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Restoration of Ancient Wood Buildings

Restauration von historischen Gebäuden

Restauro di vecchi edifici storici

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1 Introduction

China is a great country with ancient civilization. There are a large number of ancient buildings (heritage buildings) in China. According to the incomplete statistics, the number of important historical relics reaches around 60,000.

As an important part of the historical and cultural heritage of the Chinese nation, these old buildings enjoy great fame of high historical, artistic and scientific value in the world. They are named as the accumulation of oriental architecture.

33 items of the world heritage are in China, of which, 26 items are world culture heritage and 16 items of them are ancient timber buildings.

For example: Imperial Palace, also known as Forbidden City, took the Ming emperor Zhu Di 14 years (Year 1407 ~1420) to build it. It became the Imperial Palace of both Ming and Qing dynasties. 24 emperors once lived in the place. There are more than 9,000 rooms of different styles in the palace; all the rooms are timber structures. The roofs are made of Yellow glazed tiles while the substructures are made of green white stone, on which are the resplendent color paintings. The palace covers an area of 150,000□. The palace is symmetry, the front three palaces (the Hall of Supreme Harmony, the Hall of Complete Harmony, the Hall of Preserving Harmony), locate on the axis of the entire city. These majestic and spectacular halls are the largest and most complete group of existing ancient buildings in China.

The Hall of Supreme Harmony should be mentioned specially, it is the place where the emperors hold the ceremonies. It locates on an eight-meter-high white marble base, with 28 meters high, 63 meters wide from east to west and 35 meters from south to north. There are 92 wooden columns with diameter about 1 meter. It is the largest existing ancient building in our country. As a representative of the Chinese palace architecture, it shows the highest level of the traditional Chinese architectural skills and arts.

There are some other representatives of ancient timber buildings with a history of more than 1,000 years, such as: Nanchan Temple in Shanxi province, built in 782 BC (Jianzhong 3rd year in Tang Dynasty); Foguang Temple in Shanxi province, built in 857 BC (Taizhong 11th year in Tang Dynasty); Zhenguo Temple in Pinyao city, Shanxi province, built in 968 BC (Tianhui 7th year in North Han Dynasty); Ji-Xian Dule Temple in Tianjin city, built in 980 BC (Tonghe 4th year in Liao Dynasty); Hualin Temple in Fuzhou city, Fujian province, built in 964 BC (Qiande 2nd year in North Han Dynasty); Ying-Xian Wooden tower in Shanxi province, built in 1050 BC (Qingning 2nd year in Liao Dynasty). Besides, it is the highest preserved ancient timber building in China (66 meters high).

However, these buildings have been facing various damages for a long time, such as natural destructions and human damages. The damage during the war (e.g. Ying-xian Wooden Tower was hit by artillery), and the damage during the Great Cultural Revolution are very serious. After the Reform and Opening up, religion, tourism and other factors made the trend of ancient architectural restoration rise up, which carried constructive destruction. The so-called constructive destruction is the destruction caused by improper protection and maintenance. Because people are lack of correct understanding of the restoration principles and the standards for design and construction technical. For examples, some famous ancient buildings lost their heritage value for their timber structures were replaced by reinforced concrete structure during maintenance. In the early eighties of last century, the Chinese government and heritage experts had concerned the protection of ancient timber buildings. Meanwhile, relevant technical standards were suggested.

However there are difficulties for the standards as following.

(1) Experienced a long history and affected to varying degrees by all kinds of damages, even some dead damages, a number of ancient timber buildings are on the verge of destruction.

(2) Materials of ancient wooden structures were destroyed by the physical, chemical and biological erosion in natural environment.

(3) As other historical heritages, ancient buildings have high value because they are the accumulation of history and culture, which are impossible to regenerate and re-construct. Their original state should be preserved during the identification and maintenance, that is, to preserve their history readability. Therefore, many modern methods cannot be applied, the technical measures should not only be effective but also be reversible, which means the buildings can be taken back to the original appearance.

(4) The new-built buildings are designed for 50 years or 100years while the requirements for protection of ancient buildings is far more than 50 years or 100 years.

In 1992, 12 heritage departments and building departments of government completed the “Technical code for maintenance and strengthening of ancient timber buildings (GB50165-92)" with 8 years. The code gives the right criteria and methods for the restoration of ancient buildings.

2 Basic principles of maintenance and strengthening of ancient timber buildings

Base on National Heritage Act and International Charter on Heritage Conservation, principles for maintenance and strengthening of national treasures should be effective.

