Taylor & Francis
Taylor & Francis Group

Journal of Asian Architecture and Building Engineering

ISSN: 1346-7581 (Print) 1347-2852 (Online) Journal homepage: https://www.tandfonline.com/loi/tabe20

A Study of Western Influence on Timber Supply and Carpentry in South China in the Early 20th Century

Yiting Pan & James W. P. Campbell

To cite this article: Yiting Pan & James W. P. Campbell (2017) A Study of Western Influence on Timber Supply and Carpentry in South China in the Early 20th Century, Journal of Asian Architecture and Building Engineering, 16:2, 247-254, DOI: 10.3130/jaabe.16.247

To link to this article: https://doi.org/10.3130/jaabe.16.247

Published online: 24 Oct 2018.

A Study of Western Influence on Timber Supply and Carpentry in South China in the Early 20th Century

Yiting Pan*[1] and James W. P. Campbell[2]

[1] Lecturer, School of Architecture, Soochow University, China
[2] Senior Lecturer, Department of Architecture, Cambridge University, UK

Abstract

The formation of the Treaty Ports after the Opium Wars saw the introduction of the ideas of the Industrial Revolution to Imperial China. The Treaty Ports acted as the intersection of Chinese and Western cultures, playing a crucial role in introducing Western technology. This article shows for the first time how, counter-intuitively, the problems of supply of Chinese timber actually provided the impetus for the wider adoption of Western forms of carpentry construction such as purlin roofs with king-post trusses. It also shows how the competition between timber suppliers ultimately led to Chinese nationalist backlash against imported timber and techniques.

Keywords: timber supply; carpentry; Western influence; South China; early 20th century

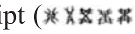
1. Introduction

The last few decades since 1985 have witnessed an increase in scholarly interest in the architecture of the Treaty Ports in the 19th and early 20th century. Although general works on the appearance of the foreign-style buildings in China are abundant, the way these buildings were constructed and the relationship between Chinese and Western building techniques have remained largely unexplored. The hybrid construction methods, which characterized one hundred years of Chinese building history under Western influence, had their origins in the two parallel systems: the Western and the Chinese building construction traditions. This article concentrates on one aspect of this broader question that has never been explored: the effect that the supply of a particularly important building material, timber, had on the development of building construction in the period.

This article does so by bringing together five sources for the first time: (a) the Chinese literature and illustrations depicting the Chinese timber trade; (b) the accounts on Chinese forestry published in the early 20th century by R. Rosenbluth (1912), N. Shaw (1914) and Y. Tang (1935); (c) import/export data and related information of timber from the *China Year Book* (*CYB*) (1912-1939), the *Far Eastern Review* (*FER*) (1900-22), etc.; (d) Shanghai Society of Engineers and Architects (SSEA) Proceedings preserved in the Institution of Civil Engineers, London; (e) and Chinese building construction textbooks and manuals published in the early 20th century.

2. Chinese Forest Trees and the Native Timber Trades

Botanical, zoological, and archaeological studies suggest that much of both Northern China (until 500AD) and Southern China (until 1300AD) was originally covered in forest (Herrmann, 1935: 6-7; *CYB*, 1921-1922: 69-79). The fact that, by the 19th century, China had been subjected to a deforestation unequalled by any other great nation (Fig.1.) can probably be attributed to three factors:

(1) The structural significance of timber in Chinese culture: the importance of timber in construction can be traced back to the Qin dynasty (221-206 BC), when the characters for "structure" in oracle bone script and bronze script () started to be used in conjunction with a left-hand character "" standing for wood, to make a new compound for structure in small seal script "" (and it is clear that construction was indelibly associated with wood). The great passion for timber can be seen from the extraordinary pursuit of structural timberwork in the Tang dynasty (618-907) and the Song dynasty (960-1279), as well as of furniture making in the Ming dynasty (1368-1644); and it is also revealed in the accounts of the gathering of "Royal Lumber" for the Imperial Palaces in the Ming and Qing dynasties.

(2) Chinese attitudes and practice: the traditional collective belief in *fengshui*, the balance of man and nature, and the awareness of the ecological benefits, usually yielded to more utilitarian attitudes in China. The methods of felling and rafting were wasteful

*Contact Author: Yiting Pan, Lecturer,
Soochow University, No. 199 Ren Ai Road,
Suzhou Industrial Park, Jiangsu, 215000, China
Tel: +86-139-1403-2745
E-mail: panyt@suda.edu.cn
(Received October 6, 2016 ; accepted March 10, 2017)
DOI http://doi.org/10.3130/jaabe.16.247

(accounting for a loss of 30-35% in some reports), while replanting was rare and largely ineffective (Shaw, 1914: 96, 92, 160; Rosenbluth, 1912: 654-55; Lowdermilk, 1926: 127-35; *CYB*, 1912: 20-21, 39-40; *CYB*, 1921-22: 69-79).

(3) Political change: Mr. P. C. King (1886-1946), former President of Tsinghua University, attributed the present scarcity of timber in China to "the decay of the Chinese feudal system in the third century before the Christian era, the laissez-faire policy of the Government, and the numerous internal disturbances from which China has periodically suffered", and his view was considered at the time "most deserving of attention among a mass of facts and theories" (*CYB*, 1921-22: 69-79).

