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Three-dimensional morphological research on the alley space of Lilong Housing — A comparative study of Japanese and French Concession in Tianjin, China

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Abstract

Lilong housing as a kind of dwelling housing was born during the modernization process of Chinese housing from 1840s. Large amounts of Lilong Housing were constructed in Tianjin from 1860s to 1940s, which formed the basic city fabric till now. Many researches focus on alley space which is very typical in Lilong housing, and some achieves are of classification by typological methods. However, most of them are based on planar analysis, though the space of alleys is three-dimensional, and the difference between different Concessions are rarely mentioned.

This paper focused on the alleys' three-dimensional morphological characteristics, especially on the aspect ratio and the interface changing in different alleys in the sequence from the city to the house. Meanwhile this study is based on the previous classification of alley's structure: line-type, fishbone-type and loop-type. Firstly, the typology depth of planar structure is studied base on the previous classification. Secondly, the redefined Alley Aspect Ratio is calculated, clear differences between Japanese Concession and French Concession are shown. Finally, typology depth was connected to the section according to the planar structure to reveal the prototype of alley space in different Concessions.

According the research, it is found that 3D characteristics have remarkable differences in the same planar type. Further, the spatial characteristic of alleys has different tendency between two Concessions. Therefore, this paper suggests that in the colonial period, the planning concepts of different colonial countries guided the construction of Concessions, and ultimately acted on the alley spaces of the residence. This paper provides new perspective to explain the forming reasons of the complex urban fabric of Tianjin in modern times.

Keyword: *Comparison of Concession, Alley Space, Three-dimensional Morphology*

Introduction

Lilong Housing was an important residential building type in modern China from the mid-19th century to the mid-20th century, it was distributed in the Concessions and their surrounding areas of modern trading port, such as Shanghai, Tianjin, Wuhan and so on. Lilong blocks constitute the most important geographical features of modern cities and fill in the basic texture of the city till now (Li, 2014, p.35).

Tianjin played an important role in modern Chinese history. From the port opening in 1860 to the stop of Concession construction in 1945, 9 countries had set up Concessions in Tianjin, including Britain, France, the United States and Japan, with self-governed urban planning and construction activities (Shang, 1996, p.1). Lilong Housing constructed in modern times accounted for more than two-thirds of the city's residential area

in 1963 when the survey organized by Tianjin municipal government written by Modern Tianjin Research Group (1963, p.4).

As a unique residential type that contains both internal space and outdoor space, previous studies have focused on the house type and its evolution, but paid less attention to the alley space which is the transitional level between the residence and the city. Alley space has a high research value, because it reflects the plane organizational relationship of the low-rise and high-density building group as well as the relationship between them and the city.

A quantitative study on the alley space has tried in this paper to establish the corresponding relationship between the plane structure and the three-dimensional morphology. By comparing the alley space in two adjacent Concessions in Tianjin (Japanese and French Concession), the different depth between the residence and the city and the reasons are analysed (Figure 1).

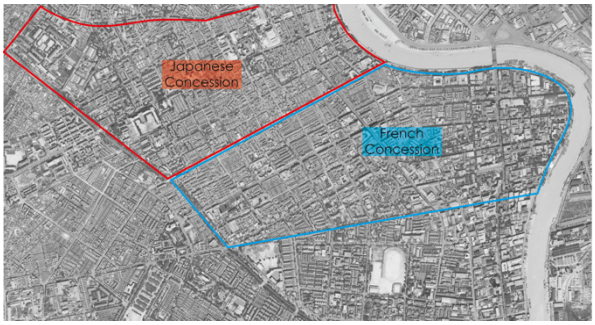

Figure 1. *The region of the original Japanese and French Concessions in Tianjin*

