Experience space practice based on ecological building materials: paper bamboo house architectural design in Panyu, China

Yile Chen[1*], *Junzhang* Chen[2], *Liang* Zheng[1], and *Qiang* Tang[3]

[1]Macau University of Science and Technology, 999078 Taipa Macau, China
[2]City University of Macau, 999078 Macau, China
[3]Shunde Polytechnic, 528300 Foshan City, China

Abstract. Buildings carry people's emotional thoughts. Paper Bamboo House establishes an emotional connection between space and people through characteristic ecological materials, pays attention to people's true perception of buildings, and emphasizes the rhythm of architectural form and rhythm. The architectural design needs to explore the possibility of space existence from the regional culture, rebuild the relationship between the building and the surrounding environment, strive to create a harmonious building that coexists with nature, and practice the regional practice of low-carbon architecture. Advocate to use the comprehensive thinking of reason and art to explore the meaning of space and form.

1 Introduction

With the development of modern architecture today, the method of shaping space through physical design has reached a relatively mature level, while focusing on the experience subject of architecture, the era of multi-creation based on the subject's "experience" has arrived, on the other hand. As one of the important elements in architectural design, building materials have always attracted more and more attention, and their expressiveness also has rich connotations at the experience level. Therefore, the re-focus and interpretation of materials is undoubtedly the development of space experience research important ideas. With the help of the cultural, historical, regional and symbolic nature of the materials, a "place" with humanistic spirit is created with the advanced form of perception—the level of psychological perception.

Some people say that bamboo is the steel in the plant kingdom. As a high-quality building material, the use of bamboo, in addition to the advantages of creating artistic atmosphere, reducing costs, easy processing and low-carbon environmental protection, also has ever-changing designs. Throughout the world, the works created using bamboo as a building material make modern buildings less industrial, and also bring a bright color to modern architectural design.

* Corresponding author: 2009853gat30001@student.must.edu.mo

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2 Literature Review

At present, the rapid development of modern cities has turned the world's cities into reinforced concrete urban forests. The ever-expanding material demands of human beings have led to the destruction of the earth's environment, ecological imbalances, and resource depletion. From the perspective of national policy, the development of green buildings will gradually become the standard for future economic development. In 2017, the Ministry of Housing and Urban-Rural Development issued the "Thirteenth Five-Year Plan" for the development of the construction industry, which requires that by 2020, all new civil buildings in China's cities and towns will meet the requirements of energy-saving standards, green buildings will account for 50% of new buildings, and the proportion of green building materials will reach 40%. The National Development and Reform Commission issued the Interim Measures for the Promotion and Management of Energy-Saving and Low-Carbon Technologies, which focused on the application of energy-saving and emission-reduction technologies in the building sector, proposed an ecological indicator system for sustainable development and regulatory control and guidance indicators, and advocated the creation of green and technological housing, and create economic benefits by protecting the environment. Therefore, building energy conservation and emission reduction should first find the source of the problem in the material.

Buildings using paper and bamboo as materials belong to the representative of low-carbon and environmentally friendly buildings. In 2015, Japanese architect Ban Shigeru, who is good at paper building, won the Pritzker Prize, which represents the high recognition of the world's architectural circles for paper materials for buildings. However, Ban Mao did not immediately get official recognition from Japan in the early days of exploring paper architecture; the design and research on the use of original ecological bamboo as building materials have been fruitful, and there are many outstanding bamboo architects around the world. For example, Simon Ville, who is known as "the brave bamboo builder in Colombia", used bamboo to create structures that subverted traditional building regulations, especially the ingenious combination of steel components and bamboo to effectively solve the problem of connection structures; Vietnamese young architects Wu Zhongyi is currently a hot bamboo architect in the world. He skillfully combines various bamboo materials to create extraordinary architectural spaces; Japanese architect Kengo Kuma also uses bamboo in material decoration, and his masterpiece Beijing The Bamboo House in the Commune at the foot of the Great Wall cleverly interprets the oriental artistic conception of Zen, and creates a series of artistic conception spaces that meet the needs of the oriental people through bamboo, which has become a powerful argument for his "negative architecture". At present, most bamboo buildings exist in a relatively single form, or are combined with steel, wood, and concrete. Buildings that effectively combine paper and bamboo are relatively rare, and buildings that combine paper and bamboo will fully reflect low-carbon environmental performance.

