Analysis of the Differences between Chinese and Japanese Traditional Wooden Architecture

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Abstract. Buddhism has been the link between China and Japan for more than 1,500 years in terms of architectural technology. With the introduction of Buddhism, Japan has been absorbing and transforming traditional Chinese wooden construction technology into a part of its own culture. The history of Japanese architecture is mostly the process of ingesting and assimilating Chinese architectural culture. The study of Chinese and Japanese wooden architecture is an important supplement to the history of east Asian architecture. This paper starts from the origin of Chinese and Japanese traditional wooden architecture, compares the differences between Chinese and Japanese traditional wooden architecture technology, and analyses the reasons for the differences between Chinese and Japanese traditional wooden architecture from the perspective of natural environment and construction technology.

1. Introduction
The communication of ancient East Asian architectural culture was based on the spread of Buddhism. Its main feature is the carrier of the spread of Buddhist culture. Making East Asian ancient building technology disseminated widely and developed, among them, China, Korea and Japan have close exchanges. They are also the most representative research objects.

2. Development of Chinese traditional wooden architecture
Before Buddhism was introduced into China, Chinese wooden architecture had been transformed from the early dry appendix buildings to the high-rise buildings and pavilion buildings. Construction technology was already at a relatively mature stage. After Buddhism was introduced into China from the western regions, the architectural form began combining Buddhism with Chinese local architectural technology. In the Southern and Northern Dynasties, as China was in a state of war and division, the dominators used Buddhism as a tool to rule country. Buddhism gained great popularity and development in that time, and architecture also developed rapidly. The layout of Chinese-style Buddhist architecture was also basically finalized in the period. In the Sui and Tang Dynasty, Buddhism reached its heyday in China. Its form and practice of bracket set were basically finalized. Buddhism in the Song Dynasty was further secularized, which was reflected in more diversified architectural styles. Although it was less solemn in the Sui and Tang Dynasty, it was lighter than before with more diversified architectural shapes and more complex architectural group combinations.
3. Inheritance and Development of Japanese Wooden Architecture

According to the three-point division of Japanese history, the history of Japan until the Meiji Restoration (1868) is divided into three periods: ancient, middle, and modern times. Prior to the introduction of Buddhism in Japan, the architectural form of Japan was still in a relatively primitive “dry-style building” (called a high-bed type building in Japan). At East Asia, Chinese Buddhist architecture first passed through the Korean Peninsula and then entered Japan. In 553 AD, Buddhism was introduced into Japan from Baekje of the Korean Peninsula. With the development of Buddhism in Japan, Buddhist architecture has also developed rapidly. The introduction of wooden structure technology made Japan enter the Asuka era from the Kofun era. In 607 AD, Prince Sade of Japan sent Sui and Tang ambassadors to begin to input of Sui and Tang’s cultures. At the same time, he vigorously promoted Buddhism, built Buddhist temples, and learned advanced Chinese culture and technology. The Asuka era was mainly an imitation of Chinese building technology and culture, commonly known as "Asuka style". Therefore, the early Chinese architecture can also be seen in the Kondo of Horyuji Temple, the oldest existing wooden building. Jintang is also a representative of the "Asuka style".

In the Nara Period, temple construction flourished and Buddhist architecture developed more rapidly. In this period, China was in the prosperous Tang Dynasty. Japan sent more envoys to Tang to learn more advanced culture and technology. The architecture style was more mature, commonly known as the "White Phoenix style", such as the East Tower of Yakushiji Temple.

The Heian era was the heyday of Japanese Buddhist architecture. Its architectural style tends to be more mature and stereotyped. As a traditional Japanese classical style[1], its representative is the Golden Hall of Toshodai Temple. In the late Tang Dynasty, due to the war, Japan stopped sending envoys to Tang.

