Vaulting churches in China: True gothic or imitation?

Th. Coomans

*Department of Architectural Engineering, KU Leuven, Belgium
Raymond Lemaire International Centre for Conservation, Belgium*

ABSTRACT: Nineteenth-century Christian missionaries promoted Gothic architecture worldwide, including in China, a country with a totally different building tradition. The present essay gives an overview of the various Gothic looking vaulting systems that the missionaries experienced in China and contextualizes China's Gothic churches in the complex architectural debate on construction techniques, building materials, style, economy, and Christian identities. Because building traditional stone and brick Gothic vaults in China was hardly possible, other vaulting techniques were experienced. Besides open timber roofs and wooden vaults, a particularly successful technique was the imitation of Gothic rib vaults with planks, lath and lime. This technique is analyzed in detail. Moreover, imitating Gothic vaults with lattice and lime, included a moral dimension that is examined in the context of the nineteenth-century architectural debate on truth and imitation.

1 INTRODUCTION

Many nineteenth-century Christians considered the Gothic style as the universal style for church buildings. Therefore Catholic, Anglican and other Christian missionaries exported Gothic worldwide. The main characteristics of Gothic and Gothic Revival architecture are modular and repetitive structures, rib vaults, elaborate buttressing systems, pointed arches, and large traceried windows (Nussbaum & Lepsky 1999). From the 1860s to the 1920s hundreds of churches were built in China, a great number of which in the Gothic style (Coomans 2014b, 2015). Did missionaries succeed to construct Gothic rib vaults in China, a country that ignored the technique of rib vaulting as well as the principles of load transfers through buttressing systems, mural arches and stepped foundations?

This essay examines how missionaries circumvent the issue of stone and brick rib vaults by building wooden imitations of brick vaults. This was only possible with the help of Chinese carpenters who had to be instructed in Gothic forms and Western timber roof trusses, but integrated elements from the Chinese timber building tradition as well. What kind of innovative structures did this technologic encounter generated in China?

Based on fieldwork in China and archival research in the West, this essay reveals that besides the technological aspects of the vaulting issue, there were economic and aesthetic considerations as well. Moreover, imitating Gothic stone vaults with planks, lattice and lime had a moral dimension that will be examined in the context of the debate on truth and imitation in nineteenth-century architecture.

2 STONE AND BRICK GOTHIC VAULTS

The Anglican St John's cathedral in Hong Kong was the first important gothic church to be built in China in the years 1844–50. It has no vaults but an open timber roof or beam roof referring to English Gothic models.

In 1863–88 French missionaries built the cathedral of Canton in the style of a French thirteenth-century cathedral (Wiest 2004). A French architect came to Canton to supervise the works but was confronted with huge technical and human problems. On the one hand, granite stone had to be shipped from Hong Kong and stone carvers attracted from the Yunnan province because there was no stone architectural tradition in Canton. Both stone carvers and masons never had constructed Gothic arches, traceried windows, arch stones, flying buttresses, vaults and all other fabric with inner tensions. On the other hand, the Cantonese population was terrified by the construction of a stone cathedral with two high spires that would bring bad luck and change the *fengshui* of the city. Because of this 'cultural clash' the works lasted a quarter of a century and were very expensive. Workers and craftsmen had to be taught from scratch about Gothic forms and structure as well as other Western building techniques. The arches and ribs are of granite, while the vaults' panels are made of red bricks (Fig.1). These perfect rib vaults are the earliest true Gothic ones in China.

Even in the treaty ports, the Christian missions to China had no money for building such expensive vaults that required buttressed walls, deep foundations, and run the risk to be badly built by unskilled workers. Therefore, Canton cathedral is unique.

Figure 1. Canton (Guangdong province), Sacred Heart cathedral, Gothic rib vaults of the nave, 1863–88 (© THOC 2012).

Figure 2. Yangzhou (Jiangsu province), Sacred Heart church, Gothic hammerbeam roof, 1864–73 (© THOC 2014).

