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## Research on Characteristics of Timber Framing Techniques of Representative Constructions by Xiangshan Bang in Nanjing

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# Research on Characteristics of Timber Framing Techniques of Representative Constructions by Xiangshan Bang in Nanjing

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**Abstract.** Xiangshan Bang, originating from Suzhou, is one of the most influential groups of craftsmen in Jiangnan region and plays an important role in Nanjing traditional architecture. Through literature research, field investigation and interviews with craftsmen, this paper makes a comparative study on the composition and scale of the timber frame, the shape and interlocking of beams, and the characteristics of Xuan (veranda with windows), in order to analyze the characteristics of Xiangshan Bang timber framing techniques in Nanjing. This study will supplement the research on the traditional architecture in Nanjing and lay the groundwork for further research on the division and pedigree of timber frame design in Jiangnan region.

## 1. Introduction

“Xiangshan Bang”, originating from Suzhou, is active in Jiangnan and remains one of the most well-known schools of traditional architecture in China. Despite plenty of research achievements on this group of craftsmen, research on their construction activities and representative constructions focuses on Suzhou, short of in-depth studies and analyses in other areas<sup>1</sup>. To supplement the existing research, this paper explored the characteristics of woodwork techniques of Xiangshan Bang in Jiangnan region with Nanjing as the study case.

Renowned as “the capital of six dynasties”, Nanjing has long been a leading city in China in virtue of its political significance, economic impact and cultural development. Both situated in Jiangnan, Nanjing and Suzhou share the same cultural origin. In history, lots of craftsmen of Xiangshan Bang were summoned to construct the ancient capital in Nanjing, who left valuable architectural heritages to later generations and promoted transmission, exchange and integration of traditional architectural techniques. Based on analysis of well-preserved buildings that were built or restored by Xiangshan craftsmen and through such methodologies as literature review, field research and interviews, this paper studied the timber framing techniques of some representative buildings constructed by Xiangshan Bang craftsmen in Nanjing and aimed to lay a foundation for division and pedigree of timber frame design systems in Jiangnan.

## 2. Representative Constructions by Xiangshan Bang in Nanjing

The bond between Xiangshan Bang and Nanjing, tied back in Ming Dynasty, remains tight today. Prestigious Xiangshan Bang craftsmen like Zhang Ning and Kuai Fu made great contributions during



construction of Nanjing City in Ming Dynasty and witnessed the glories of ancient buildings in Nanjing<sup>2</sup>. Yet, centuries' battles and wars have left most of these architectural heritages in tatters and those that have been well-preserved are mainly buildings constructed or restored by Xiangshan craftsmen in Nanjing in Modern times.

As one of most time-honored architectural schools in China, Xiangshan Bang, mainly organized in the form of ancient architecture and landscape corporations in modern times, have played an active role in restoration of many ancient buildings in Nanjing, passed on their traditional construction techniques and promoted integration of their techniques with traditional architectural techniques of Nanjing.

In 1958, Mr. Liu Dunzhen with his team began to revamp Zhan Garden, and the project was undertaken by the classical garden restoration team of Suzhou Garden Management Administration with a Xiangshan Bang master Lu Wen'an. Later in 1986 and 2007, Mr. Ye Jvhua again started two sessions of restoration and extension projects which were undertaken by Wu County Ancient Architecture Corporation and Suzhou Xiangshan Ancient Architecture and Garden Engineering Company respectively, craftsmen involved in which were Zhong Xiongchun, Yang Genxing, Tang Jinsheng and others. Only the Jingmiao Hall (Hall of Tranquility and Ingenuity) of the original Zhan Garden was kept, and some new buildings were added including the Exit Hall, the Flower Basket Hall, the Turquoise-ringed Shed, the Mountain-Hidden Thatched Cottage, the Greeting Pavilion and some others.

Between 1979 and 1980, another Xiangshan Bang master Gu Jianming was engaged in the overhaul project of Xu Garden. In the Presidential Palace of Nanjing next to Xu Garden, colored paintings in the palace of Taiping Heavenly Kingdom were restored by Gu Dejun, also a Xiangshan Bang craftsman.

