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Conservation, Reuse and Overwriting the Morphological Unit of Fenghuang Ancient Town

The Case of Dang Yard

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Abstract

The Fenghuang Ancient Town in Zhashui County has a history of 1,400 years ago, and it is well preserved so far. By 2010, Fenghuang Ancient Town was given the status of "Qingjiang Ancient Town Living Fossil" with mixed culture and was named as a historical and cultural town in China. Similar to the construction of ancient Chinese town space, Fenghuang Ancient Town also has a strong sense of order and a clear radial structure[1]. However, with the development of society and economy, the traditional dwellings were gradually engulfed by new buildings, and the radial structure of the ancient town was severely damaged. At the same time, the value of the rural landscape of the ancient town has been ignored and destroyed, and the backyard has gradually shrunk and disappeared.

For the continuation of the radial structure and the reproduction of the rural landscape, this paper proposes a strategy to revitalize the backyard by studying the theory of conservation, reuse and overwriting with the case study. By digging and reproducing the rural landscape, and then inserting new entertainment activities, the courtyard is activated and the attraction is increased.

For the assessment of the current status of a morphological unit[2], this thesis mainly analyzes from three aspects. For the analysis of historical context, it mainly summarizes the important historical elements and landscape of the area. In-depth mapping survey on features of the architecture. For typology study on buildings, through the investigation of each building in the area, they are divided into types to summarize the characteristics and existing problems of different types of buildings.

As to the design part, courtyard design is based on the revitalization strategy, enhance the historical wall as the focal point and overwriting[3] the backyard based on original usage, as well

1 The idea of 'radial structure' comes from prof. Laura Anna Pezzetti's book which is 'Layered Morphologies and Latent Structures—Reading, Decoding and Rewriting Enhance Historic Rurban Landscape' in 2019.

2 The idea of 'morphological unit' comes from prof. Laura Anna Pezzetti's book which is 'Layered Morphologies and Latent Structures—Reading, Decoding and Rewriting Enhance Historic Rurban Landscape'.

3 The idea of 'overwriting' comes from porf. Laura Anna Pezzetti. Overwriting the Urban Palimpsest: A Regeneration Structure for Historic Public Spaces and Buildings.2017

as insert leisure facilities. Meanwhile, the road in the entire area project is re-planned to the activation of the courtyard provides the premise. For the design of the area, not only focus on the main backyard, but also consider the impact on the surrounding backyard during the design process.

In terms of architectural design, it is designed to protect and reuse Dang Yard. Based on the decay analysis of Dang Yard, combined with the design of continuity[4], the reuse of the traditional dwelling focus on the restoration of the *Zhaiyuan* type, the continuity of the 'Front Store, Back House' form and preservation of the featured elements, such as the lantern roof, removable door panel and fire wall. At the same time, the design considered the adaptive reuse of the secondary floor and modern life. To improve the living condition of the traditional dwelling, some measures are necessary to take. What's more, to highlight the historical wall and the value, two new volumes are inserted.

Keywords: conservation reuse overwriting Fenghuang Ancient town

4 The concept of 'continuity' comes from Emesto N. Rogers, which author got from the lecture of prof. Fulvio Irace in Polimi.

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Overall Understanding of Fenghuang Ancient Town

1. Overall Understanding of Fenghuang Ancient Town

1.1. Urban Radial Structure[1] Impacts from Geographical Conditions and Habitat Concept

1.1.1. Geographical Location

Zhashui County belongs to Shangluo City in the south of Shaanxi Province. It is located at the southern foot of Qinling Mountains, near Xi'an, and upstream of Qianyou River (old zhashui). It borders Shangzhou City and Shanyang County in the east, Zhen'an County in the south, Ningshan County in the west, and Qinling Mountain in the north with Chang'an and Lantian. *(Fig.1.1)*