3 WOODEN GOTHIC VAULTS

A Chinese roof was the easiest and most economical way of roofing a church because it was built according to the local building tradition and did not require load-bearing walls. Such roofs, however, were impossible to combine with well-proportioned Gothic forms. Therefore, many missionaries preferred to opt for well-founded load-bearing walls, Western trusses resting on the walls, and open timber roofs that looked like early-Christian basilicas. Gothic capitals and profiles could be added as pure decoration. Several late nineteenth-century churches are covered with trefoiled hammerbeam roofs that refer to English Medieval carpentry. The church of Yangzhou, with its red painted wooden structure, ornamented hanging lotus pendants, and iron tie-rods, looks Chinese, but in fact is only a little (Fig. 2).

In the context of nineteenth-century national identities related with religious identities, Anglican missionaries preferred referring to English Gothic carpentry, while Catholics, as we will see, preferred rib vaults. In 1865, the famous architect George Gilbert Scott designed the plans of the Anglican Holy Trinity Cathedral of Shanghai. This prestigious building associates stone and bricks of different colors, and is covered with an open timber roof. The sanctuary, the most sacred part of the church, is covered with a Decorated Gothic style wooden stellar vault and ends with a polygonal apse (Fig. 3). It is not known who realized this refined vault, but it certainly was easier to find a Western

Figure 3. Shanghai, Holy Trinity Cathedral, wooden vault of the sanctuary and the apse, 1866–69 (© THOC 2011).

Figure 4. Xuanhua (Hebei province), church of the Holy Cross, wooden vault of the crossing, 1903–06 (© THOC 2011).

carpenter in Shanghai than everywhere else in China at that time.

Because of the cold winters and the hot summers, open timber roofs were not ideal in Northern China. The climate, indeed, required some insulation, ideally a ceiling under the roof. The Belgian Father Alphonse De Moerloose was the most brilliant missionary-architect in Northern China during the two first decades of the twentieth century. He had been educated at the St Luke School in Ghent that promoted the radical world vision of A.W.N. Pugin's Catholic Gothic style (Coomans 2016). Because he was not able to build stone or brick vaults in Northern China and refused to make imitations of such vaults, he designed wooden paneled barrel vaults that fitted with his pure 'puginesque' Gothic architecture. In order to realize his designs and supervise the building works Father De Moerloose trained several skilled Chinese craftsmen. Two are known: Master Wang was a joiner and Master Yao became a foreman. Most of De Moerloose's large churches with Gothic barrel vaults were demolished; the best preserved is the church, later cathedral, of Xuanhua (Coomans & Luo 2012). The skills of the carpenters were of a high level, as shown by the complexity of the apse's wooden polygonal vault, the perfect assembling of the trusses, and the Western vaulting of the crossing (Fig. 4).

Figure 5. Sections of hall churches with wooden portal frame structures (*Le missionnaire constructeur*, 1926, plate 35).

4 IMITATIONS OF GOTHIC RIB VAULTS WITH PLANKS, LATH AND LIME

Covering the nave of a church with a wooden imitation of a stone rib vault gave the inner space a nice Gothic look. It was another way of hiding the roof and creating an insulation space under the roof. Pastiche Gothic rib vaults were light wooden structures made of planks, covered with lath, plastered with lime, and finally painted. Most important Gothic churches and cathedrals in China were equipped with such vaults. Two main types of vaults must be distinguished according to the construction type of the church: the hall church and the basilica church.

4.1 Hall churches with wooden portal frame structures

In a hall church, the aisles are of approximately equal height and width as the nave. Light is not entering directly in the nave but through the windows of the aisles' sidewalls. Two rows of high columns between the nave and the aisles support the vaults. Medieval hall churches are covered with different types of roofs (one saddle roof, several parallel saddle roofs, perpendicular saddle-roofs on the aisles etc.).

