

Chinese craftsmen of wooden arched bridge

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ABSTRACT: As the unique human residence cultural relics in mountainous regions, Chinese wooden arched bridges are mainly distributed in the mountains area of the border between Fujian and Zhejiang provinces, where the author has investigated and carried out field studies for many years and obtained considerable information about wooden arched bridges. The paper makes a tentative analysis on the studies concerning the bridge craftsmen, such as the whereabouts of the craftsmen and families of craftsmen, the way of inheritance between craftsmen, conventions between craftsmen and bridge-building directors before building bridge, building procedure and technology and customs concerning building bridge formed during the past centuries.

1 FAMILIES OF BUILDING BRIDGE

There are only about 100 wooden arched bridges existing in China at present, which are mainly distributed in Fuzhou, Nanping and Ningde prefectures of Fujian Province and Wenzhou and Lishui prefectures of Zhejiang Province, i.e. the long and narrow mountainous region bordering Fujian and Zhejiang, situated between Oujiang River in Zhejiang Province and Minjiang River in Fujian Province.

“Traditional building technology of Chinese wooden arched bridges” was listed the first batch of intangible cultural heritages that urgently needed to be protected in the UNESCO convention to protect intangible cultural heritages held in Abu Dhabi, the capital of The United Arab Emirates in October 2009. Here the technology mainly refers to the traditional bridge building technology in the border of Fujian and Zhejiang Province, especially in Shouning County and Pingnan County of Fujian Province. It is said that most chief craftsman of the wooden arched bridges in the border between Fujian and Zhejiang Province were built by natives of Fujian Province, but the problem is how to find them. According to the tradition, after the building of the bridges, information concerning the date of building, names of the directors, promoters (“Yuanshou” in Chinese), supporters and craftsmen would be written on the inner beams of the bridge house. Sometimes, however, names of the craftsmen were either missing or illegible due to the long history. Fortunately, after the author’s field studies, 147 craftsmen and 3 families of building bridge have been founded.

1.1 The Zhang Family in Xiukeng Village of Zhouning County

Xiukeng Village is located in Limen Township, Zhouning County, Fujian Province. There are about 300 villagers (about 60 families) in this village, and most of their family names are Zhang. According to the family tree of Zhang, there have been 28 generations ever since their ancestor Zhang Gui’s migration from Henan to Fujian. At first, his descendants lived in Aiyao, Pingnan County, and moved to Xiukeng Village 13 generations later. From 1767 (the 32rd year of Emperor Qianlong’s Reign of Qing Dynasty) when Zhang Xinyou built Xiangong Bridge in Shouning County to 2006 when Zhang Changyun et al built Qingyan Bridge, the 8 generations (from the “Xin” Generation to the “Chang” Generation) of Zhang Family in Xiukeng Village have been building bridges for about 240 years. According to preliminary statistics, they have built 28 wooden arched bridges, with 13 bridges in actual existence. Besides, they have built some wooden arched bridges such as Meichong Bridge, Baixiang Bridge, Qiansheng Bridge, Denglong Bridge, Gongxin Bridge and Zhangkeng Bridge, the arch spans of which are more

than 30 m. Among all the craftsmen, Zhang Maoxiu (of the 3rd generation) (Picture 1) is the outstanding one. From 1852 (the 2nd year of Emperor Xianfeng's Reign of Qing Dynasty) to 1894 (the 20th year of Emperor Guangxu's Reign of Qing Dynasty), he had built 15 bridges all together. Unfortunately however, there are only two bridges, i.e. Luoling Bridge and Houshan Bridges, (Picture 2) left at present. Xiukeng Village is located in a basin surrounded by mountains and usually called "Xiajian" by villagers. Therefore, craftsmen in Xiukeng Village are often called "Master in Xiajian" (Xianjian Shifu).