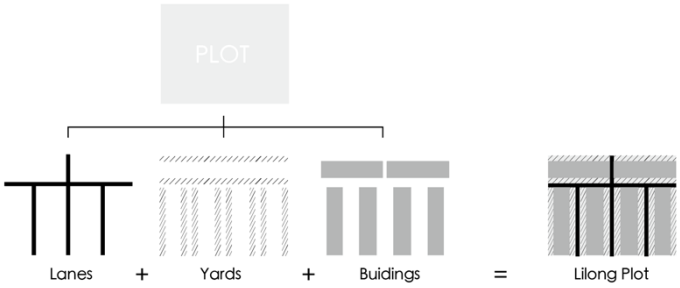

Figure 2. *The composition of the Lilong plot*

Background

Lilong Housing is considered to be a residential community type formed by several buildings which constituted by one or more repeated house type (Liu, 2016), and these buildings formed a group which has obvious internal alley space. Arranged in many rows, the layout was once thought to be the embodiment of the capitalist productivity of high-density buildings (Bracken, 2015).

However, compared with the British terraced house driven by capitalist production efficiency at the same time, Lilong Housing showed different characteristics: it inherited the practice that the gate was opened towards the alleyway instead of facing the street which always appeared in the Chinese traditional residence (Wei,2007). Therefore, alley space is a necessary part of the Lilong Housing. From the perspective of private property, alley space is the public space in the community which constituted the whole Lilong Plot together with private buildings (Bracken, 2015) (Figure 2). From the perspective of blocks and streets, it extended the system of urban streets as a part of urban traffic (Kang,2019). From the pedestrian perspective, it is the only way from the city to the house, and it is formed naturally after the fixed layout and defined by the buildings on both sides (Zhu,2002). Therefore, the alley space is affected by the interface form and building interval, so different alleys have different atmospheres rather than homogeneous space.

Background of Li

Because the whole area called Li is a group formed by different number of row buildings, it has different plane organization structure. In this paper, 61 Li with alley space are identified in two Concessions, with an average of 2-3 alleys in each one and they were placed in the block map (Figure 3), with a total of 176 alleys (Table 1).

Table 1. The number of Lilong Housing samples

	Numbers of Li	Numbers of Alleys	Average Alleys in one Li
Japanese Concession	24	65	2.7
French Concession	37	111	3
Total	61	176	2.9

Figure 3. *Lilong Housings in the block map*

To sum up, the research object is the alley space of Lilong Housing in the Concession area of Tianjin in the period of mid-19th century to the mid-20th century. The purpose is to explore the plane and three-dimensional morphological characteristics of alley space, in order to clarify the depth

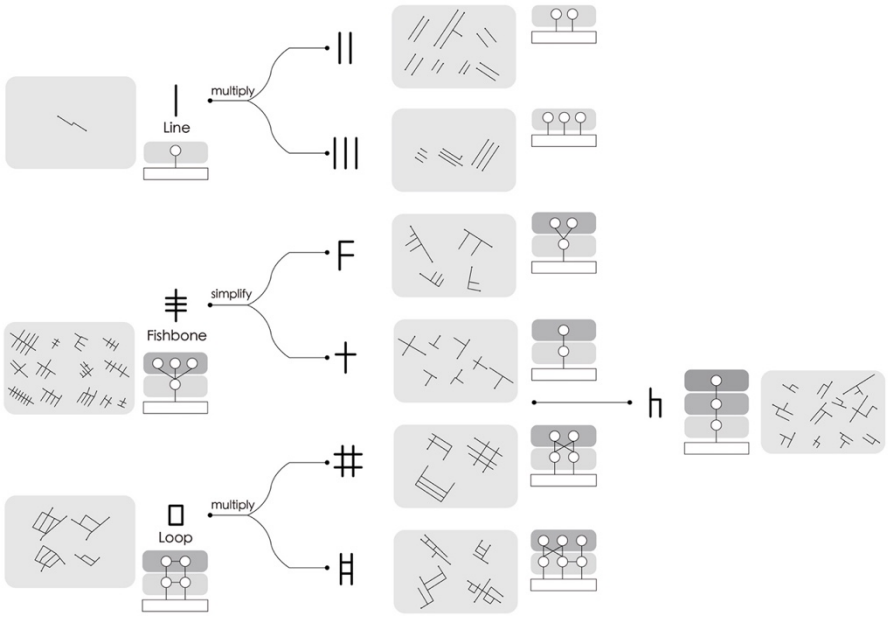

Figure 4. *Alley planar type and topological diagram*

between the city and the residence, and further study the influence on city texture by the independent Concession subjects.