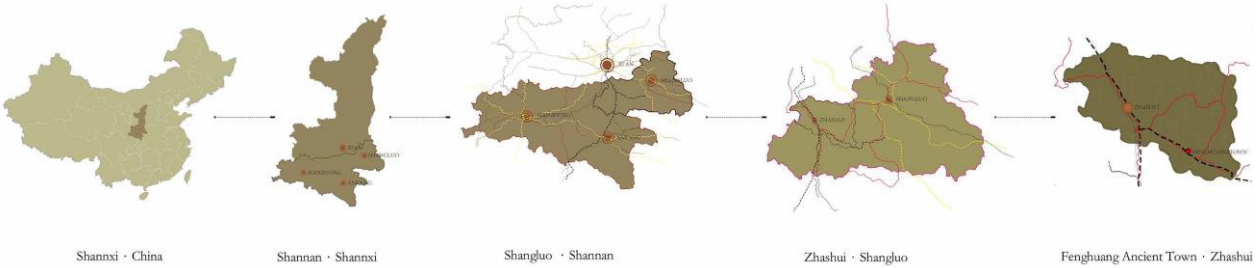

Fig. 1.1 The location of Fenghuang Ancient Town in Zhashui County
(Elaboration by author based on Google Earth and Gaode Map, 2018)

Fenghuang Ancient Town is located on the banks of Shechuan River in the southeast of Zhashui County, 45 kilometers away from the county seat and 116 kilometers away from Xi'an City. At present, the G65 Baomao Motorway connects Xi'an and Zhashui County, and the Shuiyang Motorway (formerly Shanzha Motorway) has been opened to traffic. From Xi'an, it takes about two hours by car to reach Fenghuang Ancient Town. The town is well connected, with Luozha highway passing through from east to west and two highways connecting from north to south.

1 The idea of 'radial structure' comes from prof. Laura Anna Pezzetti's book which is 'Layered Morphologies and Latent Structures—Reading, Decoding and Rewriting Enhance Historic Rurban Landscape' in 2019.

1.1.2. Landscape Conditions

The Fenghuang Ancient Town is located in the Chuandao Valley surrounded by mountains in the southern foothills of the Qinling Mountains, and the average terrain is higher. The riverway where it is located is a valley plain formed by the alluvial floods of the Shechuan River. On the north side is Fenghuang Mountain, on the southwest side is the Daliang Mountain Range where Yingpan Mountain is located. Surrounded by mountains on three sides, only the east side is wider. The Shechuan River flows here from west to east, and the Shuidi River and the Zao River merge into the Shechuan River from the north and south sides. The area where these three rivers connect where the ancient town is located has flat land and sufficient water resources, which is suitable for cultivation. *(Fig.1.2)*

The tall mountain surrounded by the Fenghuang Ancient Town on three sides has become a natural barrier for the ancient town. On the one hand, it can become a natural mountain city in the ancient times to defend the village and protect the safety of the ancient town. This has also become an important basis for the ancient ancestors to build towns here; On the other hand, it can also effectively block the cold air from the north and stabilize the natural ecological climate of the valley basin, which is suitable for agricultural production. Among them, Fenghuang Mountain is rich in forest and stone resources. The raw materials for the ancient houses used to build the Fenghuang Ancient Town are all derived from this. At the same time, the animals, plants and local products in the mountains are rich in materials.

In addition, the Shechuan River, as the mother river of the ancient town, flows through the valley, bringing stable water to this area, and it has also become a transportation route for the Fegnhuang Ancient Town to transport and trade to the outside in old time. The mountains and rivers surrounded by the Fegnhuang Ancient Town are densely covered with vegetation, the rivers of the Shechuan River are gurgling, and the mountains and rivers are shining together, forming a unique natural landscape of the town. *(Fig.1.3)* The surrounding mountains and rivers have created favorable conditions for the development of ancient towns. Since ancient times, ancestors have gathered and lived here. The ancestors of Fenghuang Ancient Town combined the resource advantages of mountains and waters, and attached great importance to the mountains and rivers for urban construction, making the ancient town a model of combining

and practicing Chinese traditional human settlement environment ideas with the help of mountain and water construction. Unfortunately, the waters of Shechuan River have almost dried up now.