The age of Fujiwara is an accumulation period for Japan to learn Chinese technology and culture for hundred years, as well as a period of cultural integration within Japan, which was an important period for the gradually Japanese Buddhist architecture. There has been a great change in architectural style, the so-called "national wind". In the Song Dynasty, the original exchanges between Song and Japan resumed. The monks exchanged more closely and introduced Chinese culture to Japan once again. Among them, a Chinese named Zen had a huge impact on Japanese culture, and even directly affected the core of Japanese culture. With the introduction of Zen, the architectural form and technology of temples in the Southern Song Dynasty were also introduced to Japan, bringing new impetus to Japanese architecture. This architectural style is called "Tang style" and "Zen style".

Until the beginning of the Meiji Restoration in Japan, since the introduction of Buddhism, Chinese technology and culture have been continuously studied. At the same time, combined with the cultural heritage, natural resources, climate and environment of Japan to carry out localization innovation. It shows both similarities and differences with Chinese architectural culture and technology. As Ito Chuta said, "The history of Japanese architecture is the uptake and assimilation of foreign architecture".

4. Comparison of Chinese and Japanese traditional wood construction technology

4.1. Changya

“Changya” is a unique component of ancient Japanese architecture. At present, there is only one building in China that has a 'Changya'-the tomb of Jingzang Zen Master in Dengfeng County, Henan (Tang Tianbao, 746). The earliest existing wooden structure in the world, Horyuji Kondo, is equipped with "Changya". It can be seen that this structural component is quite old. The purpose of the component is supposed to be to prevent natural disasters, such as earthquakes and so on. As a specially reinforced building component is a building practice with Japanese local characteristics. “Changya” is a general name of the cross bar that clamps the post from the outside or inside, and nails are fixed on both sides. It is similar to binding several chopsticks together with a rope to increase the overall stiffness. This is a kind of connection component, which is equivalent to the
function of "ring beam". There are various names and component forms depending on their location. In Horyuji Kondou, the “changya” placed on the foundation of the rammed soil is called the “Ground Changya”; placed under the window is called “Waist Changya” (Figure 1). In general, “Changya” is a unique building component in Japan, not coming from China. When Chinese construction technology and form were introduced to Japan, the Japanese also added localized construction forms on the basis of retaining Chinese construction forms.

Figure 1."Waist changya" and "ground changya" (photo source: taken by the author)

4.2. Rafter
The layout of roof rafters can be divided into two types: parallel rafts and fan-shaped rafts. The method of parallel bunting is to arrange the corner rafters in the eaves in parallel to each other, which belongs to the early way of laying rafters in China. The method of parallel arrangement is poor because the rafters at the corner beams cannot bear the eaves load, and the mechanical performance is poor. Horyuji Kondou adopts this form of parallel rafters, so pillars and auxiliary steps are added to support the roof. Ancient Japanese pavilion-style wooden pagodas and Buddhist temples are basically in the form of parallel fabrics, which is relatively primitive.

The fan-shaped rafters appear after the parallel rafters, that is, the rear end of the rafters near the corner beam is unchanged. Only the hoe heads are dropped on the stigma side and arranged radially. This approach increases the overall structure and stiffness of the roof. This form of layout is very common, such as the main hall of the Foguang Temple in Wutai Mountain. (Figure 2)

Figure 2.Parallel rafters and radial rafters
(photo source:Horyuji - the oldest wooden structure in the world)

From the history of rafters' development, the parallel arrangement in Japan is an ancient practice. It was also adopted in earlier Chinese traditional buildings, and gradually disappeared after the Tang Dynasty. The rafters' layout of Chinese ancient buildings have been completely replaced by fan-shaped rafters. So that the ancient Chinese buildings that have survived today can no longer see the form of parallel rafters. Only in some murals, stone towers and early Japanese ancient buildings, these rafters can be seen.