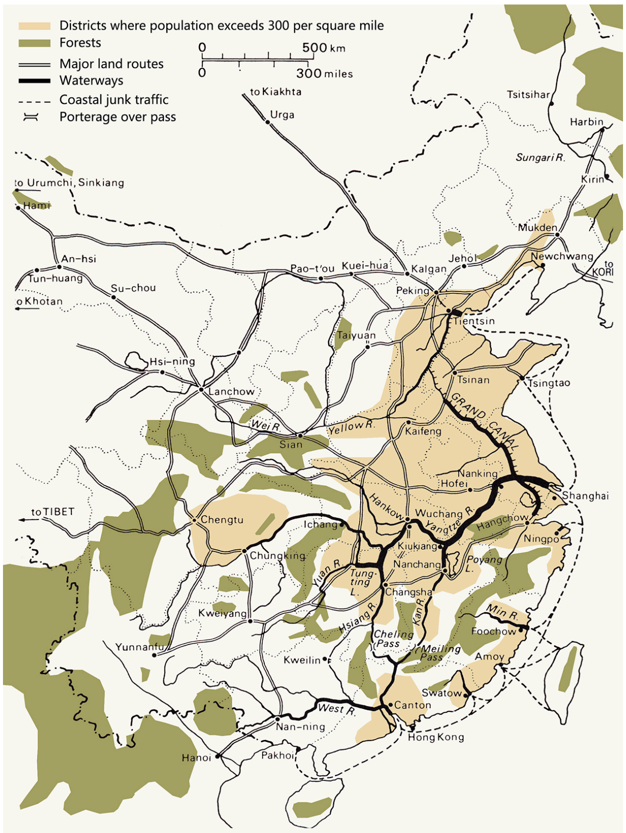


Fig.1. Map of Forests and Local Communication Routes in the 19th Century.
(This map is made by combining information from Shaw's forest map with the "Trade Route" map in "Economic Trends, 1870-1911", in J. K. Fairbank and K. C. Liu (eds.) (1980) *Cambridge history of China. Vol. 11: Late Ch'ing, 1800-1911: part two*. Cambridge: Cambridge University Press, p.42)

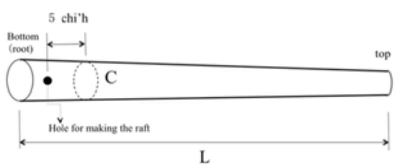
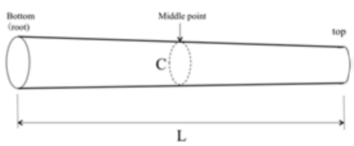
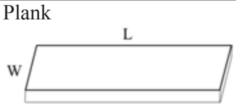
Whatever the causes, the direct impact on the building history is that, by the 19th century, good construction timber had become a scarce commodity, and limited the size of available trees. Felling usually took place in the autumn and winter. Choosing an auspicious date for felling was an important issue in geomancy or *fengshui* (Li, 2006: 66-67). Trees were usually cut down with axes or saws, sometimes further assisted by people on both sides pulling on ropes tied to the saw when sawing a larger tree. In some areas, the trees were only cut half through, and left for the first gale do the rest of the work (Shaw, 1914: 58-59). Once felled, branches were chopped off with axes, saws, knives, or adzes. A wedge was driven into the log near the center of gravity to act as a handle, allowing a man to carry it on his shoulders and walk with it for several hours; alternatively, a whole tree might be transported by a team using ropes and carrying poles (Hommel, 1937: 219). In mountain regions, a temporary transport structure, or *jiaxiang*, was usually built, which was used to drag the logs to the water head (Li, 2006: 69-70). (Fig.2.) After the logs were gathered near the river, the names of the workshop and the mountain (*shanhao dianhao*) from which they came were marked on the log ends. (Hommel, 1937: 221) Rafts of logs were constructed and sent down the river to the timber markets. It was said that from the forests in Southern Human Province it could take one to three years for the rafts to float down to the markets on the Yangtze River (*FER*, 1916: 103). Contemporary illustrations show that the *shanmu* (Chinese fir/*cunninghamia lanceolata*) logs that made up these huge rafts were so buoyant that they could support houses and even layers of earth, allowing vegetables to be grown and pigs to be kept on board (Li, 2006: 70); over the months and even years of travel, they became floating farmsteads.

Fig.2. "*Tianche yuejian*", or "Sky Vehicle Over Creek", in Gong Hui's *Xicha huicao* (The collected essays on timber-felling in the western region), 16th century.
(Source: Chinese Rare Book Collection, Library of Congress)

Because of the great difficulties of obtaining and transporting timber, an extraordinary trade network developed throughout China by the late 19th century. While guilds in Europe declined in the early modern period, the local *Mushang Gongsuo* (Timber Trade Guilds) in China flourished much later and were particularly significant in the early 20th century, uniting individual merchants to compete in the new markets in open ports against the tide of imported timber (Zhu, 2011). The precise way timber was traded varied in different regions of China. The common practice was that the raft merchants bought timber from the local villagers who paid some form of government tax each year. Raft merchants then transported the raw logs down to the nearest markets, where they were sold on to the members of the timber merchants' guilds who carried out all the selling down the line.