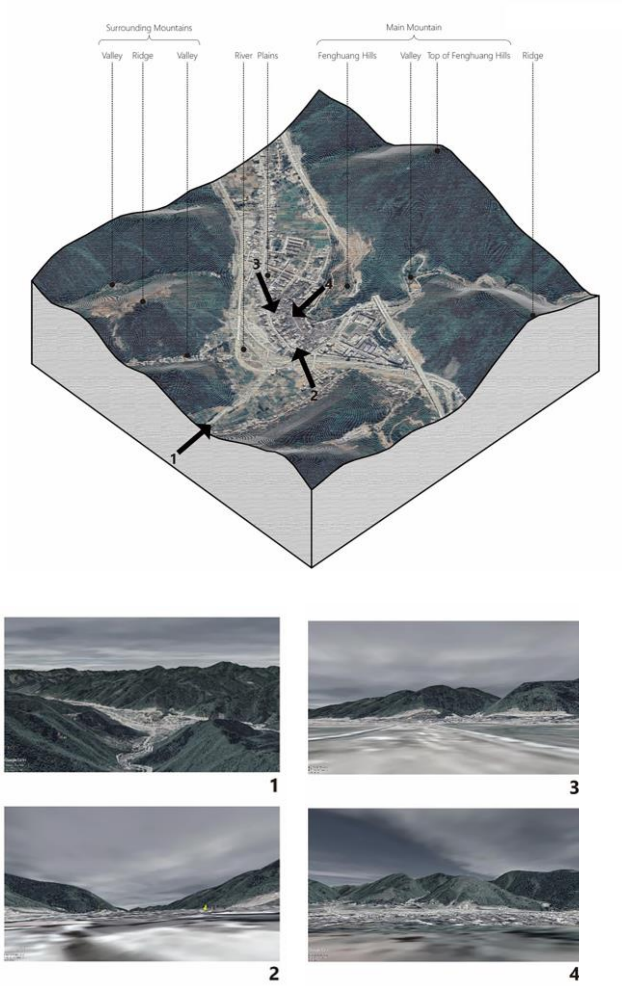

Fig. 1.3 The geomorphology of Ancient Town
(Elaboration by author with Xiong Zesong based on Google Earth orthophoto,2018)

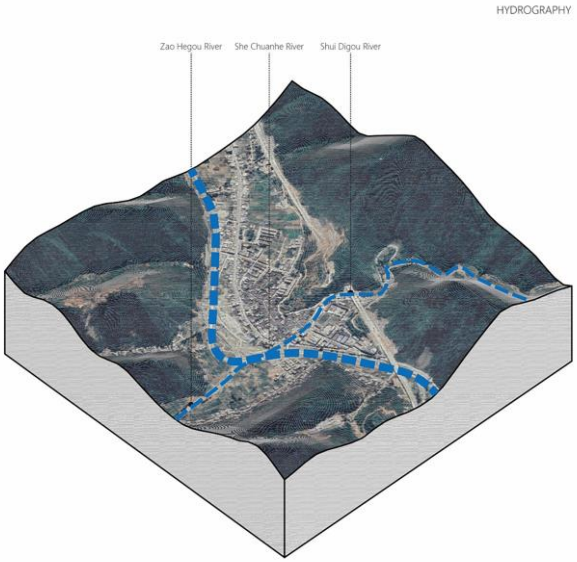

Fig. 1.2 The hydrography of Ancient Town
(Elaboration by author with Xiong Zesong based on Google Earth orthophoto,2018)

1.1.3. Habitat Environment

(1) Road's Network

Roads' network, including external system and internal system. The external transportation system includes S307 Provincial Highway, Shanzha Expressway, and several highways leading to nearby villages and towns. The provincial road is located on the north side of the ancient town and the south side of the Shechuan River. It runs through the ancient town and forms a new but relatively depressed commercial street in the ancient town. The Shanzha Expressway is located on the south side of the ancient town and runs through Daliang Mountain. It was opened to traffic at the end of December 2018.[2] It is an important channel to promote the development of the tourism economy in the three cities of southern Shaanxi (Shangluo, Ankang, Hanzhong). There are many villages and towns around Fenghuang ancient town, and the other roads in the ancient town are the main roads leading to these villages and towns. *(Fig.1.4)*