3 Planning and positioning analysis of the area where the building is located

Paper Bamboo House is far away from the hustle and bustle of the world. It is located in the agricultural park of Zinitang Creative Park in Zini Village, Panyu District, Guangzhou. It is adjacent to the tranquil Shawan waterway and on an island surrounded by water. The building is surrounded by farmland and waterways, with year-round lush trees and a beautiful and pleasant environment. The predecessor of Zinitang was the Zini Sugar Factory, a large state-owned enterprise in Guangdong. Thanks to the support of Guangzhou's Three Old Reconstruction Policy, Panyu District has included it in the protection and utilization plan of

Shawan historical and cultural town, with the industrial heritage museum as the main body, to build a large-scale cultural and creative industry park integrating traditional handicrafts, innovative technology, art education, creative life and other formats. Promote local characteristic culture and historical relics, create diversified cultural tourist attractions, provide new trends for the supplementation and improvement of urban culture, and inject new strength into the development of local culture and characteristic tourism.



Fig. 1. Project location(Image source: Baidu map screenshot).

4 Architectural design concept and functional analysis

Paper Bamboo House has a construction area of 650 square meters. It is not only the material exhibition center of Dongnan Haiye Environmental Protection Materials Co., Ltd., but also an ecological club that integrates various functions such as leisure, negotiation, entertainment, and living. The company produces honeycomb paper wallboards The low-carbon environmental protection performance is fully demonstrated through the physical building of Paper Bamboo House, which also meets the needs of the owners for reception and living, reflecting the modern people's yearning for a natural living environment (Figure 2).



Fig. 2. Exterior of Paper Bamboo House (Image source: Photographed by Qiang Tang).



Fig. 3. Design concept (Image source: Drawn by Qiang Tang).

Paper Bamboo House follows the overall development mechanism of "coordination, sharing and regeneration" of Zinitang, and the architect adopts the design concept of "taking it from nature and using it for life". The architectural prototype is derived from ordinary leaves. Every leaf of every tree on the earth has a different shape, but it is a tedious process to convert the leaf into a solid spatial structure. The leaves are generally composed of three parts: leaves, petioles and veins.

First, it is proposed to simplify the original shape of the leaves to extract a simple shape to form an architectural prototype with a combination of child and parent spaces (Figure 3). The "petiole" part becomes the parent space, and the "leaf" part becomes multiple subspaces connecting the "petiole", which continue to be connected to the parent space through the "vein", and the subspaces of the "leaf" form multiple courtyards with different shapes . The peculiar spatial form creates a special architectural tension, showing the interspersed flow of solid architectural forms between the landscapes. The undulating buildings interact and interweave with the surrounding landscape, relying on each other. Roof, accessible green roof has become a new outdoor activity space and viewing platform, increasing the area of people's activities, allowing people to wander in the roof garden and enjoy the fun of the experience space (Figure 3). The "leaf" subspace extends from high to low to the ground near the lake, and the gradually lowering end of the building is implanted into the soil, which expands the area of people's activities again, leading to the lakeside to experience the environmental experience of water surrounded by water.



Fig. 4. Master plan (Image source: Drawn by Qiang Tang).

