

Tradition and Modernity: Inheritance and Innovation of Ancient Chinese Architecture

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Abstract: With a history of five thousand years, China has made many outstanding achievements in architecture. Even in modern times with advanced technology, there are still many advantages that can be used for reference. This article expounds the modern development of ancient Chinese architecture through the unique structure of ancient Chinese architecture and the application and evolution of ancient Chinese architectural styles in modern times. In general, the two unique structures of ancient Chinese architecture, the mortise and tenon structure and the bucket arch structure, due to the development of science and technology, no longer need them to play a load-bearing role. Now they are more used as decorations to reflect Chinese culture in architecture. middle. The architectural style of ancient China is also combined with modern architectural style to simplify the cumbersome construction process while still retaining the unique charm of ancient Chinese architecture. The main purpose of this study is to study the application and development trend of ancient Chinese architecture in modern times.

Keywords: ancient chinese architecture, mortise and tenon structure, dougong structure

1. Introduction

China has a history of more than 5,000 years and has achieved outstanding achievements in many areas since ancient times, among which architecture is one of the outstanding ones. Whether it is the imperial palaces or the gardens of wealthy merchants, they are still intact in mainland China after thousands of years of exposure to wind and rain. Why can ancient Chinese buildings stand for thousands of years without falling? Is it because they are made of strong materials or because their foundations are very strong? Actually neither. Due to technical limitations in ancient China, buildings were constructed with wood and some bricks and stones were used, but these bricks and stones were only used for the construction of roofs and steps, not for load-bearing structures. In addition, when ancient Chinese buildings were built, they did not build foundations.

This makes it even more puzzling why ancient Chinese buildings are so strong. In 2017, channel 4 broadcasted such an experiment. Make a miniature model of the Forbidden City in Beijing in equal proportions, and then conduct simulated earthquake experiments on the miniature model in the laboratory. Starting from a magnitude 4 earthquake, it increases in the order of 4.5, 5, and 5.5. Each earthquake lasts 30 seconds. Everyone thought that the wooden palace would not last long and would collapse soon. However, the wooden structure of the Forbidden City remained intact until the magnitude 10.1 earthquake. This experiment will stop here because the largest earthquake that can

be simulated in the laboratory is only 10.1. In reality, the largest earthquake that humans have ever encountered is only the 9.5 earthquake that occurred in Chile [1].

However, in modern times with highly developed technology, the building materials used are not limited to fragile materials like wood. Brick, cement, steel, and concrete are common building materials that are stronger than wood. Moreover, the service life of buildings built today is far less than that of wooden buildings built in ancient China. Modern buildings often show obvious signs of aging after several years to decades of use. Moreover, it is impossible to keep the structure intact after experiencing a severe earthquake like the Forbidden City. If there is only one Forbidden City that can survive for a thousand years, it may be just a coincidence. But in fact, various types of buildings in ancient China have managed to maintain the integrity of the main structure after hundreds of thousands of years of wear and tear. The Forbidden City is a representative of government agency buildings, the Great Wall of the Ming Dynasty is a model of military architecture, and the Humble Administrator's Garden is an example of civil architecture. Even in modern times with highly developed technology, in the construction industry, many technologies of ancient China may still be used for reference to improve modern construction technology to a higher level. This article will analyse the development of ancient Chinese architecture in modern times through two aspects. First, it will introduce two unique structures of ancient Chinese architecture, the mortise and tenon structure and the bracket structure; secondly, it will introduce the unique architectural style of ancient Chinese architecture.

2. The Evolution of Ancient Chinese Architecture in Modern Times

There are many unique structures left in ancient Chinese architecture, and it is precisely these structures that allow ancient Chinese architecture to survive thousands of years of natural disasters. Among these unique structures, the two most famous and important structures are the mortise and tenon structure and the bucket arch structure.