Methodology

According to the characteristics of the planar structure of alleys, it can be classified into three main types: Line, Fish-bone and Loop, and the types become complicated or simplified on these three basic types. Among them, Type Line use the principle of replication to produce 2-3 parallel alleys. Type Fish-bone simplified itself to become the F type by cancelling the one-side alleys, or reduce the parallel alleys to become the ┼ type, and then further simplified to be the T and H type. Type Loop has the alleys which all become entrance to the city on the basis of inner circle way, to form a grid-shape alley further.

Further, based on the planar structure, the Alley Topology is defined according to the depth between the alley and the city, as well as alleys and alleys. One linear, unturning alley is abstracted as a point, and the connection between alleys and the city is abstracted as a line. If the alley is broken by another one but no turning point (such as T type), it is still abstracted as a point.

The topological diagram shows that different alleys are in different depths. Using the difference of the background colour from light to dark, it can be seen that the spatial depth of the Line is generally shallow, and most of them only have the one level that connected with the street. While the depth of Fish-bone is generally deep, manifested as a transition from one level to the next, and there is deeper and deeper cul-de-sac. The alleys of Loop are equally distributed in two levels (Figure 4).

To sum up, in terms of planar structure, alleys are first divided into three types, namely, Line, Fish-bone and Loop, and then the types had simplified or complicated transformation. When these types are abstractly classified in topological diagram, it can be concluded that the structures are gradually complicated from Line to Fish-bone and then to Loop. Similarly, the depth of the topology increases gradually from Line to Fish-bone and Loop.

After the research on the planar structure, it is found in the field research that although they are linear in plan, different alleys have great differences in three-dimensional forms, which are mainly manifested as different interfaces on both sides and different building intervals. Therefore, this section includes the three-dimensional form of alleys into the study, and obtains the interface and storey height data of Lilong Housings from the historical map.

Aspect Ratio is a parameter to measure the sense of enclosure on street and reflect the characteristics of three-dimensional space. In the article, it is used to measure the size of the three-dimensional alley. In the calculation of Aspect Ratio, D refers to the width of the street, and H refers to the height of the building's exterior wall. When D/H >1, the increasing of the ratio produces a sense of distance and when the ratio exceeds 2, the feeling of broad and not-surrounded is generated. When D/H is less than 1, the decreasing of the ratio will produce a sense of proximity. When D/H =1, it’s an ideal distance (Ashihara, 2006, P.207).

According to the method of Street Aspect Ratio as mentioned above, D is the alley width of fence to fence, and H is the building storey height. It is found that among the 176 alleys included, the Aspect Ratio of 171 alleys is less than 1, it means that most alleys are the same to make people feel a sense of enclosure and narrow (Figure 5, left). Obviously, this method cannot fully describe the size of different alleys due to the difference of interface in field research.