The Paper Bamboo House living room is divided into three functional spaces:

(1) The public space is the open public hall "petiole" parent space. As part of the public space, the hall can connect various functional sub-spaces, and the long and narrow hall has a distinct spatial hierarchy. The architect put a lot of thought into the design of the gate and the hall, and designed the entrance gate as an irregular "square cylinder" which is inserted obliquely from the side of the building (see Figure 4). A small space with depth. Paper Bamboo House comes into view with a wide square covered with green grass. After passing through the slightly low entrance gate, and then entering the hall, I feel an immediate sense of openness, which effectively increases the spatial rhythm of the building. In the second half of the hall, three steps are intentionally raised to form a platform tea bar, so as to break the single spatial form of the hall. At the end of the tea bar is a narrow passage, which connects the hall and the backyard through this passage;

(2) the living space is the "leaf" sub-space distributed on both sides of the mother space, and the five sub-spaces are distributed in an orderly manner in the mother space. Around the space, on the east side are relatively hidden health care room, entertainment room and two sets of living rooms. The entertainment space includes a billiard room and a KTV room. The first one on the west side is the dining room and kitchen, and the second one is the health room and sauna. The growth of leaves transports nutrients to the leaf end smoothly through the leaf veins, so the interior of the paper bamboo house also forms a smooth interior space. People can easily shuttle in different spaces of the paper bamboo house, and the building is not limited to the parent space and the sub-space. It is convenient to enter and exit, and the subspace and subspace can also enter and exit through the open glass window;

(3) The functional space, that is, the end of the "blade", acts as an auxiliary space such as the power distribution room. On the whole, the space with use function is mainly concentrated in the front part connected to the "petiole", but the space at the end is also effectively used, and the low end space is suitable for building auxiliary functions, such as power distribution rooms, toilets And saunas, after all, people in such spaces spend less time in them.

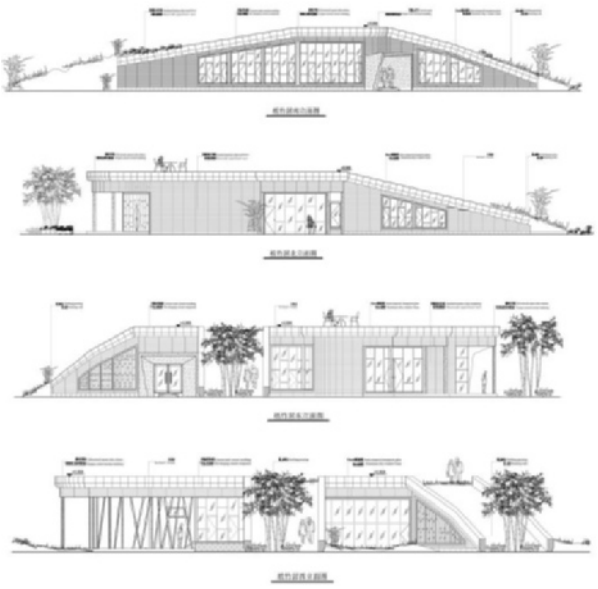


Fig. 5. Elevation view (Image source: Drawn by Qiang Tang).

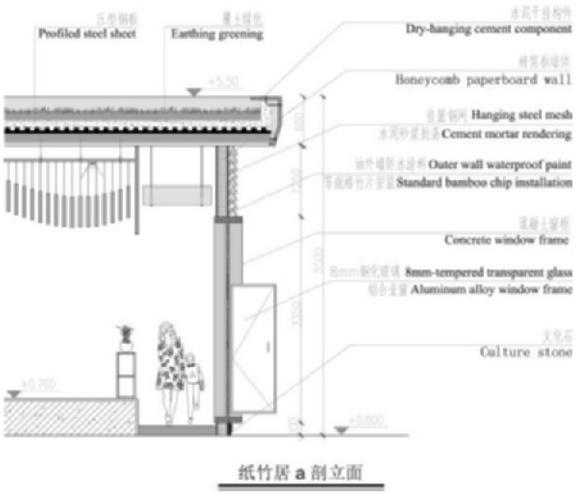


Fig. 6. Elevation view (Image source: Drawn by Qiang Tang).