4.3. Roof truss
After the construction technology of Buddhist architecture was introduced to Japan, a more simplified beam-up frame was used. In the Horyuji Kondou, the roof truss system is relatively simple, the connection of horizontal components is relatively weak. There is no substantial "beam" component. In the Sui and Tang Dynasties, due to frequent exchanges, Japan tried to move closer to China's wood structure technology, with far-reaching eaves. But the Japanese roof truss in this period was as gentle as that in the Tang Dynasty (Figure 3). In the Song Dynasty, due to the increase of rain and snow weather in East Asia, it became an important task for the ancient buildings to removal the rain and snow from roofs to protect the building structure. Therefore, China and Japan took corresponding measures respectively. China has further developed the roof truss system, raising the beam truss, and the discounts have become higher and steeper. In the Heian
period, although Japan also began to raise the roof truss, it abandoned the beam lifting method introduced from China and instead used the “hut group” to change the height and slope of the roof. The girder part of the building has also become a composite model of stacked beams and lightweight frames. The emergence of this structural form has led to fundamental differences in the nature of Chinese and Japanese architecture, with steeper and huge roofs. The "hut group" is more like a truss structure that can support higher and farther roofs. The appearance of the "hut group" led to the demolition of beams in Japanese buildings. Early architectural styles such as the Nara period were also replaced by "hut group". Like the Golden Hall of Toshodai Temple (Figure 4). After using the “hut group”, although the Japanese roof has been elevated, the discounts have disappeared and the roof shape is huge. The Chinese and Japanese buildings are separated. This form of “hut group” should be the original creation of Japanese, not the early wooden form of China.

5. Analysis of the differences between the development of traditional buildings in China and Japan

5.1. Natural Environment
First of all, Japan is an island country with many volcanoes, earthquakes, and typhoons. Therefore, the natural environment has led Japan to choose to own wooden buildings with readily available materials, easy reconstruction, and good earthquake resistance. Secondly, Japan belongs to the temperate maritime monsoon climate type, with humid and rainy summers and blizzards in winter, which made Japanese roofs very steep. This form deeply affected later Japanese architecture. However, the weather in mainland China is very different from that in Japan, which determines that some of its building structures cannot copy the Chinese style. It should be combined with the natural climate of this island country. So there will be "changya", "orange wood", "make-up rafters", "hut group" and other building structures, which is also a reflection of the unique combination of Japanese architecture and natural style. Of course, part of the reason is that Japan is not good at Chinese wooden structure technology, and has to adopt technical methods in order to overcome various problems. The natural environment is the most important external cause of the differences between China and Japan.

5.2. Cultural Factors
In the early days, due to the introduction of Chinese architectural forms, the architecture of the Asuka and Nara era we are now seeing is similar to Chinese buildings. However, in the long course of architectural evolution, due to the "illness" of Chinese architecture, Japan had to seek a
breakthrough. Therefore, the shape of the original Shinto architecture gradually returned to the mainstream of Japanese architecture, and it affected the wood of Chinese architecture Construction technology and building shape in Japan.

5.3. The Difference Of Modular System
The modular system used in Chinese wooden buildings is "Cai-fen System", which takes the section of Bracket Set - "timber" as the basic unit of modulus (Figure 5). The modular system in Japan is "Kiwarihou", which is based on rafter spacing for architectural plane design, column diameter, total opening value for facade design, column diameter, rafter thickness, rafter clear distance for component design(Figure 6).[2] There is a clear difference from this point. Due to the difference in the basic modulus, differences in architectural dimensions will inevitably result.

6. Summary
Culture can affect many aspects of a country or a nation, and a nation is not copying foreign cultures, but taking its essence and removing its dross. Japan is a country that is good at absorbing the achievements of other countries[3]. At the same time, it also integrates the achievements of other countries into cultural values with its own national characteristics, and further develops and expands them. Therefore, the difference between Chinese and Japanese traditional wooden buildings is an inevitable result. The reasons are mixed by the influence of geography, climate, politics, culture, technology and other factors. Its connotation cannot be judged directly. The relationship between Chinese and Japanese ancient buildings is in one continuous line. As a branch of Chinese architecture, Japanese wooden architecture has formed a different wooden technology and architectural form from China after its own development. Of course, most of the Japanese buildings still retain the rudiments of traditional Chinese wood structure, which can be used as an important reference value for the study of Chinese architectural history and has important textual significance.

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