Between 1983 and 2016, in the restoration project of buildings of the Confucius Temple, architectural designers Pan Guxi, Zhong Xunzheng and Ye Jvhua rebuilt major buildings including Dacheng Hall (Hall of Achievement), Jvxing Pavilion (Star-Gathering Pavilion) and Kuiguang Loft. The project was undertaken by Suzhou Kuaixiang Ancient Architecture Company (named "Wu County Ancient Architecture Corporation" in 1983), with joint efforts by craftsmen including Yang Genxing, Jiang Shuiyi, Shen Chunfa, Tan Caibao, Yang Liannan, Li Jinming, Tang Qinhua, Deng Jvsheng, Wu Liangen and Wu Xiaofei. It's worth mentioning that Suzhou Kuaixiang Ancient Architecture Company led by Yang Genxing has undertaken many ancient building restoration projects in Nanjing, among which were the restoration project of Chaotian Palace, the maintenance project of Historic Street of Nanbuting in Nanjing and restoration of towers in Jiming Temple.

In 2011, a Xiangshan Bang master Guo Hanquan, in cooperation with architects from Suzhou Landscape Architecture Corporation, fulfilled the restoration of colored paintings in the Hall of Glory (Rongguang Dadian), Youzhengyue Palace and the Grand Council Office in Presidential Palace in Nanjing<sup>3</sup>.

The construction projects Xiangshan Bang has worked on in Nanjing in modern times have contributed much to protection and restoration of traditional buildings in this area (Table 1).

Table 1. Representative Constructions by Xiangshan Bang in Nanjing.

Time	Construction Case	Type	Contractor	Xiangshan Craftsmen
1958-2009	Zhan Garden	Restoration & Extension	Classical Garden Restoration Team of Suzhou Landscape Management Administration, Wu County Ancient Architecture Corporation, Suzhou Xiangshan Ancient Architecture and Landscape Engineering Company	Lu Wen'an, Zhong Xiongchun, Yang Genxing, Jiang Shuiyi, Shen Chunfa, Yang Liannan, Tan Caibao, Tang Jinsheng, etc.
1979-1980	Xu Garden	Restoration	Suzhou Yiyuan Ancient Architecture Company	Gu Jianming and etc.
1983-2016	Buildings of Confucius Temple	Restoration	Wu County Ancient Architecture Corporation, Suzhou Kuaixiang Ancient Architecture Company	Yang Genxing, Jiang Shuiyi, Shen Chunfa, Tan Caibao, Yang Liannan, Li Jinming, Tang Qinhua, Deng Jusheng, Wu Liangen, Wu Xiaofei, etc.
1985-1987	Chaotian Palace	Restoration & Extension	Wu County Ancient Architecture Corporation	Yang Genxing, Jiang Shuiyi, Tan Caibao, Yang Liannan, etc.
1987-2006	Tower of Jiming Temple & Annexes	Restoration & Extension	Wu County Ancient Architecture Corporation, Suzhou Kuaixiang Ancient Architecture Company	Yang Genxing, Pan Borong, Wu Bingrong, Deng Jusheng, Li Jinming, etc.
2003-2005	Historic Street of Nanbu Ting	Restoration	Suzhou Kuaixiang Ancient Architecture Company	Yang Genxing, Yang Liannan, Deng Jusheng, etc.
2011	Halls of Taiping Heavenly Kingdom in Presidential Palace	Restoration of Colored Paintings	Suzhou Landscape Architecture Corporation	Guo Hanquan and etc.

(information in the table above is from historic documents and interviews with craftsmen and architects, as listed hereafter: ① Feng X D 2012 *Cheng Xianglu – Xiangshan Bang Traditional Architectural Craftsmanship* (Beijing: China Architecture & Building Press); ② Ye J H 1980 Zhan Garden in Nanjing *Journal of Nanjing Engineering University*(4) p 1-22; ③ Gao C 2008 *Case Study on Traditional Architectural and Building – Analysis of Restoration Techniques of Nanbuting* (Nanjing: Southeast University); ④ Interviews with Cheng Maocheng, Yang Genxing, Gu Jianming and other craftsmen.)