5 Construction experience summary and inspiration

5.1 Fragile materials carefully crafted into stable spaces

The paper bamboo house is surrounded by bamboo, and bamboo materials are presented in various forms in the building. The bamboo cores left over from the outer walls are cleverly used for decoration in many parts of the interior. As a symbol of Chinese civilization, paper and bamboo play an important role in traditional culture, condensing the feelings of Chinese literati. Papermaking is an outstanding invention that contributed to the world in ancient my country, and made an indelible contribution to the dissemination of human knowledge. Bamboo is not just a simple building material in China, it is a symbol of a kind of moral integrity and noble character. spiritual outlook and special aesthetic value. The architect hopes to establish an emotional connection between people and space through materials, so that people can truly enjoy the "knowledge of bamboo life".

On the one hand, the birth of Paper Bamboo House stems from the architect's attachment to bamboo, and on the other hand, the owner produces lightweight honeycomb paper wallboard (hereinafter referred to as: honeycomb cardboard).



Fig. 7. Side Elevation Photos (Image source: Photographed by Qiang Tang).



Fig. 8. Side Elevation Photos (Image source: Photographed by Qiang Tang).



Fig. 9. Side Elevation Photos (Image source: Photographed by Qiang Tang).

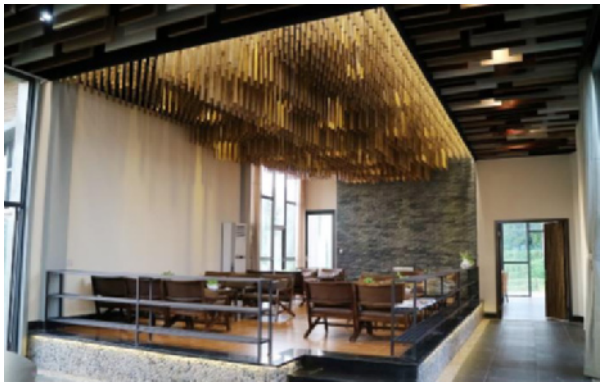


Fig. 10. Indoor tea shop (Image source: Photographed by Qiang Tang).

However, the use of paper and bamboo, two relatively fragile materials, brought challenges to the design, and architects needed to make breakthroughs in spatial forms and construction techniques. The park where Paper Bamboo Residence is located is leased agricultural land, and the land lease term is only 20 years. Taking into account the land use period and construction cost, a lightweight steel structure frame is used as the support system, and the walls are all made of lightweight honeycomb wall panels. (The middle is the paper

honeycomb board, and the two sides are the Eter board). Honeycomb cardboard that most people know is a green packaging material with high strength, good cushioning, heavy load-bearing and low price, but its performance is not limited to packaging. In the environment of reducing carbon dioxide emissions, its low-carbon and environmentally friendly performance has been used more and more in construction in recent years. Honeycomb paperboard has five major advantages:

(1) the honeycomb structure inside the honeycomb paperboard is one of the most amazing organizational structures in nature, and the honeycomb paperboard has the characteristics of light weight, high strength and not easy to deform;

(2) Honeycomb paperboard has excellent evacuation and thermal conductivity;

(3) It has good sound insulation and thermal insulation properties, and its shockproof, flame retardant, moisture-proof and thermal insulation properties are outstanding;

(4) It is a real environmentally friendly substrate, The formaldehyde content can reach E0 level;

(5) The two sides of the honeycomb paper wallboard are Eite boards with stable performance, which can be drilled, nailed, and sawed, so that the veneer is firm and the process is flexible. However, the middle of the honeycomb paper wallboard is still a paper material after all, and it cannot contact water at all. In order to solve the problem of difficult waterproofing of honeycomb paper, two coats of waterproof exterior wall paint are first applied to the building surface, and then bamboo pieces of the same specification are used for decoration. The paper bamboo house has been built and used for nearly 4 years, and it still stands as before after many typhoons and rains in the south, which verifies the original intention that fragile materials can build a solid space through careful design.