The internal system is mainly composed of "S" -shaped ancient streets that run through the entire ancient town, as well as multiple paths. The historical and commercial Old Street[3] is the core area of the entire Fenghuang ancient town. It is called Fenghuang Old Street which is the main road of the pedestrian route, starting from the old bridge in the western town and ending at the secondary entrance in the east. The street space of Old Street combines the *matou qiang*(the 'House Head' Fire Wall) and the under-eave space of shops along the street to form the spatial change of "street space-transition space (under-eave space) -commercial space". *(Fig.1.5)*

2 The information comes from http://www.jiaotongwang.cn/index/shuoye/qiyefencai/2018/1219/177613.html

3 The 'Old Street' corresponds to the area of traditional dwellings, which is mentioned in Zhashui County Local Gazetteer. Xi'an: Shaanxi People's Publishing Press, 1998, 427. （柞水县编纂委员会. 柞水县志. 西安：陕西人民出版社，1998.）

Fig. 1.4 Road's network of Fenghuang Ancient Town
(Elaboration by author based on Google Earth and Gaode Map, 2018)

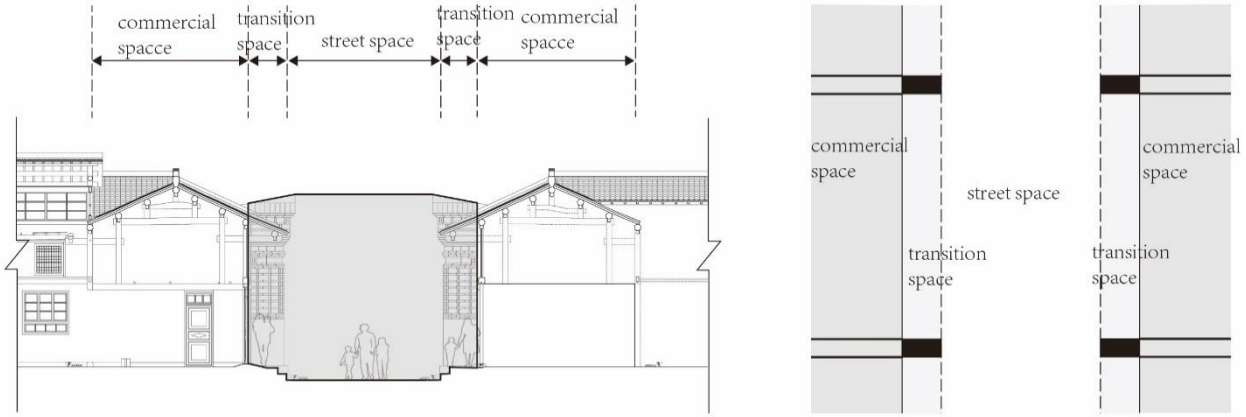

Fig. 1.5 Street space of Fenghuang old street
(Elaboration by author,2018)

At the same time, the *matou qiang* not only plays a role in limiting the space, but also makes the facade of the ancient commercial street of Fenghuang ancient town have a sense of rhythm. Each *matou qiang* is different for each household. The presence of the *matou qiang* makes the turning of the commercial street more natural.*(Fig.1.6-1.7)*

Due to the mountainous terrain of Fenghuang ancient town, the small paths and lanes have small scales and height differences.*(Fig.1.8)* Generally, the width of roads is 1.2 meters, 1.5 meters, and 2.0 meters, and the roads without paving are earth roads.

Fig. 1.6 Façade of the northern middle Old Street
(Elaboration by author during the PoliMi-XAUAT Workshop, May 2018)

Fig. 1.7 Façade of the southern middle Old Street
(Elaboration by author during the PoliMi-XAUAT Workshop, May 2018)