Timber was measured in *chi'h*, or the Chinese foot. The price was arrived at through a complicated calculation system, involving the measurement of the circumference at different points for different kinds of woods and the certified length of the log (Table 1.). The measure of length varied at different open ports and again with different trades. The timber merchant's *chi'h* equaled to approximately 13.3 English inches (33.8 cm) in Shanghai and Hankow. (Jernigan, 1904) The timber merchant's ruler was called a *tanchi*. There were two common types of *tanchi*: one (made of wood) was for measuring the length of the log; the other (made of bamboo) for measuring the circumference of the log. The latter could be subdivided into ten types for different discounted values of *chi'h* (Fig.3.). Therefore, the price of timber also depended on the choice of *tanchi*, which had to be clarified in every timber contract. According to *The Civil Engineering Manual of New China* (1953), this method was typical in China and maintained until the 1950s.

Table 1. Methods of Measuring Different Types of Native Timber in Hankou, 1921-25

Type of Timber and Method	Classification by sizes
Shanmu (pole)	C ≤ 1*chi'h*
	L< 30 *chi'h*, C: 1 ~ 1.5 *chi'h*
	30 *chi'h*≤L < 36 *chi'h*, C: 1.55 ~ 1.8 *chi'h*
	36 *chi'h*≤L <40 *chi'h*, C: 1.85 ~ 2.2 *chi'h*
	40 *chi'h*≤L <48 *chi'h*, C: 2.25 ~ 2.5 *chi'h*
	48 *chi'h*≤L <52 *chi'h*, C: 2.6 ~ 3 *chi'h*
	48 *chi'h*≤L <52 *chi'h*, C: 3.05 ~ 3.5 *chi'h*
	L = 60 *chi'h*, C: 3.5 ~ 4 *chi'h*
	C: 4.05 ~ 4.5 *chi'h*
	C: 4.5 ~ 5 *chi'h*
	C: 5.05 ~ 5.5 *chi'h*
	C: 5.55 ~ 6 *chi'h*
	C: 6.05 ~ 6.5 *chi'h*
	C: 6.55 ~ 7 *chi'h*
Songmu (log) 	$\frac{(C-1.5\,chi'h)\times L}{100}$ (unit: *fang*)
Plank 	$\frac{L\times W}{100}$ (unit: *fang*)

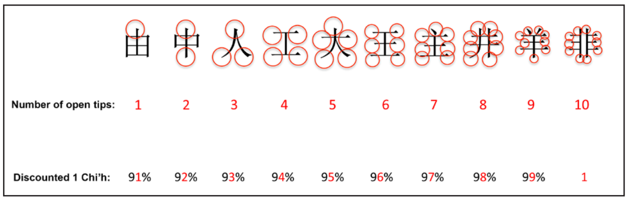


Fig.3. Diagram Showing the Discounted 1 *chi'h* of Timber Merchants' Rulers (for circumference), Hankou, 1925. The First Row Shows the Chinese Names Once Used for the Ten Types of Rulers.

3. Timber Supply for Native Buildings

Chinese carpenters used many different woods in building construction. In general, softwoods were widely preferred for carpentry as they are usually larger-sized, straight-textured, and easier to process. More importantly, they could provide the pleasing smooth surface finish preferred in Chinese buildings. By contrast, hardwoods are of beautiful texture and wearable character, but easily deformed or cracked, and are more difficult to process, so they were normally reserved for joinery.

Shanmu was the wood which dominated the native timber market. According to the data from Hankou (1925), *shanmu* was commonly supplied in thick logs or long poles with bark removed, and ranged from 0.4 to 1.5 *chi'h* (13.5 ~ 50.7 cm) in diameter. *Songmu* (Chinese pine/*pinus massoniana*) commonly ranged from 11 to 30 *chi'h* (3.7 ~ 10 m) in length, with smaller ones supplied in long logs and larger ones in sawn planks. Both *shanmu* and *songmu* were used in building and shipbuilding. *Bomu* (Chinese weeping cypress/*ping juniper*) was normally around 1 *chi'h* (33.8 cm) in diameter and 50 to 60 *chi'h* (17 ~ 20 m) in length. *Bomu* was supplied mainly for the construction of temples, furniture, and coffin making. Woods in native timber markets were commonly categorized not only by species but also by geographical origin. Timber in commercial quantities was mainly produced in Fujian, Manchuria, and Hunan (*FER*, 1906: 76-77; *CYB*, 1926: 719-20).

Climate and insect attack were two critical aspects that also influenced the decision of the choice of timber. *Shanmu* from Fujian Province was famous for its resistance to attack by termites (white ants). Smedley (1905: 160) noted that: "The climate of Shanghai and the North of China has the disadvantage of great extremes in temperature it is true, but still there is one thing to be thankful for, there are no white ants to eat away the woodwork; and ordinary woodwork, i.e., the beams and supporting posts of a Chinese house, unless destroyed by fire, will last a good many years". But Smedley did not realize that it was due to the wise choice of timbers. When the imported timber market was being developed in China, some imported species of trees were inevitably better than others. Rosenbluth (1912: 659-60) gives some good examples: "Oregon pine rots rather badly in China south of the Yangtze basin, it will probably be less used after five years than it has been in the past. […] Japanese wood is practically worthless on account of the rapidity with which it decays; and in the southern parts also because of the partiality which the white ant show for a diet of Japanese wood."

