

# Container building design based on the concept of sustainable development

Kai Cao, Zhipeng Zeng

School of art and design, Wuhan Textile University, Wuhan, China.

**Abstract.** The containers abandoned in the storage yard are endowed with certain building functions, and become single-cell buildings or building organizations by cutting, strengthening, adding facilities, stacking, assembling and extending space. The improvement of the main frame structure of the container allows more people to find the value of its being reconstructed, designed and reused, and the container building emerges as the times require. Container building design can not only meet people's living needs, but also play a certain construction role in urban development. However, because people are too eager to meet the concept of urban modernization development and meet the needs of Party A's functional use, it is easy to ignore the consideration of aesthetics, and the proportion of design aesthetics really integrated in the design is very small. When users enter the container building, it is difficult to have the opportunity to feel and appreciate the beauty brought by the internal design and the surrounding environment.

**Keywords:** Building function; Assembly; Single cell building; Life demand; Sustainable development concept.

## 1. Introduction

The containers abandoned in the storage yard are endowed with certain building functions. Based on the concept of sustainable development, they can be cut, reinforced, equipped with facilities, stacked, assembled and extended into single-cell buildings or architectural organizations. The improvement of the main frame structure of the container allows more people to find the value of its being reconstructed, designed and reused, and the container building emerges as the times require. Container building design can not only meet people's living needs, but also play a certain construction role in urban development. However, because people are too eager to meet the concept of urban modernization development and meet the needs of Party A's functional use, it is easy to ignore the consideration of aesthetics, and the proportion of design aesthetics really integrated in the design is very small. When users enter the container building, it is difficult to have the opportunity to feel and appreciate the beauty brought by the internal design and the surrounding environment.

## 2. Overview

### 2.1 Research background

With the rapid development of the global economy, China's port transport has become an indispensable part of the global ports. The annual container throughput has steadily increased. By December 2019, the total container throughput was 261.07 million TEU, 104.4 % of the same period last year (from the relevant data of the Ministry of transport of the people's Republic of China).

For the sake of maritime transport safety, such containers generally have a service life limit of 10-15 years. Therefore, a large number of containers that exceed the legal age are discarded, but this does not mean that they can not be used. The modularization and prefabrication of containers in buildings has become a general trend. They are built in standard sizes. Compared with the construction cost of brick concrete buildings and reinforced concrete buildings, the construction cost of containers can be saved by at least 1 time [1]. Passive design refers to the reasonable design of the layout, structure, material and other aspects of the building according to the climate and geographical conditions of the site where the building is located. Even without using mechanical equipment, a comfortable and livable building environment can be created to reduce energy consumption. The

application of passive design in container buildings is conducive to the sustainable development of human living environment. It is an important architectural design form to deal with energy crisis, climate change and pursue high-quality life quality.

## 2.2 Development status and trend of container buildings

The research and Practice on container creation and design originated from abroad, which is more systematic and comprehensive than the research and practice of container architecture in China and developed countries in Europe and America. There are already a large number of designers and firms in Europe and the United States that specialize in the development of container architectural design, such as LOT-EK in the United States. In the early stage, the research and development of container buildings in China mainly depended on container manufacturing enterprises. With the further development of container buildings in China, more and more research scholars and experts paid attention to them. A group of pioneer designers and firms also began to practice in this field. After the Wenchuan earthquake in 2008, they began to rebuild after the disaster, Only then did containers officially appear in the form of buildings in people's vision. The earliest research on container architecture in China is "alternative folk architecture in Hong Kong" and "container architecture in Hong Kong" published by Gu Daqing and others, which is a summary based on the application status and cases of container architecture in Hong Kong [9]. In the following few years, most of the research on container buildings focused on the combined application design. At home and abroad, the application of passive design in traditional buildings has formed mature theoretical research, but due to the characteristics of containers, the application of passive design in container buildings has not formed a system. This paper summarizes the application examples of passive design of container buildings, and provides opinions and suggestions for architects.

## 3. Advantages of container architectural design

As a relatively special single-cell building, the container building has a small space but more uses. Architects often quote from Laozi's Tao Te Ching that "when there is nothing, there is something to use as a tool. When there is nothing, there is something to use as a room. When there is nothing, there is something to use as a room. So there is something to benefit from and nothing to use." To interpret the space theory of architecture. With the use of functions, why do we look for "tools"? The above two container architectural designs have given containers a new life form, entered the public's view, and received widespread attention and praise. The advantages of using containers in architectural design units are summarized as follows.

1) The nature of the movable temporary space is to meet the temporary functions of residence, exhibition and storage. It does not need to occupy the construction land resources for a long time. The container has the characteristics of movable transportation and the inherent temporary space attribute.

2) Dimension standardization the characteristic of container industry is dimension standardization. Most of the construction units of container buildings are from ready-made containers, which are limited by the size of existing boxes. Most of the external dimensions of containers are subject to uniform size limits.

3) Safety and durability: the service life of containers in the transportation industry is generally 10-15 years. The container boxes that are eliminated and undamaged still have good physical properties and can be used for 15 years in general. If they are well maintained or matched with other structures such as concrete, they can be more durable. Influenced by the physical characteristics of its metal structure, the container material has strong heat conduction capacity and poor thermal insulation performance, which leads to unstable indoor thermal environment. In order to effectively control the thermal environment within the container, an additional thermal insulation layer needs to be set. In the southern region, the container body needs to be sunshaded for thermal insulation; In addition, the box is easy to rust, so it is necessary to brush anti rust paint inside and outside the

container to prevent corrosion. In addition to the robustness of containers, attention should also be paid to the fact that chromate, phosphorous or lead-containing paints are often used in container paints produced in some countries to prevent the spread of pests and diseases during international shipping. Therefore, the origin of containers should be identified before making them into building units. For some containers, the original residual paint should be polished off before safe use.