1.2 The Xu Family and Zheng Family in Xiaodong (Dongshanlou) Village of Shouning County

Xiaodong Village is an administrative village in Kengdi Town, Shouning County, Fujian Province. A craftsman called Xu Zhaoyu in Xiaodong Village built Xiaodong Upper Bridge in 1801 (the 6th year of Emperor Jiaqing's Reign of Qing Dynasty). His technology passed down for 5 generations to his cousin Xu Zechang (called "Master in Xiaodong" by villagers) and then was inherited by Zheng Huifu in Dongshanlou Village (also under the jurisdiction of Xiaodong Village), and Zheng Huifu's passed down the technology to his son Zheng Duojin (usually called "Master in Dongshanlou" by villagers). Therefore, for the past 200 years, the bridge building technology in Xiaodong (Dongshanlou) was passed down by 7 generations. The craftsmen there also built some wooden arched bridges such as Xuezhai Bridge, Jingning White Crane Bridge, Dachikeng Bridge, Tanxi Bridge, Red Army Bridge, Luanfeng Bridge and Yangxitou Bridge, the arch spans of which are more than 30 m. Among these bridges, the arch span of Luanfeng Bridge reaches 37.2 m, which is the largest one of this kind in China. Ever since the foundation of the Republic of China, Zheng Huifu and Zheng Duojin (Picture 3) were the most outstanding craftsmen in Xu and Zheng Family. From 1923 to 1967, Zheng Huifu built 17 wooden arched bridges in Fujian and Zhejiang Provinces, with 7 bridges (Picture 4), including Yangmeizhou Bridge, in actual existence, which are extremely rare in China, two were selected as the state-level key cultural relic preservation sites, and five as the county-level key cultural relic preservation sites. Their building technology of wooden arched bridge was listed in the second batch of state-level intangible cultural heritages by the State Council in June, 2008 and Zheng Duojin was selected as one of the representative inheritor of the third batch of state-level intangible cultural inheritors.

1.3 The Huang Family in Changqiao Village of Pingnan County

Changqiao Village is an administrative village in Changqiao Town, Pingnan County, Fujian Province. During the past century, the technology was passed down for 4 generations. The first craftsman in this village is Huang Jinshu who built Jielong Bridge in Longbei River of Jian'ou County and his most recent inheritor is Huang Minping, son of Huang Chuncai. Also being a craftsman himself, Huang Chuncai is still strong enough to draw the blueprints. Craftsmen of Huang Family have built Jielong Bridge (in Zhangkeng Village, Dongkeng Town, Jingning County, Zhenjiang), Tanghuan Bridge (in Gutian County), Wan'an Bridge (in Nanping County), Shangge Village Bridge, Jinzao Bridge, Shuanglong Bridge and Shijin Bridge. The building technology of wooden arched bridge in Pingnan County was listed in the second batch of provincial level intangible cultural heritages by Fujian Provincial People's Government in August, 2007.

2 TECHNOLOGY OF BUILDING BRIDGE

2.1 Technological Process

In spite of the slight differences in the span, length, width, slope and deck material and the style of corridor house between different Covered Bridges with Wooden Arched Structure, the basic structure of abutment and the bridge building technology are quite similar. The basic technological process is to choose the location, build the abutment, measure the horizontal line, construct Sanjiemiao (i.e., Three Rows of Sticks), erect kingposts, construct Wujiemiao (i.e., Five Rows of Sticks), build scissors bracing (a wooden structure like a pair of scissors), erect Carriage Posts ("grasshopper's legs" in Chinese) and bridge deck, set up bridge house, the ridge

structure and decorations.