2.1. Modern Application and Development Trend of Mortise and Tenon Structure

The first thing to talk about is the mortise and tenon structure. When it comes to this, the first question to be solved is what is the mortise and tenon structure? Mortise and tenon structure, just like its name, is composed of two parts: mortise and tenon. A tenon is a raised part deliberately made on a wooden building component, while a mortise is just the opposite of a tenon, which refers to a groove made on a wooden component. This raised part and this groove can be just butted, this is the mortise and tenon structure [2]. In general, the mortise and tenon structure is a structure that connects different wooden parts. To give a simple example, the wooden doors in ancient China were all carved out of a complete wooden board. The craftsman would leave a cylindrical protrusion on the top and bottom of one side of the wooden door and leave a corresponding place for the lintel and threshold. The next groove, so that when building, you only need to put the protrusion on the door into the groove to complete the construction of the door. This protrusion and groove are the mortise and tenon structures. Using the mortise and tenon structure to connect different parts, they can be tightly connected without using any adhesive, and the connection method is very simple, just like building blocks, which can save a lot of costs. In addition, it is also convenient when a certain part of the building is damaged and needs to be repaired. Only need to separate the mortise and tenon, it can easily remove a part for replacement or repair.

Modern buildings made of reinforced concrete are often easily destroyed by earthquakes, while ancient Chinese buildings with seemingly fragile wooden structures can survive earthquakes. Among them, the mortise and tenon structure plays an indelible role.

The wood has a certain degree of flexibility and ductility, so when it is subjected to external forces, it can be deformed to reduce the damage of external forces to itself. The mortise and tenon structure itself is a flexible connection method, that is to say, this connection structure itself can also allow the two connected parts to rotate or expand freely to a certain extent. Therefore, when an earthquake occurs, the wooden structure buildings in ancient China will be affected by the earthquake waves, just like the plants living in the sea will swing with the waves but will not break after being washed by the waves. It swings with the earthquake waves, but because of the flexibility of the wood itself and the flexibility provided by the mortise and tenon structure, the wooden structure will not be damaged. This can explain very well why in the Forbidden City earthquake simulation experiment in 2017, the entire miniature model began to sway not long after the experiment started, but even after the experiment ended, the entire wooden structure was intact [1]. This is also the secret that all ancient Chinese buildings can survive earthquakes.

But in general, because the fire resistance and bearing capacity of wooden structures can no longer meet the requirements of modern society, the modern development of the mortise and tenon structure supporting wooden structures has also been greatly restricted. The application of mortise and tenon structure in modern society has three main significances. First of all, it is mainly applied to wood. Wood is undoubtedly the most environmentally friendly building material in the construction industry. Secondly, if the mortise and tenon structure can be developed so that it can be used not only for wooden structures, but it may also greatly improve the earthquake resistance of modern buildings. Finally, it is an excellent product of ancient Chinese architectural culture and an intangible cultural heritage [3].

2.2. Application and Development Trend of Dougong Structure in Modern Times

Another unique structure in ancient Chinese architecture to be introduced is Dougong structure. The mortise and tenon structures are composed of two parts, the mortise and the tenon. The DG structure is also composed of two parts, namely the dou and the gong. The gong is a kind of bow-shaped wooden block, which plays a load-bearing role in the whole structure, and the dou is the wood between the arches. There is a notch on the bucket to facilitate the placement of the arch. DG structure is formed by stacking dou and gong layer by layer [4].

DG structure can be placed in many places in a building, and it will have different effects depending on the placement. Usually, they are placed above the columns in the building, so that the load can be transferred efficiently. The most amazing thing about the bucket arch is that its material is only wood, without any other materials, but it can support a wide roof stably and firmly. It is one of the most common structures in ancient Chinese architecture, and it is even easier to observe than the mortise and tenon structures. Because the mortise and tenon structure is often hidden as a connection structure, so that the appearance of the building looks more concise and tidier, while DG structure not only plays a load-bearing role but also is displayed by various patterns on the map. as an ornament. Therefore, the DG structure can be seen on the top of the load-bearing columns or under the eaves of ancient Chinese buildings. DG structure, like the mortise and tenon structure, is also one of the reasons why ancient Chinese buildings have excellent earthquake resistance. The difference between the mortise and tenon structure can be relieved by a certain degree of deformation in the stress. The way for DG to relieve the force is to transmit the force from top to bottom, and finally to the base, to reduce the force [5].