Fig. 11. Construction Material: Bamboo (Image source: Photographed by Qiang Tang).

5.2 A variety of ecological energy-saving technologies produce low-carbon effects

Paper Bamboo House use low-carbon and energy-saving natural construction technologies in many places. The integration of various technologies can effectively reduce the overall operating energy consumption of the building, which can achieve the effect of being warm in winter and cool in summer. The following three construction techniques are mainly used:

(1) Lightweight honeycomb paper wallboard, the honeycomb paperboard wall has been analyzed in detail in the previous section, and will not be repeated here;

(2) Green vegetation on the roofs of earth-covered buildings, and replace traditional thermal insulation layers with ecological thermal insulation layers. Therefore, the architectural form of the paper bamboo house is an earth-covered building, and the site selection is also affected by a series of factors such as soil, groundwater level, sunshine, and wind direction. The geological conditions of the base are complex, with high groundwater level and more sandy soil, which does not have structural performance, so the reinforced concrete structure is used to bear the load. Guangzhou belongs to the subtropical monsoon climate zone, with southeasterly winds in summer and northwesterly winds in winter. Guangzhou is located south of the Tropic of Cancer. In summer, the sun rises in the northeast and sets in the northwest. In winter, the sun rises in the southeast and sets in the southwest. Taking into account the sunlight and ventilation in the Guangzhou area, the openings of the

doors and windows of the building are in the north-south direction, and the roof part of the building in the east-west direction is covered with soil, forming a natural barrier to resist the strong radiation in summer and autumn, and is also effective. It solves the problem of roof heat insulation, plays a role in heat insulation and heat dissipation in the hot southern region, and has a positive effect on the energy saving and emission reduction of the building itself, and alleviating the urban heat island effect. The value of earth-covered buildings has attracted more and more attention. Green grass and shallow soil can effectively cool the interior space, and the difference in cooling is 5 degrees. It saves a large cooling cost for the building, and the maintenance cost is low. The roof of the Shangren covered with green vegetation can have a panoramic view of the pastoral scenery, and at the same time solve the problem of indoor heat insulation;

(3) Indoor natural ventilation and convection space design, the main structure of the building is supported by steel structure, and the architectural shape is bold and creative, without The regular space presents the beauty of opening and closing, relaxation and lawfulness. The architect connects the entrance gate, hall, and multiple indoor spaces, using completely transparent glass, which connects the interior and exterior in sight. Natural light can enter the interior to create a poetic light and shadow, forming a space sequence with relaxation and relaxation.



Fig. 12. Green Roof (Image source: Photographed by Qiang Tang).

5.3 Low-tech combined with high-tech strategy of ecological architecture practice

According to the direction of global sustainable development, ecological architecture represents the future development direction of architecture. In the field of architecture, we call for the design concept of ecological architecture that breathes with the environment, and advocate the use of modern ecological technology to develop ecological architecture. At present, ecological building technology is divided into low-tech ecological buildings and high-tech ecological buildings. Low-tech ecological buildings refer to local conditions and humanistic customs, using ecological resources on the spot, and using traditional construction techniques and regional materials for construction; and high-tech ecological buildings. Architecture refers to buildings designed with advanced energy-saving technologies in the world, including high-cost modern energy-saving equipment and new synthetic materials.

Paper Bamboo House effectively combines the two, and does not use high-end energy-saving materials. Based on regional ecological conditions, it introduces an eclectic design method of newer technologies. Huaiji, Guangdong, near the building, is rich in moso bamboo. The moso bamboo is straight and long. It is treated with borax salt preservative to effectively exert the toughness, flexibility and low-carbon properties of bamboo. popular building materials. Moso bamboo is used in all corners of paper bamboo to realize the effective use

of regional resources. The construction period of the paper bamboo house is only 3 months. It was put into use at the end of 2013. The low carbon and environmental protection performance of the lightweight honeycomb paper wallboard is fully demonstrated through the physical building, which reflects the architect's original intention of pursuing green environmental protection and energy saving. This architectural model has been gradually promoted in the market and has broad application prospects.