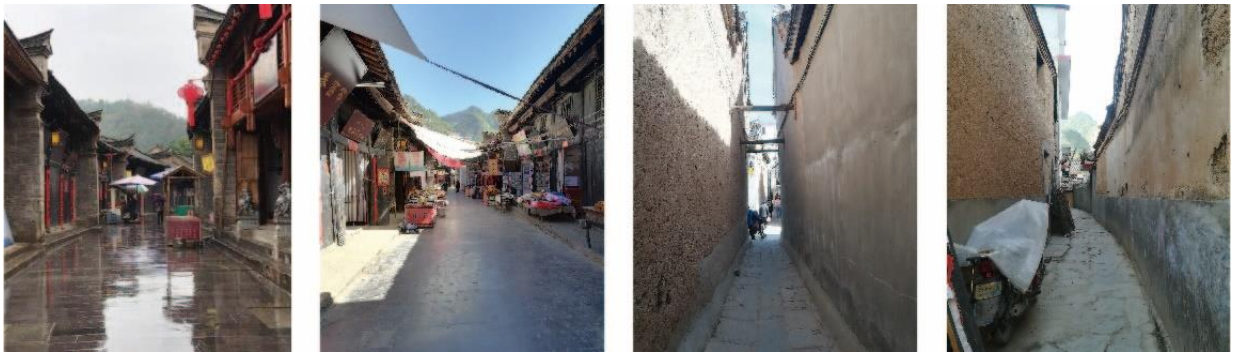

Fig. 1.8 Situation of the paths
(source: the author, 2018)

(2) Water System

The water system of Fenghuang ancient town is mainly composed of rivers surrounding the ancient town and water channels inside the ancient town. *(Fig.1.9)* There are three main rivers surrounding the ancient town, namely the Zao River, Shechuan River and Shuidi River. *(Fig.1.10)* The Zao River runs north-south and is located in the northernmost part of the ancient town. It converges with the Shechuan River and does not cross the ancient town. The Shechuan River follows the east-west direction and embraces the entire village and town. At present, the Shechuan River has a small amount of water, and a large number of river banks are exposed, and the landscape effect is poor. The Shuidi River runs from north to south, flows under the old bridge on the west side of the ancient town, and is also the main source of water in the ancient town.

The water channels inside the ancient town are mainly distributed on the north and east sides of the ancient town and on Old Street. The channel in the Old Street used to be the open channel. As the main drainage channel of the ancient street, according to the interview, when the old street still has the open channel, the villagers often wash their clothes by the open channel. The open channel becomes an important part of the living space, and But now it becomes an underground culvert, and is still the main drain of the ancient town.

Fig. 1.9 Water system of Fenghuang Ancient Town
(Elaboration by author based on Google Earth and survey during the PoliMi-XAUAT Workshop, May 2018)

Shechuan River Shuidi River Zao River

Fig. 1.10 Water situation images
(Source: the author,2018)

(3) Greenery System

The green space system of Fenghuang ancient town is mainly divided into wild fields, crops, gardens, cemetery. (Fig.1.11-1.12) There was a large area of agricultural land on the north side of Fenghuang Ancient Town, but now there is only a small area of cultivated land, and the rest are wild fields, which has not been used. In the ancient town, some backyards grow crops for self-sufficiency, which are scattered on both sides of the ancient street. Some residential backyards plant plants and arrange the backyard into a garden, which will produce a certain landscape effect. The surrounding mountains provide a good visual landscape for the ancient town. (Fig.1.13) The north side is Fenghuang Mountain, and the south side is Yingpan Mountain. A part of the north side of Yingpan Mountain serves as a cemetery for local people and cultivates crops.

garden

wild & agriculture

wild & agriculture

Fig. 1.11 Greenery situation images

(Source: the author, 2018)

Fig. 1.12 Greenery system of Fenghuang Ancient Town
(Elaboration by Laura Pezzetti with Alberto Malabarba in Laura Anna Pezzetti. *'Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape'.* Tongji University Press, 2019.)

view on the Old Street | view in the garden | view on the top of building

Fig. 1.13 Landscape corridors
(Source: the author, 2018)

1.1.4. The Radial Structure[4]

Similar to the construction of ancient Chinese town space, Fenghuang Ancient Town also has a strong sense of order and a clear axis relationship. *(Fig.1.14)* The ancient town center forms a south-north axis with Yingpan Mountain in the south and Fenghuang Mountain in the north. The ancient streets in the ancient town form the east-west axis, which conforms to the trend of the mountain and the flow of water. *(Fig.1.15)*