According to National Heritage Act, the protection and restoration of heritage buildings should not change the original state. The original state is referred to the remained situation of individual or group of ancient timber buildings with historical significance. If it is necessary to return the buildings to their initial stage or the stage at some specific historical period, reliable historical evidence and technical feasibility studies is indispensable. The dialectical relationship between the original state and the situation remained should be treated scientifically and convincingly. It not only gives the operability to the requirements, but also solves the problems in controversial on the law from National Heritage Act. These core content can be subdivide into four basic principles, they are preservation of original styles, original structures, original materials and original technologies.

As other historical heritages, the value of ancient buildings lies in the fact that they are the historical heritages, which cannot be regenerated and re-constructed. Once being destroyed, they cannot be restored. Although the duplicate can be done, the value is far less than the original one. Because the original buildings or any historical relics were produced in historical conditions, they reflect the social production, the lifestyle, the scientific and technological level, the skills, artistic style and customs of that time. Their value comes from the accumulation of history. As to the old building, the structural plan, the structural style, the structural material and the kind of structure, all of them are the trace of history. Therefore, if the original state is changed a lot in maintenance, the ancient building will lose its historical feature. So it will no meaning and no longer be a architectural heritage.

3 Principles of earthquake-resistance identification of ancient timber buildings

According to the characteristics of ancient buildings, the earthquake-resistance identification principles should be as follows.

(1) Earthquake-resistance identification of structure should be placed at dominant position. The good preservation of Chinese ancient wooden structures mainly thanks to the structural ductility, which playing an important role of seismic restraint and dissipative. For example, Ying-Xian Wooden Tower, Baoguo Temple in Ningbo, Foguang Temple in Wutai Mountain, etc. They all have a typical earthquake-resistant structure.

(2) Earthquake-resistance identification of ancient buildings should be checked necessarily. earthquake-resistant bearing capacity can not be assessed quantitatively. In order to make up this insufficiency, calculations of sectional dimension and deformation should be done.

(3) Expert proof is necessary. If the seismic fortification intensity is 10 degree, expert proof for earthquake-resistance identification of ancient buildings should be organized.

4 Reinforcement and repair technology

The reinforcement and repair technology is applied to the single component reinforcement and repair, decentering, thorough overhaul, correct displaced member and the whole reinforcement, etc. Reversible and effective modern technology can be used, on the condition that the original condition of cultural relic does not be changed and original value of ancient building does not be harmed. For example, the methods can be applied respectively in the thorough overhaul and reinforcement of timber frame, depending on the damaging degree. The methods mentioned above are as follows.

(1) Decentering and thorough overhaul

Detach the timber frame wholly or partially. Repair the damaged components one by one. Replace awfully damaged components and do integral reinforcement during installation.

(2) Correction of displaced member

Correct displaced member and then restore the massive structure without detaching the timber frame. If there are timber components destroyed badly, replacement or other methods of reinforcement should be used.

(3) Maintenance and reinforcement

Reinforce the massive timber structure without removing the tile roof and detaching the frame. This method is accepted only if the deformation and displacement of timber component are small.

5 Protection technology for ancient timber structure

With the goal of the long-term preservation, complete protection technology should be established. Such as: prevention of corrosion, protection against insects, fire resistance, protection against lightning, etc.

In order to prevent the ancient timber structure from corrosion or vermin, following measures should be applied when maintenance and repair.

(1) Improve ventilation and moisture-proof conditions through structural measures to keep the timber structures dry.

(2) If the timber structure is vulnerable to corrosion or vermin, pharmaceutical treatment should be taken.

In view of the characteristics of ancient timber structure, there are some special requirements for the pharmacon. Such as the pharmacon should be environmentally friendly, be colorless or light-colored, and not be harm to oil paint and decorative painting.

6 Engineering application

The identification and reinforcement of ancient timber buildings can be generalized as followings: identify of the status through scientific technology then take effective method in order to keep a long-term preservation. In another word, it includes three aspects: identification, reinforcement and long-term preservation.

Some examples of identification and reinforcement of ancient timber buildings such as: Beijing Imperial Academy, Confucian temple, Ying-Xian Wooden Temple, East Mausoleum of Qing Dynasty, etc.

7 Conclusion

It is important to apply appropriate methods to the maintenance of ancient buildings. Then nature mutilation and constructive destruction can be prevented efficiently. These ancient buildings should be protected, because they are belong to China and also the whole world. It is our duty to stop the tragedy of the precious relics' destruction.