In China, missionaries often used the hall church type when they needed a large church because it was the easiest and cheapest structure. Only the outer walls are in brickwork, while the columns, the roofs structure and the vaults are of timber. The two rows of columns are huge posts or trunks forming the main portal frame of the trusses (Fig. 5). The aisles are a little lower than the nave and are under the same saddle roof. Usually there is no transept. Such structure is similar to that of Western barns.

The planks, lath and plaster vaults are inserted under the main portal frame structure. Seen from the nave, one has the feeling that the columns wear the capitals and the springers of the vaults (Fig. 6), while in fact the trunks forming the columns go further through the vaults, straight until the tie-beam of the portal frame truss (Fig. 8).

The arches and the ribs of the vaults are made of wooden planks covered with lath and plaster. The ribs converge to the center of the vault where a wooden

Figure 6. Beijing, North Cathedral or Xishiku church, hall-type nave built in 1887–88 (© THOC 2013).

Figure 7. Tianjin, Wanghailou church, planks, lath and lime vault of the aisle, rebuilt after 1900 (© THOC 2011).

Figure 8. Ningbo (Zhejiang province), Jiangbei church, calcined portal frame structure of the nave (© Reuters, July 2014).

block serves as the vault's key. This umbrella-structure is solid and freestanding; it is thus not necessary to hang the key to the purlins. The vaults' panels are of lath and plaster. Usually the tops of the vaults are slightly higher than the tie-beams (Fig. 7).

On 28 July 2014, a fire destroyed the Jianbei church of Ningbo, a hall church with a wooden structure and Gothic vaults as described above. Only the brick tower and the brick walls survived the fire. Pictures of the burned nave show the calcined portal frame structure as well as the shafts of the columns assembled around the main vertical beams (Fig. 8).

Figure 9. Daming (Hebei province), Lady church, section of a basilica type church, 1917–21 (© Peking University, School of Archaeology and Museology).

Figure 10. Daming (Hebei province), Lady church, stone column and wooden rib vaults, 1917–21 (© THOC 2014).

4.2 *Basilica churches with clerestories and single nave churches*

The other main church type is the basilica. The nave is higher than the aisles and has upper windows (Fig. 9). Both from a spatial and structural point of view, the basilica church type is very different from the hall church type.

In China, basilicas were more difficult and expensive to build than hall churches. Not only the outer walls of the aisles, the façade and the apse had to be in masonry or brickwork, but the columns, the side walls and the clerestory of the nave too. Therefore this type was specially used for main churches and cathedrals built after 1900 and often has a transept, such as Xujiahui cathedral and Sheshan basilica in Shanghai, the Catholic cathedrals of Jilin, Shenyang, Wuhu, Jinan, Qingdao, Hong Kong, etc. A basilica with wooden columns and clerestory such as the hybrid Chinese-Anglican church in Beijing (1907) is exceptional.

The basilica type has no portal frame structure. The vaults are spanned between the two upper walls of the nave and two transversal arches. Their wooden springers rest on shafts along the walls (Fig. 10). The transversal or diaphragm arches could be brickwork as

Figure 11. Daming (Hebei province), Lady church, extrados of a planks, lath and lime vault of the nave (© THOC 2014).

well as lath and plaster. In the case of brickwork, the pressure on the side walls requires buttresses. Because buttresses are complex and expensive, most transversal arches are from planks, lath and plaster, and were built together with the vaults (Fig. 11). The transversal arches are located under the tie-beams of the trusses but are not connected with them. The roof and the vault are totally independent, the latter being always built after the former because it had to be protected from the rain.

Single nave churches and aisleless chapels are comparable with the upper level of basilicas (Fig. 12). Because there are no aisles, it is easier to build side walls with buttresses and open larger windows.