A remarkable feature of traditional carpentry in China, which set it apart from its Western counterpart, was the use of round wooden members for purlins, rafters, columns, and sometimes beams. This can be partly explained by the long tradition in Southern China of using the circumference to set out buildings. According to *Yinzao fayuan*, an early-20th-century native building construction manual, the carpenters in Suzhou measured the circumference of the log with a flexible bamboo strip, called *weimie*. The depth of the house, or *jinshen*, was commonly used as the reference size (module) for the whole building. First the *jinshen* was decided, and from that the circumference of each beam was fixed as a set fraction of *jinshen*, thereby ensuring the correct depth of beam for the span. It is worth noting that the design ratios were adjusted depending on the species and grade of wood. A reduction was applied to the ratio when superior woods were used. Use of inferior woods required only a modest upward amendment to the ratio, but demanded a careful examination of knots and other timber defects especially for beams to be used over large spans.

Smedley (1905: 160-61), a Western observer, noted that in Shanghai ordinary Chinese houses were commonly built of *shanmu* from Fujian (i.e., "Foochow poles"), which generally came in a standard size: 5 inch (12.7 cm) in diameter and 12 ft (3.7 m) in length (this was among the smallest sizes of the supply of *shanmu* according to the data in Hankou). Smedley observed how these Foochow poles were used in building construction in Shanghai: "After the foundations have been built, the wooden framework of the house is set up. This consists of the wood pillars supporting the first floor girders, which continued above in one piece, support directly the roof truss. These frames are placed from 11 ft to 11ft 6 in (3.35 ~ 3.5 m) apart. This space makes a good large room […]. These [poles] are rough tooled and spaced 2 ft (61 cm) apart." According to Smedley, with this arrangement, the ground floor was usually 12 ft (3.7 m) high, and the first floor usually from 10 to 11 ft (3 to 3.4 m), while the shape of the roof truss allowed a greater height of the ceiling with a minimum of wall.

4. Timber Supply for Early Foreign-style Buildings

The trade in importing timber into China probably started in the middle of the 19th century and was initially associated with shipbuilding. A comparison between the four editions of *The Chinese Commercial Guide* 1834-1863, the precursor of *The China Year Book*, gives clues to the early development of this foreign timber trade in China. In the 4th edition (1856), in the list of tariffs on "Articles of Imports", no articles that could be counted as "building materials" are listed. Certain "woods, viz. Ebony (Sandal-wood, Sapan-wood)" were included, but according to the attached description the imported woods were used mostly for other purposes, such as making incense sticks. Construction timbers appear for the first time in the 5th edition (1863) of *The Chinese Commercial Guide* (actually the *North-China Herald* on 8 December 1860 had also listed the same articles) in the list of imported timber in the table of "Tariff on Articles of Import", which listed 6 types of masts and spars, 1 type of beam, and 3 types of planks. The Chinese government report, *Statistics of China's Foreign Trades* (1931), produced by the National Research Institute of Social Science Academia Sinica, also shows that foreign timber had arrived in China by 1867.

The design of foreign-style or colonial buildings by Western professionals (architects and engineers) presumed the use of Western construction techniques, but, of course, the buildings could only be realized in the materials available to the Chinese builders and through their skills. The lack of suitable timber and the Chinese tradition of working with round timber created problems when dealing with Western carpentry designs. This can be seen in the following account of the building of an English House in Hong Kong in 1844-45: "Some old masts [were used] as girders […] For the roof we had provided King Post trusses; and when these were set up, the carpenters began to bed the hip pieces; four clumsy round pine logs – they were tied to nothing, had no square bearing anywhere – being just bedded in the brick walls, and the purlin spars rested on them […] Every morning some blunder stared me in the face." (Ashworth, 1851) From Edward Ashworth's memoir, we can see that British architects found working with Chinese materials and craftsmen a challenge. What started out as Western King Post trusses or Queen Post trusses with squared timber and carefully worked joints became re-worked as best as could be done in the circumstances. The resulting mix of Western and Chinese structures can be seen in a considerable number of examples, including many early industrial buildings.

Without the correct joints, such structures were potentially extremely dangerous. Chinese carpentry had developed to cover limited spans. Its limitations became even more apparent when it was applied to inappropriate forms, such as those shown in Ashworth's drawings. The roof structure employed in the first Holly Trinity Church (built in 1847-48) in Shanghai fell down in a storm in 1850. The failure was put down to its excessive weight for such a large span. This accident probably partly explains the later preference for Western roof construction and the subsequent greater attention to detail in Western-style buildings in Treaty Ports.

Cost was one of the top considerations and undoubtedly influenced the architects' choice of timber.

Native timber was cheaper than foreign woods by the end of the 19th century. An article about Chinese labor in *The Builder* in 1880 addressed the comparative prices of timber in China and Britain, noting that: "ordinary [Chinese] fir being of less than half the cost in Hong-Kong that it is in London." It was not only the cheaper cost of native timber over its foreign rivals that determined the overall cost; cheaper labor was also a significant factor (Stuart, 1902). Chinese carpenters were inevitably used. They customarily followed the methods they had learnt from their masters in working native woods. Their setting out and structural calculations had relied on rules of thumb based on circumferences and traditional species handed down for generations. Imported timber was unfamiliar. Chinese patrons were wary of using it, and the market for imported timber remained relatively small despite the rising costs of Chinese timber until some time after the WW1 (Jin, 1991).