### 3. Characteristics of Timber Framing Techniques of Xiangshan Bang in Nanjing

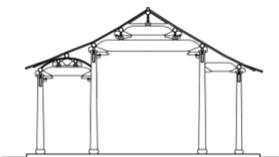
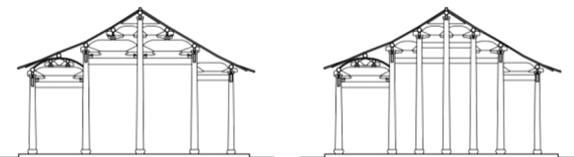
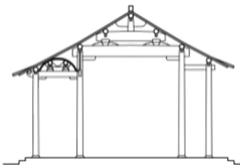
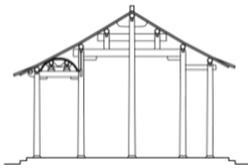
In general, the timber framing techniques applied to representative buildings constructed by Xiangshan Bang in Nanjing are developed on the basis of the original Xiangshan Bang techniques which have undergone subtle changes due to influence of the unique natural and social contexts of Nanjing and engendered new characteristics in combination with traditional architectural features in Nanjing.

#### 3.1 Composition and Scale of Timber Framing

There are three types of traditional timber framing in China – post-and-lintel construction, column-and-tie construction and log cabin construction. In the history of architectural development, the types of timber framing of specific areas remain generally unchanged. Representative constructions by Xiangshan Bang, both in Suzhou where it maintains a strong presence and in Nanjing, all have combined zhengtie post-and-lintel construction (zhengtie: timber frame for the central bay, not relying on the garble and dispensing with pillars) with biantie column-and-tie construction (biantie: timber frame for side bays, relying on the garble and with pillars).

As for composition of timber framing, the representative buildings by Xiangshan Bang in Nanjing are similar to those in Suzhou, but there are still differences. Firstly, the major biantie piece of the timber frames of buildings in Nanjing (usually the inner central part) are structured with the main pillar connected to the ground but the hypostyle columns not connected to the ground; in contrast, those in Suzhou show more diversified structures: for some, the main pillar and the hypostyle columns are above the ground, but for some others, they are connected to the ground. Secondly, biantie of timber frames of buildings in Nanjing dispense with the additional tie under beams, but biantie of timber frames of buildings in Suzhou usually use additional tie under beams. The table below (Table 2) shows this comparison with the common timber frame of “veranda- inner central part -corridor” as the example.

Table 2. Comparison of Timber Frame in Buildings by Xiangshan Bang in Nanjing and Suzhou.

Region	Zhengtie of Timber Frame Construction	Biantie of Timber Frame Construction
Suzhou		 Hall of Former Residence of Wuyun      Hall of Former Residence of Pan Shi'en
Nanjing		 Yougong Hall of Former Residence of Ganxi

Due to the social hierarchy, constructions by Xiangshan Bang in Nanjing are mainly of the three-bay structure, and few are of the five-bay structure. The scale of extension is usually 4-10 jie (jie refers to the horizontally projected distance between two purlins) and that of the largest hall (Hall of Achievement in Chaotian Palace) reaches 14 jie. The ratio of the central bay size to that of side bays is 1:0.8, (between 1:0.75 and 1:0.85), which is consistent with what is recorded in *Yingzao Fayuan*. That is to say, the scale of constructions by Xiangshan Bang in Nanjing is similar to those that they have built in Suzhou.

### 3.2 Shape and Interlocking of beams

In representative constructions by Xiangshan Bang in Nanjing, the structures of beam frame mainly include three types: flat beams, round beams and Gong-style beams, with different connecting methods among beams.

#### 3.2.1 Flat Beam

##### 1) Shape

There are mainly two types of flat beams (Fig. 1): flat crescent beam and flat straight beam. The former is typical of Xiangshan Bang: with both ends of the beam top curved (juansha), both ends pruned (bahai) and the bottom hollowed-out. Higher beams are spliced by offcuts and the beams are decorated with delicate carvings. Yet, flat straight beams in buildings by Xiangshan Bang in Nanjing differ considerably from those in Suzhou, bearing features unique to Nanjing. The flat straight beam resembles a shuttle, with a larger midsection but smaller sections on both ends. The beam has no

obvious trace of being curved (juansha) or being pruned (bahai), generally unadorned and giving a sense of simplicity.



