variable modular building form which can be quickly disassembled, replaced and reassembled, so that the adaptability and stability of the building can be ensured in the natural disasters and special circumstances. In the scheme design, we use recyclable floating plastic barrels on the ground floor, which are closely arranged in a rectangular way to achieve the states of floating on the water. Then we cover the floating barrel with bamboo plates, they are closely connected with the corrosion-resistant metal components. The floating plate is hollowed-out in the middle, and a plant filter layer with the metal net is laid above. On top of the plate, we set up a ventilation platform, the upper part of which is used as the floor of the building. At last, we put lightweight ceramic panels on the roof of the building. Figure 4 shows the modular construction of the building. The whole building adopts the modular assembly construction method, and the module components are assembled directly on the site. This can not only improve the level of building industrialization, but also can improving the construction efficiency. If components are damaged during natural disasters, such as the damage of barrels, ceramic panels, or floating plates, the same module component can be quickly replaced and assembled to enhance the resilient of the building.

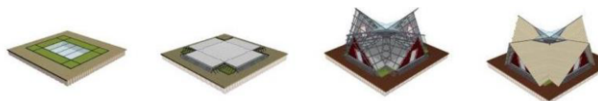


Figure 4. Modular building construction form.

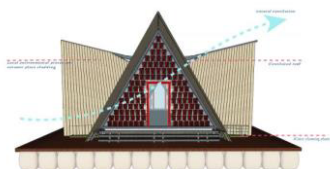


Figure 5. Analysis diagram of building green performance.

Green building performance to realize the resilient symbiosis. Green performance is another important point in the resilient symbiotic architectural design. It can not only improves the sustainability of the building, but also provide people with a comfortable, healthy and environmentally friendly building space. As shown in figure 5, we use the following two points of green performance to design the floating ceramic cabin. One is the elevated platform. It can rise ventilation rate at the bottom of the cabin and reduce the ground heat transfer, thereby improving the thermal comfort of the interior space. At the same time, the elevated platform avoids direct contact between the bottom of the

cabin and the wet water surface, reducing the problem of mildew caused by humidity. The other one is the rainwater treatment. The roof rainwater is discharged into the river through the plant filter layer, and the impurities and pollutants in the roof rainwater are filtered. It helps to reduce the pollution and maintain the ecological health of the river.

Choosing local materials to realize the symbiosis between architecture and history. The using of vernacular materials in the floating ceramic cabin reflects the integration of traditional building materials and modern design concepts. It is not only a respect for environmental sustainability, but also highlights the harmonious coexistence of regional culture and natural environment. In the design, the wood frame of the building roof is made of local hardwood which has high density and durability, this can simultaneously reduce the transportation costs and environmental impact. The outermost ceramic of the roof construction is made of clay or other ceramic raw materials, it is a recyclable and reusable material with excellent thermal insulation, heat preservation and waterproof properties. The unique textures and colors of the material add a unique aesthetic to the cabin. In recent years, the archaeological excavations show that there were ancestors living in Fengxian in the late Liangzhu culture, and the engraved ceramic excavated is determined to be the living objects of Liangzhu period. Therefore, using local ceramic materials in our design also creates a connection between Fengxian's past and present.

5. Conclusion

In the architectural design of Punan Canal floating ceramic cabin, the natural environment elements of the canal on the site of the project are combined. And based on the symbiosis of the architectural form design and the natural environment elements, the construction form and green building performance are fully contemplated to make the building better adapt to the natural environment. The design uses the construction form of modular assembly to cope with the impact of possible natural disasters. The use of green performance which solves the ventilation and rainwater problems achieves a resilient symbiosis between architecture and the natural environment, and the use of local materials will realize the symbiosis between architecture and history. This architectural scheme design is a practice that applies the concept of resilient symbiotic architectural design in a specific building site environment. It provides a theoretical reference for similar projects with canal natural environment elements, and provides a concrete practical path for the resilient symbiotic architectural design concept in four aspects: building form, construction form, green performance and material selection.

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