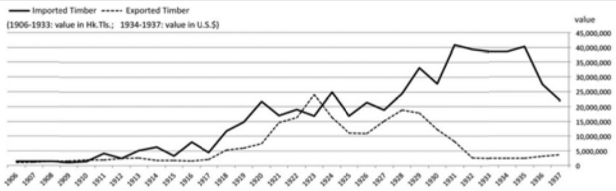
5. The Rise and Fall of Imported Timber

In the 19th and early 20th century, Western travellers in China were conscious of the acute problems of China's timber supply. Gutzlaff (1851) wrote that "there are few forests in the country", but "there is in general a great want of timber". Shaw (1914: 79-80) wrote that timber had become "almost impossible to get" or "only with the greatest difficulty and expense". Both Gutzlaff and Shaw noticed that the scarcity of woods was so severe that it had not only caused problems in construction but also in the supply of fuels. The Chinese forest problem was a heated topic in the early Western media addressing to the Western audience in China, such as *The China Year Book* and *The China Journal of Science & Art*. It is fair to say that the Western awareness of China's devastating deforestation, the scarcity of good native timber, and the great difficulty of obtaining and transporting timber in China inevitably resulted in Western promotion of foreign timber in China from the 1860s and into the 20th century. (Table 2.)

Despite its slow initial uptake, there were many opportunities for foreign timber in China. One important factor was the increasing use of multi-storey buildings instead of the traditional single-storey courtyard designs. Multi-storey buildings required more timber for flooring, windows, etc. – a trend that began in the principal ports and spread rapidly elsewhere. One of the points continually made by Western writers was the difficulty in finding out anything about the Chinese timber trade. This sparked considerable debate about whether China was able to remain self-sufficient in terms of timber supply. Rosenbluth (1912), an American timber expert, thought that there would be an increasing demand for foreign wood, while Mr. Sun Hwah Ting, the largest wood dealer in Hankou, believed that the home supply would always be sufficient. Rosenbluth (1912: 662-63) considered Sun's view biased. But two decades later, Emms (1936: 74-75), an engineer in Shanghai who investigated the carpenters' and joiners' tools in Jiangnan area, could still write that: "China at the present time is importing the bulk of her timber. This is totally unnecessary. She has more than sufficient timber for her needs standing idly within her boundaries."

Table 2. Imports and Exports of Timber and Wood of All Kinds in China (1906-1937)

Description of Goods	Year	Import (Value)	Export (Value)
Timber and Wood of all kinds	1906 (Hk. Tls.)	1,367,005	982,510
	1907	1,433,753	1,035,232
	1908	1,453,896	1,383,503
	1909	1,041,156	1,515,023
	1910	1,375,198	1,997,185
	1911	4,051,598	1,845,623
	1912	2,517,661	2,446,208
	1913	5,111,497	2,555,230
Timber and Wood of all kinds: Hardwood, Softwood, Poles	1914	6,251,781^	1,820,373^
	1915	3,271,465^	1,794,842^
	1916	8,050,067^	1,655,939^
	1917	4,400,931^	2,104,355^
Since 1918, title changed to be: "Timber and Wood of all kinds (including Sawn Timber)	1918	11,679,496	5,316,320
	1919	14,741,07	5,907,301
	1920	21,671,565	7,460,200
	1921	17,044,119	14,648,356
	1922	19,004,079	16,326,166
	1923	16,776,616*	24,134,382*
	1924	24,887,650*	16,337,748*
	1925	16,829,350*	11,008,949*
	1926	21,406,369	10,929,497
	1927	18,817,447	15,142,676
	1928	24,497,601	18,803,446
	1929	33,230,613	17,796,741
	1930	27,841,538	12,261,548
	1931	40,855,615	8,134,349
	1932	39,338,262	2,611,919
	1933 ($)	–	–
	1934	38,569,550	2,403,328
	1935	40,332,856	2,500,651
	1936	27,434,976	3,190,653
	1937	22,118,350	3,585,007



Note: (1) Between 1906 and 1932, the value was calculated in Val. Hk. Tls. (2) Data marked with ^ were not directly provided in *The China Year Book* as a single value as that in other years. The value of timber exports for the year 1914-1917, and 1923-1926 were given as "hardwood", "softwood", and "poles" separately. (3) Data marked with * given in *The China Year Book* (1925), (1926) are different from that by *The China Year Book* (1928) (4) Since 1933, value was calculated in Val. $ (= 0.51 Gold Units).

With the continuous promotion of imported timber, types of timber became increasingly varied. Imported timber was competitive in the Chinese market because it was available in multiple ready-sawn sizes at good prices. Native woods were usually supplied