Flat Crescent Beam  
(Laishuang Fengqing Hall in Zhan Garden)

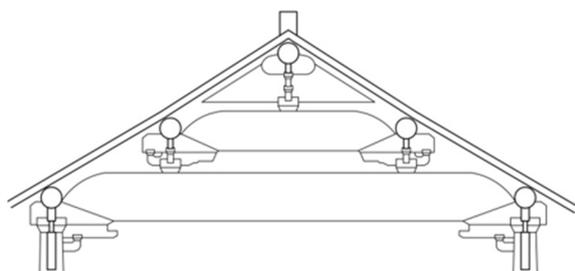


Flat Straight Beam  
(Hall of Tranquility and Ingenuity in Zhan Garden)

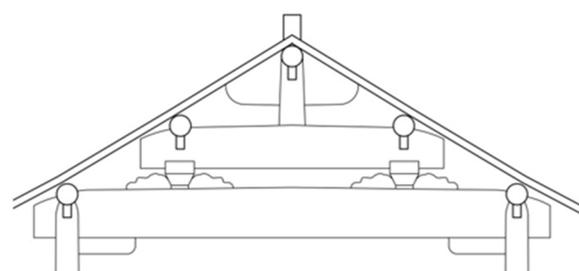
Fig.1. Comparison between Flat Beams

## 2) Interlocking of beams

For flat crescent beams, two dougongs (interlocking wooden bracket) are placed on main beam to connect with the two-jie beam (beam arranged with a distance of two jie) on which another dougou is interlocked to bear the purlin, supplemented with bigger tilted engraved planks called Shanwu Yun and smaller tilted engraved planks called Baoliang Yun. For flat straight beams, broad zuo dou (the bottom piece of dougong) and humped pieces instead of dougongs are positioned between the main beam and the two-jie beam, which seems more steady and splendid. The two-jie beam, with short column interlocked into the back, bears the weight of the purlin, supplemented with single-piece engraved plank which is parallel to the direction of the beam. The beam frame emits simplicity, with few carvings and devoid of decorative pieces (Fig.2).



Interlocking of flat crescent beam



Interlocking of flat straight beam

Fig.2. Interlocking of flat beams

Aside from the above two types of shape and according interlocking form, there is another type with features both of Nanjing and Suzhou: in a hall in Former Residence of Ganxi<sup>4</sup>, the major beams are flat crescent beams, with both ends curved (juansha) but the bottom not pruned (bahai). As for its interlocking form, zuo dou and humped pieces are used to interlock the main beam with the two-jie beam and the two-jie beam with the purlin, supplemented with single-piece engraved plank which is parallel to the beam (Fig.3).

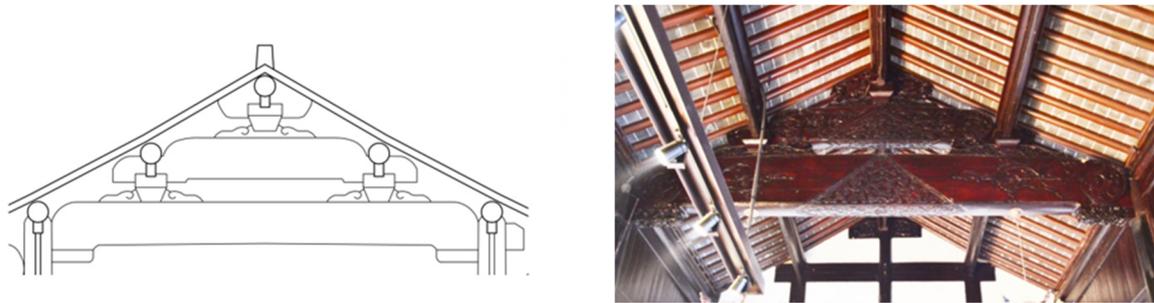


Fig.3. Profile view and image of beam frame of Zhongting Hall in Former Residence of Ganxi.

### 3.2.2 Round Beam

As for the interlocking form of round beams, there is not much difference between buildings by Xiangshan Bang in Nanjing and those in Suzhou.