2.2 Structural Styles

The main arch structure of wooden arched bridge is a valuable creation. The frame of main arch is simple and clear, which mainly consists of longitudinals (usually called Sanjiemiao and Wujiemiao by carpenters) and transversums (usually called big ox head and small ox head, i.e., big connecting beam and small connecting beam, by carpenters). And each section is composed of several longitudinals in parallel and several transversums erected on the longitudinals. Except that the feet of the arched timber that are rested beside the bayonet of the abutment, the whole structure is connected by the wooden components to form a complete and stable wooden arch structure through penetrating and crossing vertically and longitudinally, propping, inserting and pressing, and supporting with each other. Take the Big Connecting Beam, the diameter of which is the largest one in the whole Covered Bridge with Wooden Arched Structure, as an example, due to its unique structure, it can be further divided into Big Connecting Beam, upper Small Connecting Beam and lower Small Connecting Beam. As the most essential part of the Covered Bridge with Wooden Arched Structure, the Big Connecting Beam can be made of Taiwan White Pine or miscellaneous trees. Sometimes, the fir, especially the old one, can also be used; its length should be determined according to the width of the bridge. The parts outside the Sanjiemiao, however, may not be so regular. At least 4 components are connected with the Big Connecting Beam. The first one is the Horizontal Sticks of “Sanjiemiao” and the Hipped Sticks of “Sanjiemiao”, whose mortises are communicated with each other. At first, the hipped Sanjiemiao should penetrate the mortise by a semi tenon, and then the flat Sanjiemiao should be driven into the mortise with a dovetail tenon, with tops of semi tenon and heads of dovetail tenon propping with each other. Then the first system is completed through the connection of the Big Connecting Beam to the flat Sanjiemiao and hipped Sanjiemiao, thus forming the wooden arch like the shape of Chinese character “Ba” (eight). The second one is the connection of scissors sticks. The kingpost can be inserted to the root of the scissors bracing, while the tail of the scissors bracing is provided with a dovetail joint to be driven into the Big Connecting Beam. The third one is the force bearing point of the Sticks of Horizontal Beam System (Qiaobanmiao). Some Sticks of Horizontal Beam System are not long enough, so tenons are made on their joints to be driven into the Big Connecting Beam. The fourth one is the crossbar in front of the Carriage Posts (“grasshopper’s leg” in Chinese) which supports the Big Connecting Beam with a bayonet. The Big Connecting Beam connects the Upper Hipped Sticks of “Wujiemiao” through the upper Small Connecting Beam and lower Small Connecting Beam. The flat Wujiemiao carries the pressure of the flat Sanjiemiao, which is passed to the abutment by the Big Connecting Beam. Meanwhile, a bed wood may be put on the Big Connecting Beam sometimes, in order to make the stress more balanced. The existing Xianju Bridge was re-built in 1673 (the 12th year of Emperor Kangxi’s Reign of Qing Dynasty), yet it remains stable after some 330 years. It is the concrete evidence to prove the scientific value of the structure of Covered Bridge with Wooden Arched Structure.

2.3 Structural Features

(1) Easy to make.

With a simple structure, the wooden arch has only two kinds of components, sticks (“Miaomu” in Chinese) and Connecting Beams (Ox head in Chinese), which support each other as the simple beams do. Besides, it is also easy to connect and process due to the simple structure and unified specifications of the components. As the components are regular and have only a few types, the newly-cut trees can be made to qualified components after a little processing. It is also convenient to transport.

(2) Short components VS. long span

A long span can be realized by the usage of short timbers. For example, the longest timber of Zhangkeng Bridge is an 11.5m-long hipped Sanjiemiao, and the shortest is a 6.06m-long lower hipped sticks of Wujiemiao, while the span of arch reaches 33.4m. The arch span of Santan Bridge in Taishun, Zhejiang, which was built by Zheng Huifu and has already been damaged, reached 40 m, being the largest of this kind. And the arch span of Luanfeng Bridge reaches 37.2

m, which is the longest in China (Picture 5 and Picture 6).

(3) Prefabrication

The chief craftsman should work out the numbers and dimensions of the wooden components, which can be prefabricated beside the bridge and assembled in site. Some components such as the scissors sticks and Sticks of Horizontal Beam System can be assembled on the wooden arch.

(4) Primary strength

There is certain strength between the sections that have been assembled, which is of great importance to streamline the building and corresponding auxiliary facilities. For example, once the Sanjiemiao is completed, the related work can also be carried out on its wooden arch.

(5) Reassembly

Both the wooden arch and bridge house of the Covered Bridge with Wooden Arched Structure adopt the mortise and tenon structure, which can be removed and reassembled conveniently. For example, during the rebuilding of Zhangkeng Bridge in Shouming County and Jinzao Bridge in Pingnan County, some decayed or damaged sticks and beams, including through tenons, semi tenons and double dovetailed keys, (Picture 7) were removed and changed.