Table 3. Types of Foreign Timber (Commercial), 1935

Areas	Tree species	Character and usage
North America (Canada and America): mainly imported softwoods	Oregon pine (or Douglas fir)	For building purposes
	Larches	Hardest softwood in Canada, for building purposes
	Spruce	For paper making
	Pines	Making models
	Hemlock	Joinery, window, and general building purposes
	Cedars	Ship making
	Firs	Soft, paper making
Japan (including Taiwan and Korea): hardwoods	Oaks (Quercus spp.)	Hardwood, for decoration, devices, fuel, vehicle's wheels
	Fraxinus	Hardwood, for furniture, devices, fuel, vehicle's body
	Kalopanax spp. Or Acanthopanax spp.	Railway ties
	Keyaki (Japanese name)	N/A
	Tabu (Japanese name)	For building, furniture, devices, shipbuilding, decorative carving
	Buna (Japanese name)	For building, agricultural devices, furniture, joinery
	Cercidiphyllum. Japonicum S & Z	Devices, furniture, musical device, model
Japan (Taiwan and Korea): softwoods	Chamaecyparis	Major timber for building in Japan
	Cryptomeria japonica D. Don	Not suitable for beam and column, good for ship bottom
	Picea spp.	Match, paper, building, shipbuilding
	Pinus spp.	Similar to native woods; chosen as planting trees in Qingdao; construction (rough part), railway ties, etc.
	Larix leptolepis Gord	Construction (rough part),
	Abies spp.	Box, paper
	Thujopsis dolabrata S. & Z.	
Malay, Burma, French Indo-China, Siam, Sumarata, Java, Borneo	Philippine mahogany	High quality furniture
	White lauan	Furniture
	Yakal	Floor, bridge, railway ties, shipyard
	Ipil	High-quality building, railway ties, furniture, joinery
India	Red sandal wood	Decoration
	Dalbergia	Decoration
	Ebony	Carving, wheals
	Indian laburnum	Artistic, musical device
	Indian rose chestnut	Railway ties, building, bridge, furniture
	Teak	Shipbuilding, building
Europe: Norway, Sweden	Fagus	N/A
Russia	Pine, Spruce, Fir, Larch, Oak, Birch, Popular, Alder	N/A

unconverted, and sawing was typically by hand. In the 1930s, imported timbers principally used in China consisted of Teak, Lauan (or Luan) and Oregon Pine (Emms, 1937), and these woods were subdivided into multiple grades (Du, 1935).

The rise of imported timber was associated with the scale and speed of the construction in Treaty Ports. Western architects and engineers played a significant role in promoting Western forms of carpentry. Early articles in English magazines in the 19th century show that they knew little about Chinese carpentry. The term most used by Western writers was of a "tent" or "cage" in describing the traditional Chinese timber framework. Western architects and engineers, meanwhile, were equipped with Western scientific methods for choosing suitable timber, designing timber roof trusses, and testing them.

The preference for Western carpentry in the earlier period in China mainly stemmed from the lack of understanding of the local tradition. In the early 20th century, Western professionals living in Shanghai had more experience of Chinese timber construction but their preference for Western trusses remained, based on a rational comparison. According to an article on "Chinese Buildings" in 1904-5 (Smedley, 1905), engineers discovered that the quantity of timber used to make one Chinese roof truss could make two Western King Post trusses. Because of this, foreign forms were considered both cheaper and preferable.

Western architects and engineers, used to working with and sizing foreign timbers, undoubtedly had an important part to play in preferring imported over native timber, especially in the Treaty Ports and major inland cities by 1921. This was partly a matter of convenience: if familiar woods were employed, then the construction details could be directly copied from foreign manuals. There were also sound commercial concerns: the strength of imported timber was known, hence the sizes could be minimized, an important factor in larger projects. As a result, prior to the Sino-Japanese War, imported timber dominated the Chinese building industry, particularly along the coastal and Yangtze River areas. (Table 3.)

There were, however, other factors in play. The foreign timber merchants worked closely with Chinese middle-men to develop local networks and facilitate demand. A disturbing example is the case of the British-owned China Import & Export Lumber Company, Ltd., which was formed in 1884. Jin (1991) has shown that the Company managed to establish a connection with and exert influence on the municipal council in Ningbo, which led to the government passing a law requiring all construction drawings to use the sizes and standards of Oregon pine, and all such drawings to be approved by the council.

The result of Western influence in many aspects of the building trade was that Western timber trusses were used not only in Western-style buildings but also in many new Chinese ones. In Shanghai, the traditional Chinese houses had typically consisted of a timber framework made of Foochow poles fitted together with mortise and tenon joints, locally known as *litie*. This type of timber construction, due to its simplicity (it needed no iron bolts or ties: wooden pegs were sufficient), had been continuously used in traditional dwellings in Southern China for centuries, while the choice of timber and the structural safety were completely dependent on the empirical judgment and experience of the skilled craftsmen (Shen, 1993). As already stated, during this period there were unprecedented changes in housing construction. In Shanghai, the distinguishing feature of the flourishing middle-class houses, or *lilong*, was connected with increasing commercialization of housing development (Yang, 2002). In better *lilong* houses, American Oregon pine became prevalent for flooring, while generally rough Japanese planks (1 inch, width: up to 13 inches) were used. Although the Chinese truss was still commonly used in native houses, the British king-post trusses were coming into favor in more modern Chinese buildings. These foreign trusses could be in local or imported timber, and their advantage was that they did away with the need for the center pillar of the Chinese framed roof, giving a clear span with the same cost. In the end, while the Western roof trusses remained, wooden columns gradually disappeared, leaving brick walls as the only vertical load-bearing elements. With the introduction of building regulations, structural calculations were more commonly used, and the height of houses increased from two to three or four stories. (Fig.4.)