4.3 *Building a vault with planks*

In 1926, French Jesuit missionaries published a handbook on how to build a church in Northern China (Jung 1926). The handbook contains technical advice and drawings about all aspects of the construction, from the foundations to the top of the roof, and systematically compares Chinese and Western techniques. This remarkable source has been recently studied and translated (Coomans 2014a, Coomans & Xu 2015, Coomans & Xu 2016). The authors of the handbook gained a large part of their experience on the building works of the Lady church of Daming in 1917–21 (Figs 9–11).

The handbook contains a description about how to build a wooden vault with planks, lath and lime, as well as one detailed technical drawing. “You should trace on the floor the curve of the arches to be obtained. Then boards are cut according to this curve. These boards are then nailed together, alternating the joints. These joints should not be cut straight, but following the radius of the curve. Before nailing the boards you

should mould them, as shown on the left side of the drawing” (Fig. 13).

“False Gothic arches, made of wood, come in two models: a large model for arches parallel or perpendicular to the axis of the church (wall arches and transversal arches); a small model for diagonal arcs (ribs of the vault). These diagonal arches are assembled by a wooden key at the place they cross each other, that is in the middle of the bay (*jian*). This key is made of a single round piece of wood, moulded with the same profiles as the arches that converge in it (see dotted line on the drawing). On the underside of the key one may nail a wooden board, that has previously been carved with an ornamental flower, an initial, etc.”

“At the point where the arch reaches the key, one should make a mortise for receiving the tenon of the arch. The latter should be carved to match the profiles of the key. For keys of the vaults of the aisles, the dimensions will be smaller (for example 8 inches if the key of the nave is 1 foot). They must, however, keep the same height and the same profiles. You should turn the profiles of the keys, if you have a large enough lath” (Fig. 13).

“The arches assembled by the key must form a perfectly solid support for the panels of the vaults made of lath and lime. No need to attach anything to the roof frame.”

“When nailing the lath, one should give them a slight curve upwards, so that the vault panels themselves form a more solid vault. This precaution should only be taken in the upper part of the vault panels, which is horizontal and forms the ceiling.”

4.4 Covering the vault with lath, lime and painting

The handbook’s description continues: “To coat the vault panels with lime, space the laths enough so that the lime could pass through. A worker, standing above the vault, would spread this lime over the laths.”

“Usually, the center of the arch is marked on the ‘vertical section’ drawing of the church. In principle, the key must be placed at least as high as the top of the transversal and wall arches that frame the vault. In principle too, the diagonal arches forming the intersecting ribs (those that intersect with the key) must be round arches (semicircles) and not what is commonly called ogees (pointed arches). In the Gothic style the transversal and wall arches are pointed. The cathedral of Reims is one of the few exceptions to this rule: there, the diagonal arches are pointed.”

“If, when using the round arch for the diagonal ribs, the keystone is too low (see the first rule above), one could remedy this by fixing the center of these round arches higher than the line at the level of the capitals. Only if such heightening would become too exaggerated, one should do as at the cathedral of Reims and break the top of the pointed arches.”

“If you want a very strong ceiling (vault panels), two layers of crossed lath should be placed one over the other: the first perpendicular to the transversal and wall arches, the second crossing the first one.”

Figure 12. Beijing, chapel of the bishop’s residence at Xishiku, imitation Gothic rib vault (© THOC 2013).

Figure 13. Arches, ribs and key of a planks, lath and lime Gothic rib vault (*Le missionnaire constructeur*, 1926, plate 35).

A remarkable archival inner view of the church of Xinjing (*Tchang Tsin*, Jilin province) under construction shows the completed planks and lathwork, before the coating with lime (Fig. 16). The church is of the hall type with wooden trunks as columns. The capitals, springers, arches, ribs and panels are of lath. This proves that a perfectly mastered coating technique was able to imitate a complete Gothic vaulting.

At last, the lime layer had to be covered with a nice looking covering that could imitate brickwork (Figs 10 and 15), or stress the key and the ribs with bright colors (Figs 6 and 14). We have seen one case of painted canvas fixed on the lath according to the technique of marouflage (Fig. 12).