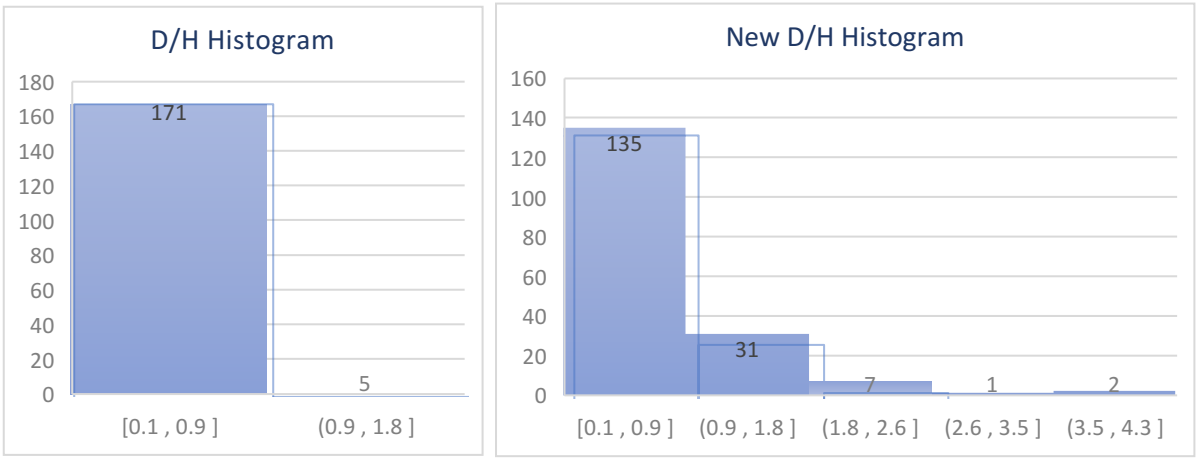

Figure 5. *Two Aspect Ratio Histograms*

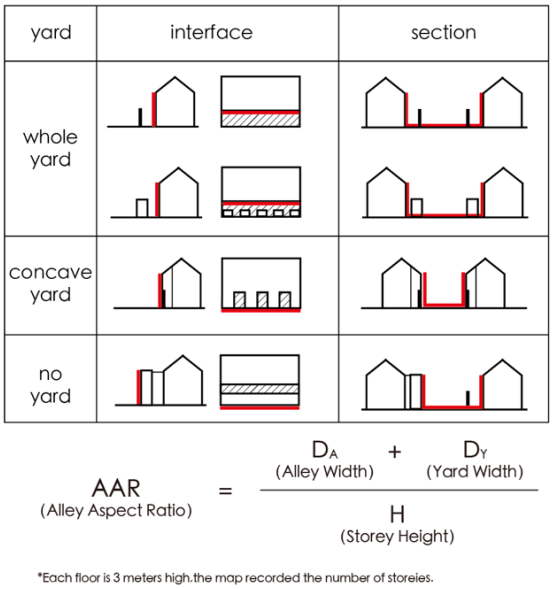

Figure 6. *The new definition of D/H*

In the application of Street Aspect Ratio, the street section is simplified as a U shape because the buildings along the street are mostly commercial, with a high near-line rate and generally without courtyards. However, in the Lilong Housing, the courtyards on both sides of the building have obvious differences in size and function, and that shape the concave and convex interface of the alley. Therefore, the courtyards are an indispensable part of the study in Lilong. Therefore, on the basis of the Street Aspect Ratio, this paper proposes the Alley Aspect Ratio (AAR), which is used to measure the alley section. In this new parameter, D is redefined as Alley& Courtyard width. For the courtyard that occupies the whole wide of the Lilong unit, its depth will be added in D. For the courtyard that occupies half a wide (or less) of the Lilong unit, the distance between the fence will still be taken as the value of D (Figure 6).

After calculation, the distribution histogram shows that the Aspect Ratio not mostly concentrates in the range of <1, but the AAR of some alleys expands due to the existence of courtyards. This means that alley is not a homogeneous space, but has a difference of size, which is affected by the interface form (Figure 5, right).

Table 2. AAR of each alleys in Qingjie Li

Qingjie Li	Alley Width (meters)	Yard Width (meters)	Storey Height (meters)	AAR
Alley 3、5	4	4.4	9	0.9
Alley 1	1.7	0	9	0.2
Alley 2、4	0.9	0	9	0.1