5.4 The form of experience space that emphasizes the dialogue between indoor and outdoor

The large-scale shape of the paper bamboo house building is placed in the sloping landscape. If some plants are used to disguise the building, the building shape will only be vaguely visible, presenting a “hidden” spatial form, reducing the building’s own sense of existence, and it is incompatible with Kuma. The "negative architecture" advocated by Mr. Kengo has similarities. These "non-buildings" are buried underground and integrated with the landscape, but they do not affect the indoor space effect at all. When people enter the room, they have a very broad view, especially the hall, dining room and living room have floor-to-ceiling glass up to nearly 4 meters. The window can be used as a frame for framing one by one. Different angles have different fields of view, which can bring all the beautiful rural scenery around into the indoor field of vision.

The architect advocates a dialogue between indoor and outdoor spaces, so that people can get close to nature at zero distance. It breaks the space boundary between indoor and outdoor, realizes the naturalization of indoor greening and the shaping of emotional space scenes, and creates a space experience similar to that of outdoor greenery. Different layers will enrich people's indoor space experience. The harmony and mutual contrast of the interior and exterior landscapes are formed. Different angles show the integration of the building and the regional environment, and meet the needs of residents for natural ventilation and effective heat insulation. For example, the health room that pursues privacy deliberately lowers the building height, extends the length of the window, and weakens the indoor light. The health room is the only space that is not directly connected to the hall. The "door" to enter the health room is directly entered from the window, which once again increases its privacy and spatial experience.

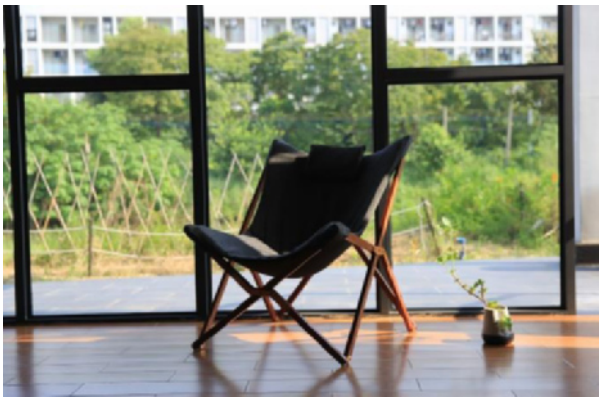


Fig.13. Indoor and outdoor dialogue (Image source: Photographed by Qiang Tang).



Fig.14. Indoor and outdoor dialogue (Image source: Photographed by Qiang Tang).

6 Conclusion

Paper Bamboo House creates a space that integrates functionality, experience and emotion. Mr. Xia Fulu, a famous American architect, once said that "the real place does not exist between buildings, but in people's memorable experiences", expressing the importance of building places in a succinct manner. The paper and bamboo dwelling is embodied in the physical space. Integrate architecture into nature and create an experience space to create a place. The architect believes that architecture carries people's emotional thoughts, establishes an emotional connection between space and people through the use of ecological materials based on humanistic feelings, pays attention to people's real perception of architecture, and emphasizes the rhythm of architectural form and rhythm. He is good at excavating the possibility of spatial existence from the regional culture, reconstructing the relationship between the building and the surrounding environment, striving to create a harmonious building that coexists with nature, and practicing the regional practice of low-carbon buildings. Create an open experiential space to attract people to actively experience and actively perceive.

In the era of China's economic rise, cultural innovation and development have followed. "Bamboo" not only has spiritual attributes, but also has practical effects, and can also become architectural aesthetics and architectural poetics. It is worthwhile for architects to explore more mysteries of bamboo use. Only with a profound experience will the customer's emotional resonance be formed. Even if he leaves the venue, he will leave a deep memory and experience.

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