The buildings in the ancient town form a centripetal linear layout perpendicular to the ancient street, forming multiple secondary linear axes. The radial structure[4] not only affected the overall structure of the ancient town, but also penetrated into the interior of the ancient town. These secondary axes are also the growth trajectories of ancient town buildings, and also reveal the trend of building development from the old buildings on both sides of the ancient street to the outside. From the photos of the Fenghuang ancient town in 1957/1958/2018, the buildings on both sides of the old street have only a part of the street from the beginning, and gradually developed along the radial direction of the radial structure. *(Fig.1.16-1.18)* Most of the new buildings now continue this structural development. The backyard after the building is also affected by the strip, and it also follows the vertical development in the division of the courtyard. *(Fig.1.19)*

The Fenghuang ancient town still has "historical evidence" of the formation and development of radial structures. [5]The first is the Fire Wall, the product of the fusion of Qin and Chu cultures in the ancient town, which originated from the Hui style architecture. It is not only one of the important elements of architectural features, but also a representative of the existence of radial structural materials in ancient towns. The ancient town used a Fire Wall to divide homesteads and neighborhood buildings. The second physical evidence is the boundary of the field that existed before 1958 on the north side of Fenghuang Ancient Town. It is obvious from the figure that the boundary forms a radial structure centered on Yingpan Mountain, which is consistent with the arrangement of the enclosed Fire Wall. *(Fig.1.20)*

4 The idea of 'radial structure' comes from prof. Laura Anna Pezzetti's book which is 'Layered Morphologies and Latent Structures—Reading, Decoding and Rewriting Enhance Historic Rurban Landscape' in 2019.

5 The summary of the 'historical evidence' of radial structure comes from the lecture and discussion with prof. Laura Anna Pezzetti during 2018 to 2019.

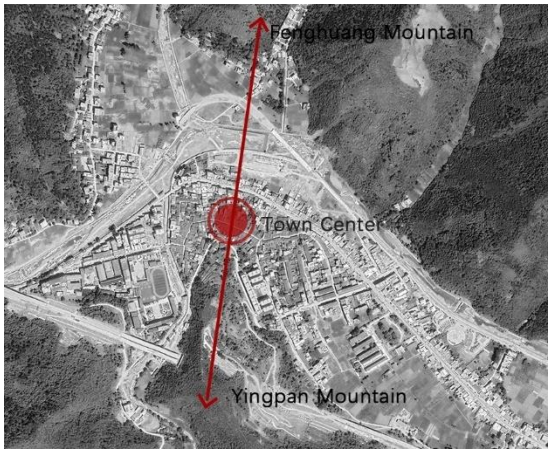

Fig. 1.14 The north-south axis
(Elaboration by author based on Google Earth, 2018)

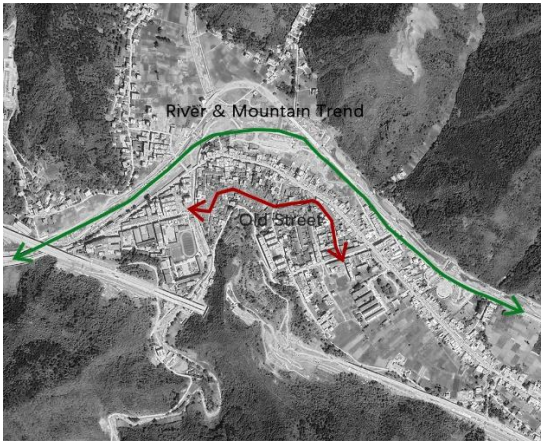

Fig. 1.15 The east-west axis
(Elaboration by author based on Google Earth, 2018)

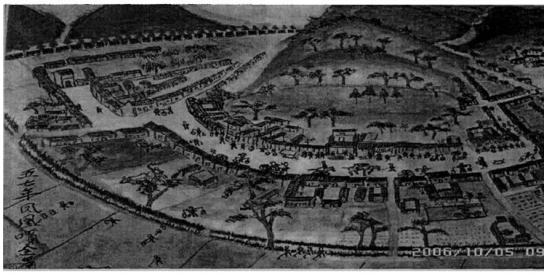

Fig. 1.16 1957 Fenghuang Ancient Town
(Source: Gao, 2008)