4) Skeleton ductility because the container is a self-contained rigid structure, it can be stacked and assembled in "multiple boxes and directions" without destroying the internal beams and columns and diagonal braces. To prevent horizontal sliding, each container can be connected by binding, riveting or welding. The corrugated steel plate on the surface can be sealed by metal plate after cutting or connected with steel beam and steel frame to form an extension member.

#### **4. Characteristics of container building design**

Because of the above main characteristics of containers, containers are widely used as design units in residential buildings, commercial buildings, exhibition buildings or scenic spots in order to achieve certain space use functions. If a container is regarded as an independent unit and other parts are regarded as additional components, it can be divided into foundation, roof, doors and windows, balcony, external finishes and stairs from the appearance. As a building form with a high degree of prefabrication and assembly, the following aspects should be focused on in terms of technical realization.

1) The function of foundation container building foundation is to transfer load, adjust horizontal angle, support and fix containers, damp proof and ventilation. Generally, concrete blocks or anchor bolts are used for anchoring by angle steel.

2) The original top surface of the roof container is a self waterproof structure, and rainwater will be sloped and discharged according to the structure. If it is ventilation and heat insulation, the roof can be attached. Generally, it can be directly covered with wood boards or short columns, beams or keels, independent supports, etc.

3) During the reconstruction of door and window containers, there are many forms of opening of doors and windows, and there is no fixed rule. It is only necessary to pay attention to the edge sealing method after cutting the steel plate. Generally, the edge sealing method of welding the section steel and the steel plate is adopted. There are no windows in the container. As a long and narrow closed unit, transparency is a key point. By matching with large transparent glass, the original simple and monotonous facade of the container can be dispelled, and good lighting can be provided for the originally narrow, closed and dark space, so as to create a good line of sight relationship inside and outside.

4) Stairs: stairs and walkways used for transportation generally include the following structural forms: cantilevered from the supporting frame structure or container, overlapped on two containers, or existing in the form of independent structures.

5) After the interior design container is reconstructed, some of the wall panels will be cut for opening or opening, and the remaining wall panels need to be added with finishes as the internal space surface. Generally, polystyrene board or rock wool board will be used as the internal insulation structure, and wire pipes will be arranged between it and the surface layer. It is also necessary to incorporate water, electricity, ventilation and heating design into the interior design, so as to meet various effects of interior design by reconstructing the inner and outer skins.

#### **5. Space design form of container modular transformation**

The form of container building is not only single space, but also different combinations of containers can create different types of wonderful spaces.

First, intersection. The combination modes of container residence intersection include vertical intersection, acute angle intersection and obtuse angle intersection. Vertical intersection means that

the two boxes are vertically connected and L-shaped, which is divided into plane orthogonal and vertical orthogonal. A waste container renovation building complex located in Chongming District of Shanghai uses the intersecting connection method to revitalize the originally chaotic waste containers. The containers intersect to form a contrast between the virtual and the real, and the light and shadow fall on the container, thus creating a poetic aesthetic feeling. This makes the box of each container have the role of a shutter in the change of light. Because the height of the box is different, the light will also be staggered and superimposed, so that the container building has the appearance of a modern building.

Second, superposition type (parallel type). Generally speaking, the height of this type of container building is not too high (no more than six floors), and the structure is relatively stable. Each unit's container is a relatively independent space. Not every container needs to be connected, and additional internal and external bridges are needed to connect each other. Patrick Partouche, a French architect, designed a modern house with cargo containers in 2010 based on traditional houses. The whole building is composed of many containers, which serve as different parts of the building. The designer installed large windows and doors on these containers, and placed a lot of modern furniture, which formed a relatively complete enclosed space. Residents can eat, play or live in it. For the upper floor of the building, the designer did not waste space, but designed a lot of building structures, which are often metal, connected by stairs or aerial panels. When the sun shines on the metal, it presents a sparkling scene, which also highlights the theme of industry. If residents want to protect privacy, they can close the door outside the container to get private space.

## 6. Epilogue

Through the writing of the research on the design aesthetics of container buildings in this paper, the author draws the following main conclusions:

(1) Cargo container is a valuable modular building material worthy of consideration in the process of urban development. It plays a very important role in both users and social development, and has certain design significance and value.

(2) The design aesthetics of container buildings has certain preconditions and foundations. One is the accurate treatment of container modularization, and the other is to treat containers as a combination of systems.

(3) Aesthetics is not a necessity of life, but more like a kind of spiritual material that meets the psychological state. When we meet all basic needs, we want to pursue aesthetics. In the process of container architecture design, we can't just stay in the functional satisfaction, but also think about people's inner feelings.

## References

- [1] Qiaosheng Jia. Study on revitalization design of historic District from the perspective of urban memory. Chongqing University.
- [2] Research on key issues of modular design of prefabricated residence [J] Zhang Guangping, Ma Cong. Journal of Jilin University of architecture and architecture. 2016 (06).
- [3] Research on adaptive design and construction of container buildings [D] Zhao Peng, Hunan University, 2011.
- [4] Research on design strategy of contemporary container prefabricated building [D] Wang Weinan, South China University of technology 201.
- [5] Building renovation of container -- a development attempt of sustainable building [J] Gong Xiaolei, Zhang Yukun. World architecture. 2010 (10).
- [6] Renovation design of abandoned container buildings under the concept of sustainable development [J] Zhang Shuhao, Chen Han. Beauty and times (Urban Edition). 2020 (09).

- [7] New exploration of modular container assembly building -- Design of Yangzhou huaduhui tourist center  
[J] Su Mn, Gao min. Jiangsu architecture. 2018 (04).