(6) Being economical and fast

The wooden arch can be completed about one month after the completion of abutment, and the bridge deck can be finished in three months. According to the description of the bridge stele and horizontal inscribed board, it generally costs 1,000 to 1,500 silver dollars to build a bridge.

3 CONTRACT FOR BUILDING BRIDGE

Building bridges and paving roads are great charities in the countryside. Sometimes, it cost more than one thousand Liang or even thousands of Liang of silver to build a bridge. As the money was usually raised from the villagers, it was prudent for the directors and promoters (“yuanshou” in Chinese) who were in charge of building the bridge to choose the experienced chief craftsmen. According to the craftsmen, before building bridge, a “contract for building bridge” (also called “Agreement for Building Bridge”) should be made between directors, promoters and the chief craftsman. The Agreement for Building Bridge is extremely rare as only more than 100 wooden arched bridges have been reserved till now in China. And this kind of agreement can be found only in traditional “families of bridge building”. In recent years, some contracts of Covered Bridges with Wooden Arched Structure have been found, which provides precious substantial material for the history of wooden arched bridge building in China.

3.1 Basic contents of Agreement for Building Bridge

Generally, the Agreement for Building Bridge should be written vertically in brush on bamboo paper or rice paper, the contents of which are:

(1) The size and structure of the bridge. The length, height and width of the bridge, the quantity of the posts on the abutment and the building of the benches and shrine should be determined by directors and promoters;

(2) The nature of building. Which and how many longitudinals, bridge decks and wood purlins and architraves would be removed and replaced should also be determined if an old bridge needed to be taken apart and rebuilt;

(3) Technology and equipments, including height, width and thickness of the abutment, ways of building and size of stone;

(4) The supply of materials, such as where to send the longitudinals and how to prepare timbers, bamboo strips and iron nails. Sometimes, even the supply of craftsmen’s black mark-lines were also included;

(5) The responsibility of the craftsmen, including who is responsible to find the masons to build abutment and the plasterers to build the bridge house;

(6) The amount of budget price and its payment;

(7) The expenses of offerings, including the offerings in the first and the 15th day of each month in Chinese lunar calendar and tips for the chief craftsman when constructing the beams;

(8) The liabilities for breach of the contract, including how to impose a fine if one party breaks the contract.

Then the date of the contract, names of all parties, witnesses and ghostwriter should be written as well. Besides, some auspicious words should also be written at the joint of two papers. The last step is to write “good luck for completion” in the top left corner of the agreement.

3.2 *Agreement for Building Houshan Bridge*

Take the agreement for Building Houshan Bridge (Picture 8) in Qingyuan County, Zhejiang Province in 1884 (the 10th year of Emperor Kangxi’s Reign of Qing Dynasty) as an example. The agreement reads as follows:

“This agreement is about the employment of Master Zhang Maoxiu and Zhang Maochun in Xiukeng (Xiajian) Village in Zhouning County to build Houshan Bridge in Zhukou Village, Qingyuan County, Zhejiang Province by director Wu Laoding. Here the word “bridge” includes all the longitudinals, the bridge and batten walls for sun-shading. The budget price is three hundred and twenty (320) silver dollars, including the offerings, board and other expenses. The expenses of the offerings and feasts for the ceremonies including worshipping the river, erecting the posts and the completion of building, the bamboo stripes and iron nails shall be paid by the director himself. The width of the bridge shall be one zhang and six chi (about five meters), and the length shall be eighteen rows, equivalent to the length of seventeen bays. The masters shall make every effort to build the bridge, and the wages will be deducted if any cheat or negligence on labor or materials happens. The expenses of meals can be paid in advance, while the wages and traveling expenses shall be paid after the completion of building the bridge.

In witness thereof, this agreement (signatures on the perforation) is concluded on the auspicious day of February of the 10th year of Emperor Guangxu’s Reign of Qing Dynasty in Chinese lunar calendar by all parties: (1)directors: Wu Laoding, Xu Yinghuai, Xu Panyan, Tian Hualao (all with signatures);(2) ghostwriter: Wu Laoding (signature).