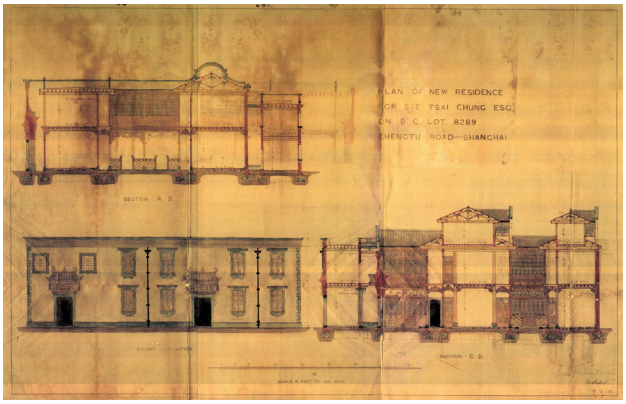


Fig.4. Design Drawing of a *lilong* Housing Project in Chengdu Road, Shanghai, 1915. (Source: Shanghai Municipal Archives (ed.), *Shanghai zhendang* (Shanghai precious archives) (Shanghai: Zhongxi shuju, 2013), p.123)

It is interesting to note that even with the increasing use of imported timber and foreign detailing, Chinese construction still managed to retain some characteristics of the older traditions. Thus, for instance, a construction textbook in 1934 shows a European truss with rounded Chinese purlins. (Fig.5.) This type of illustration could too easily be taken to mean that the building technology transmitted from Europe to China was not well understood by the Chinese builders. However, it probably indicated that the local timber industry was slow to adopt mechanized sawing well into the 20th century, and a delicate balance had developed between the imported and native timber traders. According to a previous study, in this period when local timber markets suffered a considerable depression in face of foreign competition, some native timber suppliers offered packages that bundled Oregon pine and Fujian poles together. (Jin, 1991) Perhaps it is this sort of arrangement that is being illustrated here. (Fig.5.)

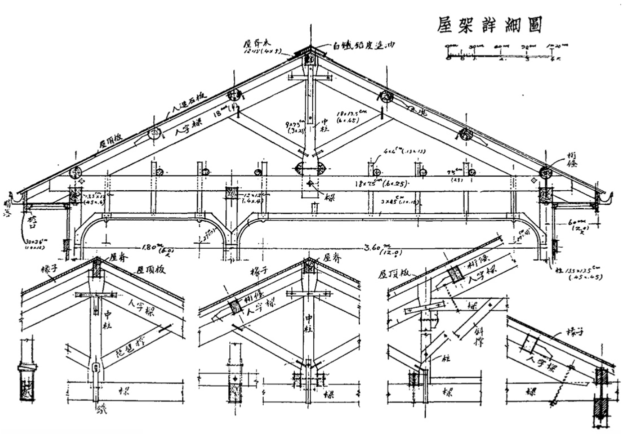


Fig.5. A Plate in the China Occupation School's (Shanghai) Construction Textbook Published in 1934

The domination of foreign woods was finally challenged in the second half of the 1930s. In fact, over two decades before the rethinking of timber supply in the building industry, the introduction of Western scientific methods of forestry had awakened the central National government to the need to regulate the industry and manage the forests (Shaw, 1914: 174; Lin, 1916; Sherfesee, 1916). From the 1920s onwards, the threat of foreign imports led the Chinese to research actively Chinese trees. Tang Yao's *Chinese Study of Timber* was among the first, providing a comprehensive account and proper nomenclature for more than 300 types of Chinese wood. The work provides a full bibliography of Chinese forestry and timber studies. The Preface sets out the purpose: "There is an urgent need to investigate the Chinese forests and trees. If native woods are found of similar property, then they can be exploited properly to replace foreign timber." The National government actively encouraged the consumption of native woods, requiring that "in future, preference must be given in all contracts to firms using native timber," and timber importation began to reduce and ceased to dominate the building trade.

6. Conclusion

There is no doubt that Western influence played an important role in the modernization of building construction in many Asian countries. This article explored how the traditional timber trade was affected by Western influence, and how new sources of timber affected building construction in South China. It revealed how Western desire to profit from the timber trade in China exploited the existing limitations and weaknesses of timber supply, but also how it initially resulted in the importation of inappropriate materials that failed, and the steps subsequently taken to resolve this. The adoption of Western carpentry in building practice in the rapidly developing Treaty Ports of China was led by foreign design professionals (architects and engineers) who felt more at ease using sawn timbers of known strength. The increasing supply of foreign (especially American) timber in multiple ready-sawn sizes at good prices provided the impetus for the wider adoption of Western forms of carpentry construction in South China. The result was a mixed form of construction using, for instance, European-style sawn timber trusses but with rounded Chinese purlins. More research needs to be done on carpentry construction details of surviving buildings in South China during the late 19th and early 20th centuries. Nevertheless what this article shows is that the importation of Western timber did not simply mean the adoption of entirely Western techniques. The reasons for the adoption of particular methods were more complex, and the result fused both traditions. In more general terms, as this example clearly shows, the reasons for particular building methods being adopted only become clear when the problems of material supply are properly understood.

Acknowledgements

This research was supported by the CSC (China Scholarship Council) Scholarship and Henry Lester Fund. The early draft of this article was presented at the First Construction History Society Conference (2014) and included in the conference proceedings.