Fig. 1.17 1958 Fenghuang Ancient Town
(Source: Fenghuang Old Town Tourism Development and Construction Management Committee)

Fig. 1.18 2018 Fenghuang Ancient Town
(Source: Drone survey made during the PoliMi-XAUAT Workshop, May 2018)

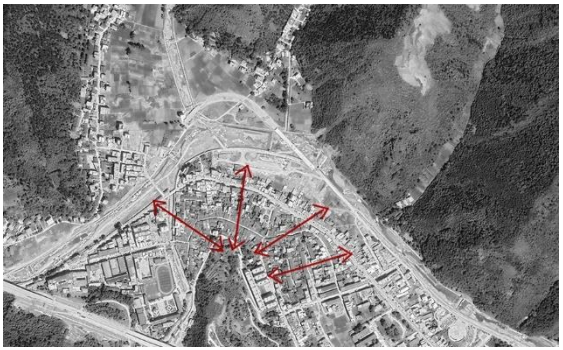

Fig. 1.19 Radial structure of Fenghuang Ancient Town
(Elaboration by author based on Google Earth, 2018)

Fig. 1.20 History mapping of Fenghuang Ancient Town
(Elaboration by Laura Pezzetti with Alberto Malabarba in Laura Anna Pezzetti. *'Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape'.* Tongji University Press, 2019.)

1.2. Urban Texture Evolution Influenced by Historical Factors

1.2.1. The History Development of Fenghuang Ancient Town

The Fenghuang Ancient Town has a long history and profound cultural heritage. Since the Tang Dynasty, it has experienced five dynasties, Song, Liao, Yuan, Ming, and Qing dynasties. *(Table 1.1)* The ancient town has developed into a market since the Tang Dynasty. Since then, it has been dominated by commerce and trade, especially the distribution of agricultural and sideline products. By the Ming and Qing Dynasties, it had developed into one of the four major commercial towns in Shangluo.

According to the "Zhashui County Local Gazetteer", the court in the seventh year of Tang Wude (624) on March 29 set the average land. In the eighth year (625), people from Hubei and Hunan have settled in Sancha Hekou(三叉河口， the name of Fenghuang Ancient Town in Tang and Song Dynasty) to accept the average land, and 53 households have reached the end of the year. Due to fertile land, abundant rainfall, mild climate, suitable for crop growth, Wude nine years (626), settlers in Sancha Hekou has reached 121 households. Tang Wansui Tongtian's first year (696) After Fengyang land was placed in Anye County, the goods transported from the river moved to Sancha Hekou, although there was no market, but there was little small trade. However, due to frequent wars in the late Tang Dynasty, the area where the ancient town was located was destroyed.[6]

Between Yuan and Ming Dynasty, the central government set up "Shechuanhe Township Capital" and "Shechuanli" (the name change is shown in Table 2.1), [7]where the economy and population have developed, and residents can reach hundreds of households. At the end of the Ming Dynasty, Li Zicheng had frequent rebel movements, mostly stationed at the Sancha Hekou. Officers and soldiers came to fight. The two sides fought many times and the streets were burned.

During the Shunzhi era of Qing Dynasty, due to the convenience of water transportation, businessmen from many places were attracted. They came here to do business for a long time, and some people gradually settled here. In the fourteenth year of the Kangxi period of the Qing Dynasty (1675), in September, Wu Sangui became queen of Pingxi. Wu Jiangtang led the soldiers to take Zhen'an from Xing'an (now Ankang). Burned out. In July of the sixth year of Qianlong (1741), because of the reclamation policy, Hubei reclaimers began to settle here. There were 147 residents in Jiaqing during the year; there had 167 residents in the second year of Daoguang period(1822). When the Fenghuang Mouth to Xi'an Mule Road was opened up and traveled, it was cloudy at Fenghuang Mouth, so the order day market was set. In the thirteenth year of Jiaqing, Kang Yongsheng came to live here and started large-scale business.