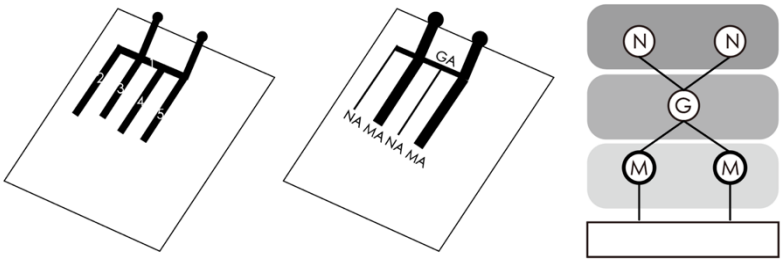

Figure 7. *Plan, plan with thickness, typology depth*

In addition to the comparison of total alleys, it is also important to study one group of Lilong Housing, which is called Li. For example, there are five alleys in Qingjie Li in the French Concession, and the AAR are calculated and shown in the following table by descending order, which can be divided into three grades: the largest (0.9), the middle (0.2) and the smallest (0.1). It is observed that AAR classification also occurs in other Li. Therefore, a Li is taken as a unit, and according to the value of AAR, the inner alleys are defined as Main Alley (MA), General Alley (GA) and Narrow Alley (NA), then they were identified in the plan by three types of lines, thick line, thin line and very thin line (Figure 7).

The MA is the most open alley in the whole area, that takes on the function of traffic and residents' activities. The GA is more enclosed than the MA, and it connects other alleys with the highest accessibility generally. Its main function is traffic and connected to the street to form a sub-entrance of the entire Li. The NA is extremely narrow and the interface on both sides is relatively closed, forming a U-shaped section. It also known as Servant Alley because it is the only way for servants to enter the backyard, but it has the same number of entrances on both sides as the MA.

Combining the alley calculated by aspect ratio with the analysis of planar topological structure in the previous chapter, 6 cases are listed as examples (Figure 8) to show the combination. It can be seen generally, that the MA with the largest AAR value is directly connected to the street and located at the shallowest depth. GA is mostly located in the second depth level, but it is the alley with the most connections. NA appear in the deepest level, where need to go through at least two levels from the city to it.

To sum up, after the definition and calculation of the AAR, it can be concluded that the AAR varies with the topological depth, namely, the closer the alley is to the city, the more complex the function is. The narrowest alleys are most away from the city which are only used by servants.

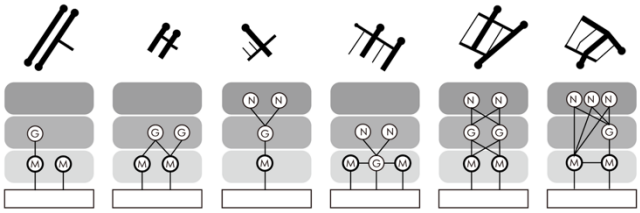

Figure 8. *Cases of AAR corresponded to typological depth diagram*

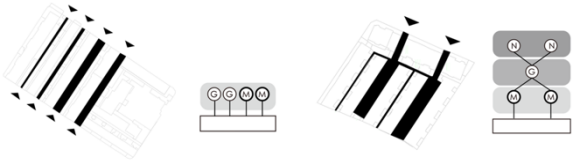

Figure 9. *The plan and typological diagram of Xiechang Li (left) and Qingjie Li (right)*

Results and Discussions

Then in different Concessions, is there morphological differences in the alley space of Lilong Housings? In the following specific cases, the planar and three-dimensional form of the alley are compared.

This paper takes Xiechang Li in the Japanese Concession and Qingjie Li in the French Concession as examples. In terms of planar form, the former is the Line shape through the plot, and four parallel alleys of different widths perpendicular to the street, and these alleys belong to the same depth level. The latter is a cul-de-sac for the plot, and the five alleys belong to three different depth levels separately, constitute the shape of Fish-bone together (Figure 9).

According to the calculated AAR, it is found that the Standard Deviation of the former Li is significantly smaller than that of the latter Li. In other words, the actual three-dimensional morphology of the former has little difference and each alley is relatively homogeneous. However, in the latter Li, the three-dimensional morphology of each alley is greatly different with obvious functional differentiation. This result conforms to the definition of MA, GA and NA in the previous discussion.

Furthermore, it is found that in the 61 Lilong cases, the Line Type is the dominant one accounting for 46% in Japanese Concession. While fish-bone Type is the dominant type in the French Concession, accounting for 70% (Figure 10). Therefore, nearly half of the alleys in the Japanese Concession are simple, not grouped, open alleys that visible to the streets. Seventy percent of the alleys in the French Concession are Fish-bone Type, with greater depth inside the plot and more complex. In this area, alleys adjacent to the city are more open, while the deeper they are, the more closed they become.