### 3.2.3 Gong-style Beam

As described in *Yingzao Fayuan*, Gong-style beams are “square beams with its bottom hollowed, resembling the curved round beams”. Beams in Turquoise-ringed Shed of Zhan Garden match this description, but with subtle differences. Gong-style beams in Turquoise-ringed Shed are simple, without ornate architraves on the surface; the beam and the column interlocks directly without complicated structures, which simplifies the shape of Gong-style beams (Fig.4).

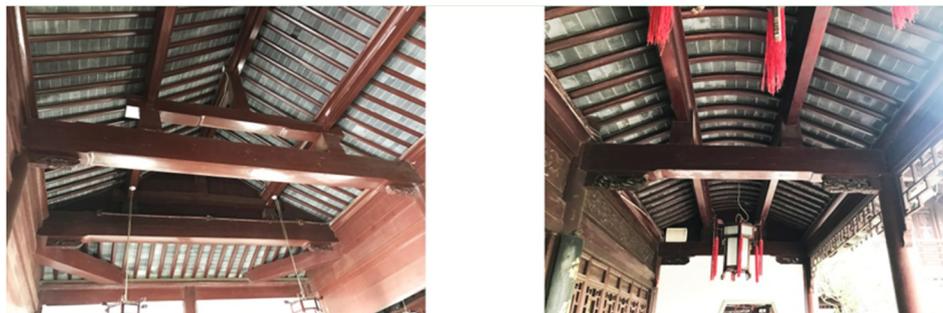


Fig.4. Gong-style beams in Turquoise-Ringed Shed of Zhan Garden, Nanjing.

Besides the above three types of beams, there is another kind of special beam above the corridor in Former Residence of Ganxi – “Ruyi-shaped” crescent beam (Fig.5). The Former Residence of Ganxi was built in Qing Dynasty, and its owner, Ganxi, was a well-known scholar in Nanjing, who was born in Shexian County of Huizhou. The residence was restored by craftsmen of Xiangshan Bang. Due to the owner’s life experience and the local context, this restored building reflects the timber framing techniques of Xiangshan Bang, those of Nanjing craftsmen and those of Huizhou craftsmen. Though these Ruyi-shaped beams are in Nanjing, they in fact find their origin in Huizhou architecture.

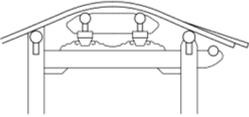
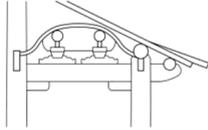
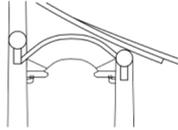
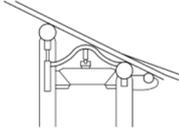


Fig.5. Comparison between Ruyi-shaped crescent beam in Former Residence of Ganxi and crescent beam in Xidi Dunren Hall in Huizhou

### 3.3 Features of Xuan

In most constructions built or restored by Xiangshan Bang in Nanjing, the Xuan displays the following features: first of all, most buildings just have one Xuan, and few combine corridor Xuan with interior Xuan. Secondly, most are “taitou Xuan” (where the veranda beam is on the same level with the main beam) and few are “kowitz Xuan” (where the veranda beam is lower than the main beam). Thirdly, the types of Xuan are limited and the structure is generally simple. The most common ones are awning Xuan, crane-neck Xuan, bow-shaped Xuan and line-incense Xuan. Fourthly, components in Xuan bear obvious features of Nanjing. For instance, hump pieces and zuo dou pieces are interlocked above the Xuan beam to carry the weight of pouch beams which feature mild curves and straight-lined bottom (Table 3).

Table 3. Types of Xuan in representative buildings by Xiangshang Bang in Nanjing.