5 THE MORAL ISSUE OF IMITATION

In his two major theoretical works *Contrasts* and *The True Principles of Pointed or Christian Architecture*,

Figure 14. Beijing, North Cathedral or Xishiku church, chapel, damaged coating showing the lath underlay (© THOC 2013).

Figure 15. Daming (Hebei province), Lady church, restoration of a transversal arch of the nave showing the lath and lime coating (© THOC 2014).

A.W.N. Pugin, states that there must be a relationship between true faith and true architecture (Pugin 1836, 1841). For him, the only true church architecture was built with authentic materials such as brick, stone and wood. Therefore he condemned the use of all kinds of imitation, both the lath and lime technique currently used in the Neoclassical architecture as the metal imitations from the industrial architecture. How could churchgoers develop a true faith in a building that is a lie? Gothic architecture, the universal style of Christianity, had to be built according to the techniques from the Middle Ages.

Pugin's theory was very influential and his Gothic paradigm was spread worldwide both by the Anglican and the Catholic missions. The case of Father De Moerloose, the Gothic church builder in Northern China, has already been evoked (Coomans 2016). The debate opposed missionary-architects who followed Pugin to the letter, and other who were more pragmatic and were ready to accept imitations of Gothic rib vaults with planks, lath and lime because it was not possible to build real vaults in the mission fields.

Figure 16. Xinjing (Jilin province), church under construction, not dated (© Archives of the French Foreign Mission, Paris).

About one century after Pugin, the *Missionary-builder* handbook still evoked the delicate issue of true vaults in Northern China: “is it appropriate to add vaults to our monumental churches, in order to give them more character [style]?” (Jung 1926).

The Jesuit father evaluates the pros and cons of imitating Gothic rib vaults. “No, answer the purists with a little indignation, since in the state of your finances, it would be folly to think of a real stone or brick vault, with its carved keystones, with its forest of buttresses, with stone columns and their rich capitals that would bear it. So, who do you mean to fool with your pastiche vault, made of boards and lime? Do nothing if you are not able to do something true.”

“However, this poor pastiche vault, this sham vault, offers many advantages. Without wanting to fool anyone, it will still give more character [style] to the church. Aside from the issue of character, it will look neater; you will not notice all the little flaws of the wooden timber structure. It will be cleaner too (sorry for this detail) because the sparrows, who can drown out the best preachers in these regions, will not be at home under this... European vault. Where could they build their nest? Moreover, it will be cooler in the summer and warmer in the winter. And furthermore, especially if the vault, made of common lathing, is well done, the acoustics of your church will be completely changed for the better.”

Figure 17. Shanghai, Sheshan basilica, reinforced concrete roof structure and rib vaults, completed 1935 (© THOC 2011).

As builder of the church of Daming, there is no doubt that Father Paul Jung, the handbook's author, was in favor of imitation vaulting. He stresses the advantages of the technique, which are aesthetic, practical, acoustical, insulation, and economical.

At last, it is worth noticing that the handbook never mentions iron and reinforced concrete roof structures and vaulting. Even in the 1920s, such modern structures only existed in the treaty ports and were not affordable to missionaries.

6 CONCLUSION

The Gothic style Sheshan basilica in Shanghai, designed by Father De Moerloose in the early 1920s, was erected from 1924 to 1935. On top of a hill, the Sheshan basilica had to resist typhoons and therefore reinforced concrete was used both for the roof structure and the vaulting (Fig. 17). The round transversal arches between the rib vaults as well as the wall plates are connected with the reinforced concrete trusses. This rigid frame structure allowed the builders to avoid heavy buttresses and flying buttresses.

Sheshan's modern roof and vaulting structure is the last stage of an evolution that began in the 1860s with the stone vaulting of the cathedral of Canton. The present essay has given an overview of various Gothic looking vaulting systems in China and contextualized their construction in the complex architectural debate on technique, style, economy, and identity.

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