3.3 *A Brief introduction to Houshan Bridge*

Houshan Bridge, also called Houkeng Bridge, is located in Fengtang Village, Zhukou Town, Qingyuan County, Zhejiang Province. It was built in 1671 (the 10th year of Emperor Kangxi’s Reign of Qing Dynasty) and rebuilt in 1825 (the 5th year of Emperor Daoguang’s Reign of Qing Dynasty) and 1885 (the 11th year of Emperor Guangxu’s Reign of Qing Dynasty). It is an east-west bridge, and there are 4 posts and 9 purlins in the bridge house with a post and lintel structure. Covered with a gable roof, the bridge is 35.78 m long and 4.73 m wide, with the arch span of 26.16m, has 14 bay and 60 posts. There are also large amount of writings in the beams, such as “craftsmen Zhang Maoxiu and Zhang Maochun...”, which is an evidence of the agreement mentioned above. The maintenance of this bridge by local government and villagers a few years ago was awarded “the excellent preservation of cultural relics” in Asian-Pacific Region by UNESCO in 2005, and the awarding ceremony was held on this bridge in May, 2007.

4 CUSTOMS OF BUILDING BRIDGE

There has been thousands of years’ history for building bridge and 900 years’ history for the building of wooden arched bridge in China. And a certain customs for building bridge has formed during the past few centuries. An agreement for building bridge made by and between Zhang Chaogao (the promoter) and the craftsmen in Pingnan County goes that: “Zhang Chaogao shall be responsible for the offerings in the ceremonies of worshipping the river, erecting the posts and beams and the completion of building...” besides, there is also another custom called “Yuefu” (the offerings to be provided every month), which can be found in the description of the Agreement for building Tangshou Bridge in Gutian County in 1837 (the 17th year of Emperor Daoguang’s Reign of Qing Dynasty): “ There is another 3 times of Yuefu, and ten thousand cashes shall be paid to Zhang Chengju (the craftsman) to prepare them.” Generally speaking, the ceremonies in building bridge include: choosing the auspicious day, getting the auspicious beam, worshipping the river, constructing the beam, rewarding the craftsmen, the first walking in the bridge, and offerings for constructing the auspicious beam and for the completion of the building.

4.1 Choosing the auspicious day

After the choice and employment of the craftsmen, the director and promoter would ask a Fengshui Master to determine the direction of the abutment and choose the auspicious day. Then the date shall be sent to the craftsmen to evaluate. In 1865 (the 4th year of Emperor Tongzhi's Reign of Qing Dynasty), Zhang Maoxiu and Zhang Maochao were employed by Zhushenhou Village in Longquan, Zhejiang Province to build Shuangguang Bridge, and the auspicious date time is the noon in June 24th in Chinese lunar calendar.

4.2 Preparing the auspicious beam

The auspicious beam refers to the beam at the top of the middle ridge of the bridge. It is made of lush fir with three or two of them sharing the same root, which is called "twin timbers" by villagers. Usually an "auspicious man" (referring to a person whose parents are still alive and whose family has three generations living under the same roof) was selected to cut the beam in the auspicious day, bringing scent candles, tea and wine with him to worship the mountain. While cutting, in order to be auspicious, the tree should fall down to the upper direction of the mountain slowly instead of the lower direction of the mountain. Branches should be paved in advance in the place to put the auspicious beam, to prevent the beam from being "stained". After worshipping the mountain, the woodcutter should say something auspicious, keep the crotches in the tail of the fir and hang them in the middle of the beam (which means complete and prosperous). Then the auspicious beam should be covered with red cloth and carried to the site by 4 people (meaning east, south, west and north), with firecracker being set off along the road. Finally, the beam should be placed beside the site by a three-legged wood support. The bark of the beam should be peeled when it was carried back and should not be disposed at will.