However, as mentioned before, in the modern age of technology, wood is rarely used as the main building material. DG structure, like the mortise and tenon structure, serves the wooden structure building, so its development is also greatly restricted in modern times when brick and stone are used as building materials. However, these did not force the DG structure to withdraw from the stage of

history. It has now appeared in the public eye with another identity. As an ornament, it symbolizes Chinese civilization.

Among the examples of using DG structure as an ornament, the most famous one is the 2010 Shanghai World Expo. The shape of the China Pavilion at this World Expo was borrowed from DG structure [6].

However, this China Pavilion only borrows the structure of DG, and it has made many innovations in the traditional structure of the bucket arch. Firstly, the traditional DG structure is made of wood, and the China Pavilion is a modern building made of reinforced concrete. Secondly, the arches of the traditional DG structure are all bow-shaped, while every steel bar on the China Pavilion is straight. In addition, the cross-section of the traditional DG structure is a cross, while the cross-section of the China Pavilion is square. These innovations not only make the structure of the China Pavilion more concise but also make the whole look tidier. Finally, paint the entire China Pavilion with classic Chinese red. This is the China Pavilion of the Shanghai World Expo, which is dubbed the "Crown of the Orient" by the world. From the high evaluation of its shape by the world, it can also be seen that people still have a high degree of recognition for the beauty of the shape of the DG structure.

The China Pavilion of the 2010 Shanghai World Expo is not the first nor the last time that the brackets are presented as decorations in front of the world. In subway stations or hotels in many Chinese cities, bucket arches are used for decoration. Especially some cities with a long history, such as Nanjing and Xi'an. When designers to design buildings in these cities, they always like to add a little bucket arch as decoration to highlight the long history of the city. Therefore, in today's construction industry, the bucket arch no longer needs to function as a load-bearing structure. It will be used more as a symbol representing Chinese culture and decorated in buildings.

2.3. The Influence of Ancient Chinese Architectural Styles on Modern Chinese Architecture

After discussing the two unique structures of ancient Chinese architecture, it is time to discuss the unique styles of ancient Chinese architecture. Compared with the simple and clear German architectural style popular in modern masonry buildings, the ancient Chinese architectural style has obvious differences.

So, what is the ancient Chinese architectural style? In fact, due to the diversity of ancient Chinese architecture, there are also many styles of ancient Chinese architecture. The more typical ones are undoubtedly the royal palace and private gardens. The most famous imperial palace today is of course the Forbidden City in Beijing. The most prominent feature of the imperial palace is its symmetry, ranging from a single palace to a whole group of palaces. The layout must be symmetrical. At the same time, the whole palace should be magnificent. In modern times, due to the growth of the population, such buildings are naturally eliminated due to the low land utilization rate and the stratification of different palaces and the identities of the people living in different palaces. Unlike private gardens, it does not pay attention to symmetry, nor does it evaluate the class of the people living in it. Therefore, it has become the architectural style that has the greatest influence on modern architecture among the ancient Chinese architectural styles.

However, due to the great influence of Chinese traditional cultural thought on the building materials and spatial layout of ancient Chinese buildings [7]. And the royal palaces and private gardens that best reflect the national characteristics are all from the royal relatives or wealthy businessmen. Therefore, many architectural design ideas have the disadvantages of high costs and long construction periods. It is precise because of these shortcomings that it is impossible to see buildings that perfectly restore the ancient Chinese architectural style in modern times. Especially in the 1970s and 1980s of the last worlds, when Chinese architects designed buildings, due to economic reasons, they could not build ancient Chinese soup temples, and they could not accept the architectural styles of the Soviet Union and the West [8]. Therefore, when modern designers design buildings with

ancient Chinese architectural styles, they often integrate them with modern architectural styles. A very classic example is the Fragrant Hill Hotel in Beijing, which was commissioned by the Chinese government in 1979 by a famous Chinese-American architect, Mr. Leoh. He also said in an interview that he hopes to find an architectural style unique to China to complete his commission. After he travelled to many cities in China, it was the Suzhou gardens that inspired him [9].