Awning Xuan	Crane-neck Xuan	Bow-shaped Xuan	Line-incense Xuan
			
Hall of Tranquility and Ingenuity in Zhan Garden	17.3 Unit of Former Residence of Ganxi	Flower Basket Hall in Zhan Garden	Laishuang Fengqing Hall in Zhan Garden

In summary, compared with constructions built or restored by Xiangshan Bang in Suzhou, those in Nanjing show deeper influenced by the local natural and social contexts. The timber framing techniques of Xiangshan Bang blend with those of Nanjing during transmission and give rise to some new features: firstly, though the composition and scale of timber framing are consistent, biantie in buildings in Nanjing is usually with the central column connected to the ground and the hypostyle column above the ground, and there are normally no additional ties under the biantie beams. Secondly, as for types of beams, both flat crescent beams and flat straight beams are used, with flexible and diversified interlocking methods. Thirdly, Xuan is widely used, but the types are limited and combination of different Xuan is rare.

### 4. Notes

1. Existing studies on Xiangshan Bang include the following: 1) Studies on construction by Xiangshan Bang, such as Cui J Y 2004 *Architecture by Xiangshan Bang in Suzhou*(Beijing: China Architecture & Building Press); 2) studies on chorographic documents about Xiangshan Bang, such as Art and

History Materials Management Committee of CPPCC of Wu County 1993 *Kuaixiang and Architecture by Xiangshan Bang* (Tianjin: Tianjin Technology Press); 3) theoretical books on Xiangshan Bang, such as Yao C Z 1986 *Yingzao Fayuan* (edited by Zhang Z G, collated by Liu D Z and punctuated by Yang Y S)(Beijing: China Architecture & Building Press); 4) Studies on woodwork construction techniques of Xiangshan Bang, such as Cai J 2016 On Xiangshan School's Architectural Characteristics in Suzhou-Based on Wood Construction Technology in Yingzao Fayuan. *Journal of Tongji University (Social Science Edition)* 27(6) p 72-78; 5) Comprehensive studies on Xiangshan Bang, such as Shen L 2011 *Systematic Research on Craftsmen of Xiangshan Bang* (Shanghai: Tongji University Press); 6) Comparative research on construction techniques of Xiangshan bang and construction techniques of traditional buildings in other regions, such as Ma Q B. *Comparative Research on Timber Framing Techniques in Jiangnan* (Beijing: Chinese National Academy of Arts)

2. As recorded by Zhang Ning, "Zhang Ning excels in construction. At the end of Yuan Dynasty, Zhang traveled to Jinling and later made acquaintance with Li Shanchang, Minister of Construction under the reign of Zhu Yuanzhang. When the Ming Dynasty was established, Li, as one of the dynasty's founding fathers, was appointed to supervise construction of the capital and recommended Zhang to Emperor Taizu (Zhu Yuanzhang). Later, the emperor called in Zhang and appointed him to serve in capital construction without official titles. Zhang's expertise in the construction project impressed and satisfied the emperor. One day, the emperor went to inspect the construction project, and found that some craftsmen abandoned and destroyed the defective tiles and stones. Enraged, the emperor was to execute the craftsmen. At the sight of this, Zhang kowtowed and implored: "I thought such defective pieces would degrade this glamorous capital city and hence asked the craftsmen not to use them. So, your majesty, it is me not the craftsmen who is to blame." Li also appealed for the emperor's mercy, and later the emperor, in recognition of Zhang's reason and wisdom, decided not to mete out penalty." (Quoted from Yu X C 2006 *Biographies of Famous Craftsmen in Ancient China* (Wuhan: Hubei Education Press) p 243.

3. Projects that have engaged Xiangshan Bang Classical Architecture and Landscape Corporation and representative craftsmen after the establishment of PRC are mainly from existing documents and interviews with craftsmen. Documents include: 1) Feng X D 2012 *Cheng Xianglu – Xiangshan Bang Traditional Architectural Craftsmanship* (Beijing: China Architecture & Building Press); 2) Ye J H 1980 Zhan Garden in Nanjing. *Journal of Nanjing Engineering University*(4)p 1-22; 3) Gao C 2008 *Case Study on Traditional Architectural and Building – Analysis of Restoration Techniques of Nanbuting* (Nanjing: Southeast University). And interviews with master craftsmen including Cheng Maocheng, Yang Genxing and Gu Jianming.

4. Address of the hall is 17.3 Hall of Nanbuting in Nanjing, now the Shibafang Exhibition Zone of Jinling.

### Acknowledgments

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