Conclusions

This paper focuses on a kind of residence from the mid-19th century to the mid-20th century, namely, Lilong Housing, and pays attention to the planar and three-dimensional morphology of its inner alley space, and compares its performance in different Concessions in modern cities. Through the method of typology and morphology, this paper finds that the planar type of alley corresponds to the topological depth, and the section form also changes with the topological depth. Furthermore, it is found that due to the different dominant types of alleys in two Concessions, the residential groups (Li) have different depths to the city. The

Li in Japanese Concession is reflected in simple structure and shallow depth, while in French Concession, it is reflected in the large depth of the plot, and the more it faces the street, the more open it is (Figure 11).

The above findings on the form of alley space reveal that in modern cities, there are differences between residential groups due to the independence of administrative subjects, which further feeds on different urban fabrics. This finding also helps to explain the forming reasons of the complex urban fabric of Tianjin in modern times under the establishment of foreign Concessions.

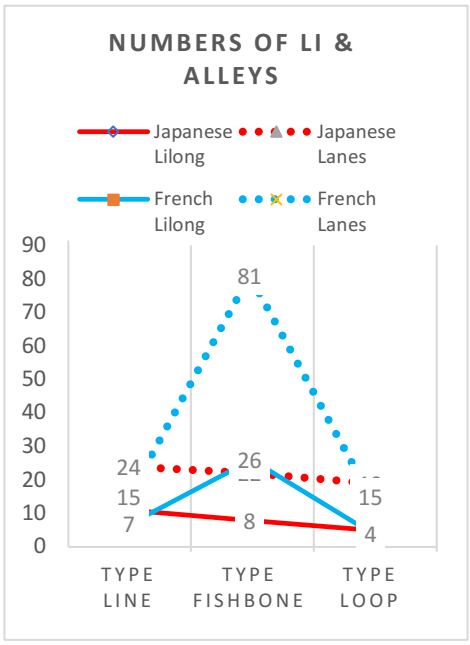

Figure 10. *The dominant type in two Concessions*

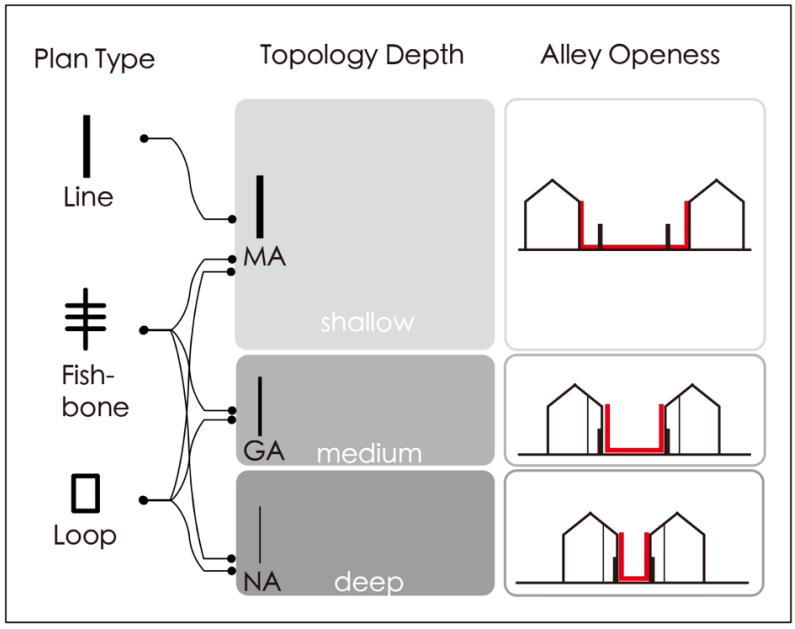

Figure 11. *Planar type, topology depth and alley section relationship diagram*

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