4.3 Worshipping the river

The building of the bridge often started in the low water period after the Autumn Equinox. Before building the bridge, villagers would worship the river at first. They would prepare sacrifices including scent candles, tea, wine, fruit, vegetable dishes and three livestock (whole pig, whole sheep and whole cock). Before the ceremony, a pig and a sheep should be carried to the riverside, killed and put into the river. It was said that the severe they struggle in water and the more they bled in the river, the luckier it would be since the river water will be redder. The dehaired pig and sheep can be used as offerings. With a Taoist priest on the spot, there were three steps of the ceremony, i.e. inviting the River God, reading the prose and seeing off the River God. When the building completed, a ceremony to thank River God, which can be further divided into a simple one and a complicated one, should also be held.

4.4 Constructing the beam and cheering

A ceremony to worship the beam should be held while placing a beam in the middle of the flat sticks in Sanjiemiao after Sanjiemiao was constructed. A program named Finding the Covered Bridge with Wooden Arched Structure was made by CCTV in November, 2001, and the famous craftsman Zheng Duojin was invited to build a wooden arched bridge. Before the ceremony of constructing the beam, Master Zheng went to the stream side and worshiped the Land God (usually called "the king" by villagers). He set an altar there, and put some scent candles, tea, wine, fruit, vegetable dishes and tools for bridge building such as ink marker, axe and chisel on the altar as offerings. These are the preparation work of the ceremony. Generally, the worship of the beam was directed by the chief craftsman. When the candles were lighted and tea and wine offered, the chief craftsman would cheer while setting off firecrackers. Then other craftsmen would move a portal crane (a tool for building bridge to transfer timbers in the past) and strain its rope to lift the beam slowly. And all the people present would cheer together.

4.5 Fetching the copper cash and rewarding the craftsmen

There was also an episode to test the craftsmen's skill. A little red bag of copper cashes were

hung in the middle of the beam in advance, and after constructing the beam, the chief craftsman would choose a smart and brave craftsman to fetch the coppers. The whole procedure was as follows: the craftsman would get to one end of the beam of Sanjiemiao with a hammer in his hand, and then he would say some auspicious words and went forward to fetch the coppers in the middle of the beam with other people applauding and cheering. Then he went to the other end of the beam, said some auspicious words again and gave the coppers back to the chief craftsman, who would give the coppers to other craftsmen and people who assisted to build the bridge.

4.6 The first walking in the bridge

The time of the first walking in the bridge depended on the number of people who would walk in the bridge. It could either be on the date when all the decks were paved if there were not so many walkers, or be one the date when only 5 or 6 decks were paved if there were many walkers. The directors and promoters would choose two rich and prestigious male elders whose wives were still alive and whose family had 3 generations living under the same roof (usually called “auspicious men” by villagers) to be the first men to walk in the bridge. The auspicious men would start walking after inscribing something on the bridge, and they could say some auspicious words at random while walking.

4.7 The ceremony of constructing the auspicious beam

The building of the bridge can be regarded as completed either by the completion of the arch and the pavement of the deck or by the completion of the whole bridge. Apart from the ceremony of constructing the beam and cheering, there was also a ceremony of constructing the auspicious beam. As the decks had already been completed, the ceremony usually was held on the bridge, the procedure of which was simpler than the ceremony of constructing the beam of Sanjiemiao and cheering.

4.8 The ceremony of the completion of the bridge

When the bridge building completed, the directors and promoters would prepare a feast to express appreciation to all the craftsmen and congratulate each other. This was called the feast for the completion of the bridge. Before the feast, the directors and promoters would settle accounts with craftsmen about the wages, bonus and other expenses, and the craftsmen would stress some cautions concerning the maintenance of the bridge. During the feast, people would say “congratulations” to each other.

5 CONCLUSION:

“Traditional building technology of Chinese wooden arched bridges” has been listed the first batch of intangible cultural heritages that urgently needed to be protected, showing that there are a lot of difficulties in its inheritance. The author hope that through the introduction of the families to build bridges, the contract for building bridge, traditional building technology and customs, the existing Covered Bridges with Wooden Arched Structure in China may arose the awareness of the specialists and scholars, the government and the whole society and be taken care of properly.

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