References

1) Anon. (1880) "Chinese labour", *The Builder*, 17 January, p.74.
2) Anon. (1906) "Lumber trade of the Far East", *Far Eastern Review*, August, pp.76-77.
3) Anon. (1923) "Fujian zhi mucai (Timber of Fujian)", *Zhongwai jingji zhoukan* 35, p.5.
4) Anon. (1925) "Hankow zhi mucai maoyi (Timber trades in Hankou)", *Zhongwai jingji zhoukan* 109, pp.1-7.
5) Ashworth, Edward (1851) "Chinese architecture", *Architectural Publication Society* 3, pp.1-18, pp.64-69.
6) Ashworth, Edward (1851) "How Chinese workmen built an English house", *The Builder*, no. 456, 1 November, pp.686-88.
7) *China Year Book* (1921-1937). London: George Routledge & Sons, 1912-1919; Tientsin: Tientsin Press, 1921/22-1929/30; Shanghai: North China Daily News & Herald, 1931-39.
8) Du Yangeng (1935) "Jianzhu shuomingshu (Building specification)", *Jianzhu Yuekan* 3, no. 8, p.4.
9) Emms, A. (1937) "The practice of joinery and carpentry amongst the Chinese of the Yangtze Valley", *Proceedings of the Society and Report of the Council 1936-1937*, pp.1-78.
10) Herrmann, A. (1935) *Historical and commercial atlas of China*. Cambridge, Mass.: Harvard University Press, pp.6-7.
11) Hommel, Rudolf P. (1937) *China at work*. Cambridge, Mass.: M.I.T. Press.
12) Hua Tongzai (1919) *Jianzhu cailiao zuoyao* (A summary of building construction materials).
13) Jernigan, T. R. (1904) *China's business methods and policy*. London: T. Fisher Unwin, pp.180-81.
14) Jin Li (1991) "Yangsong qingxiao yu Yingshang Xiangtai Muhang jiaoshe'an (The case of China Import & Export Lumber Company, Ltd. and the dumping of Oregon pine)", *Ningbo wenshi ziliao* 9.
15) Li Boning (1953) *Xin Zhongguo tumu gongcheng shouce* (Civil engineering manual of New China). Shanghai: Zhongguo kexue tushu yiqi gongsi, pp.76-80.
16) Li Zhen (2006) *Zhongguo chuantong jianzhu xingzhi yu gongyi* (Form and crafts of Chinese traditional buildings). Shanghai: Tongji daxue chubanshe.
17) Lin Dau-Yang (1916) "China and Forestry", *Far Eastern Review*, August, pp.103-10.
18) Lowdermilk, W. (1926) "Forest destruction and slope denudation in the province of Shansi", *China Journal of Science & Art* 4, pp.127-35.
19) Rosenbluth, R. (1912) "Forests and timber trade of the Chinese Empire", *Forestry Quarterly* 10, Ithaca, N.Y., pp.647-72.
20) Shaw, N. (1914) *Chinese forest trees and timber supply*. London: T. Fisher Unwin.
21) Schneider, E. E. (1916) "Philippine Woods in the China market", *Far Eastern Review*, February, pp.348-52.
22) Shen Hua (1993) *Shanghai Lilong minju* (Shanghai Lilong dwelling house). Beijing: Zhongguo jianzhu gongye chubanshe, p.14.
23) Sherfesee, Forsythe (1916) "The Chinese Forests Service", *Far Eastern Review*, September, p.143.
24) Smedley, J. D. (1905) "Chinese buildings", *SSEA Proceedings 1904-5*, pp.159-61.
25) Stuart, William (1902) "The value of Chinese as compared with white labour", *SSEA Proceedings 1901-2*, pp.75-97.
26) Tang Yao (1936) *Zhongguo mucai xue* (Chinese study of timber). Shanghai: Shangwu yinshuguan.
27) "Tarriff on imports", *NCH*, 8 December 1860, p.541.
28) Williams, S. W. (4th edn, 1856; 5th edn, 1863) *A Chinese commercial guide*.
29) Yang Bingde (2002) *Zhongguo jindai zhongxi jianzhu wenhua jiaorong shi* (The combination history of Sino-West architectural culture in modern times of China). Wuhan: Hubei jiaoyu chubanshe, pp.230-47.
30) Yang C., *et al.* (1931) "Table V. Value of import trade by classes of commodities (1867-1928)", in *Statistics of China's Foreign Trades During the Last Sixty-Five Years*. National Research Institute of Social Sciences Academia Sinica, p.19.
31) Yao Chengzu (1979) *Yao Chengzu Yingzao fayuan tu* (Yao Chengzu's original drawings for Yingzao Fayuan). Shanghai: Tongji Daxue Jianzhu Xi.
32) Zheng Hongbin (2014) "Shanghai Sanyi Jiaotang: yizuo Yingguo qiaomin jiaotang de sheji shi (1847-1893) (Trinity Church: the design history of an English residents' church in Shanghai, 1847-1893)", *Jianzhu shi* 33, pp.151-63.
33) Zhonghua Zhiye Xuexiao (China Occupation School) (1934) *Jianzhu zhitu* (Construction drawing). Shanghai: Zhonghua Zhiye Xuexiao, p.41.
34) Zhu Jinan (2012) *Yingzao Fayuan quanshi* (An interpretation of Yingzao Fayuan) Beijing: Zhongguo jianzhu gongye chubanshe, pp.4, 339.
35) Zhu Rong (2011) "Cong chuantong dao jindai de shanbian: Mushang Gongsuo gouchen (Evolvement from traditional to modern: a history of the Timber Trade Guild)", in *Shanghai huiguan shi, vol. 1* (Shanghai guild studies), ed. by Shanghai Sanshan Huiguan guanlichu. Shanghai: Shanghai Shehui Kexueyuan chubanshe, pp.114-28.