Fragrant Hills Hotel relies on the mountainous terrain of Fragrant Hills, and the layout of the entire hotel is uneven. The hotel as a whole can be divided into two parts: the building and the courtyard. The courtyard is located in the center of the hotel, surrounded by buildings on the east, west and north sides, leaving only the south side open. The design of the building is also different from the common classical large roofs, with white walls and gray sloping roofs. The overall structure of the building is a modern reinforced concrete structure, and its appearance is indeed an ancient Chinese garden, which is a combination of modern and ancient China [8].

Suzhou gardens are very representative private gardens in ancient Chinese architecture. Suzhou gardens are generally composed of buildings, landscapes, flowers, roads and other cultural elements [10]. Gardens not only display humanities and arts, but also natural beauty. The main body of Xiangshan Hotel is a hotel for guests to rest and entertain. There is an artificial lake near the hotel. The road to the hotel is full of various flowers and plants, and there are also some scattered rocks. These perfectly fit the characteristics of Suzhou gardens. And since this hotel can win an American architectural award with its unique Suzhou Garden style. It can be considered that the ancient Chinese architectural style can still be recognized by the public even if it is placed in the modern era where the simple style is popular.

Generally speaking, the ancient Chinese architectural style buildings built in modern times, represented by Xiangshan Hotel, are not entirely a kind of inheritance of ancient Chinese architectural style. Professor Jiao also said that this is due to the limited conditions of science and technology, as well as the fact that Chinese society and Chinese architects have fallen into confusion about the construction industry, and do not know how to choose between modern architectural styles and ancient Chinese architectural styles. Against the background of the times, a brave attempt was made [8].

The success of this attempt has also opened up the development direction of ancient Chinese architectural styles. That is to combine ancient Chinese architectural style with modern technology. Jumping out of the traditional fixed building system, only retaining the artistic conception of ancient Chinese architectural style.

3. Conclusion

Ancient Chinese architecture has not been eliminated in modern times with advanced science and technology, but has successfully developed better in modern times. This article analyzes the modern development of ancient Chinese architecture from two perspectives, namely, the unique structure of ancient Chinese architecture and the style of ancient Chinese architecture. A total of two unique structures of ancient Chinese architecture have been analyzed, namely the mortise and tenon structure and the DG structure. The mortise and tenon structure is an important connection structure in ancient Chinese architecture, and the bucket arch structure is an important load-bearing structure. But in the modern construction industry, no matter which one of them is, they no longer need them to play their original role, and they are now more often used as a decoration in modern buildings. And it is often an ornament used to show the characteristics of Chinese civilization. There are many kinds of ancient Chinese architectural styles, but Chinese gardens have the greatest influence on modern architecture. Many modern Chinese buildings are built in the Chinese garden style, but they are not completely inherited. Since the Chinese garden itself is very cumbersome to build, modern designers combine it with the modern, concise and lively German architectural style, and retain the original charm of the

Chinese garden on the basis of simplifying the construction steps. It is not only the inheritance of traditional architectural culture, it is also innovative. The main purpose of this article is to summarize the development trend of ancient Chinese architecture in modern times by studying the modern development of mortise and tenon structure, bucket arch structure and Chinese garden architectural style. However, since this article only studies two unique structures of ancient Chinese architecture and one style of ancient Chinese architecture, and there are many unique structures and styles of ancient Chinese architecture, which are no longer common in modern times, but They have not completely disappeared, and they have also evolved with the times and remained. Therefore, this article is not comprehensive enough to study the development of ancient Chinese architecture in modern times. Perhaps, with the development of technology, the unique structures in ancient Chinese architecture will gradually reappear in the public's field of vision as symbols representing Chinese culture, and various ancient Chinese architectural styles will also be combined with modern architectural styles, rediscover their unique charm.

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