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6 Compilation Committee of Zhashui County Local Gazetteer. Zhashui County Local Gazetteer. Xi'an: Shaanxi People's Publishing Press, 1998. （柞水县编纂委员会. 柞水县志. 西安：陕西人民出版社，1998.）.

7 Lu, Peng. 'Research on the spatial form characteristics of streets and alleys and houses in Fenghuang ancient town'. Master Disss,. Chang'an University. 2018. （卢鹏. 凤凰古镇街巷及民居空间形态特征研究. 硕士论文，长安大学. 2018.）

He opened up land transportation and water transportation, greatly expanded the commercial scope of the ancient town, and made the commercial trade of the entire ancient town more prosperous.[6]

By the end of the Qing Dynasty, the commercial development of the ancient town reached its peak, and many old brands and Old banks were established and operated along the old streets. The ancient town has a stable commercial position in the southern foothills of the Qinling Mountains. It connects the two major river systems of the Yangtze River and the Yellow River, and has two modes of waterway and land. For now, many old workshops, old craftsmanship and more than one hundred ancient residences from the Ming and Qing Dynasties are still preserved, gathered on Fengzhen Old Street. Many local people still vaguely retain ancient traditional traces in the production and lifestyle of the local people.

From the history of town development in Fenghuang Ancient Town for more than 1400 years, we can see that due to the important access roads and traffic routes in the north and south of the Qinling Mountains, the commercial and trade circulation is developed in peacetime, and the unique natural and social environment. Historically, it has been an important business and education central town in the region. At the same time, as a military necessity to enter the Guanzhong area(the middle Shaanxi), it has become a battleground for military strategists. This has also promoted population migration and cultural exchange in the area where Fenghuang Ancient Town is located, creating the unique characteristics of ancient residential construction and urban style of Fenghuang Ancient Town.

The ancient town of Fenghuang has experienced three destructions and three reconstructions. *(Table 1.1, 1.2)* Now it is combined with historical time and events to sort them out as follows:

Table 1.1 Historical Development of Fenghuang Ancient Town
(Elaboration by author based on *Compilatio*n Committee Zhashui County Local Gazetteer. Zhashui County Local Gazetteer. Xi'an: Shaanxi People's Publishing Press, 1998. and *Gao Lin. 'Study on Ancient Villages of Fenhuang Town, Zhashui County'. Master Diss., XAUAT. 2008.*)

TIME	EVENTS	PERIOD
Tang Dynasty 7th year in Wude period （AD 624）	"Average farming system" promotes agricultural development, people from Hunan and Hubei come here to live and work	Formation Period

Tang Dynasty 1st year in Wansui Tongtian period （AD 696）	The Sancha Hekou has developed water transportation, and the regional trade transit hub has rapidly developed into a trade distribution market.	Market Formation
Late Ming Dynasty （AD 1633）	Li Zicheng, a peasant uprising army, fought against the Ming Army in Fenghuang Ancient Town	First Destroyed
Early Qing Dynasty （AD1646）	White Lotus Group campaigned in Shangluo (leader Wang Cong'er)	
Qing Dynasty 1st year in Shunzhi period （AD1666）	Promulgation of the "Reclamation Order" to promote the migration of southern residents to the north	First Rebuilt
Qing Dynasty 14th year in Shunzhi period （AD1657）	Promulgating the "Regulations on Encouraging and Punishing Land Reclamation" to promote agricultural development	
Qing Dynasty 18th year in Shunzhi period （AD1661）	Promulgated the "Relocation Order" to encourage reclamation and reduce taxes	
Qing Dynasty 14th year in Kangxi period （AD1675）	Wu Sangui burned the rebuilt street building on the grounds of "Li Zicheng's Lair"	Second Destroyed
Qing Dynasty 20th year in Kangxi period （AD1681））	Thin tax policy, a large number of victims in the south flow into Shangluo	Second Rebuilt
Qing Dynasty 13th year in Jiaqing period （AD1808）	Kang Yongsheng settled in "Shangmengli", at this time the business was prosperous for a while, and the ancient town was known as "little Shanghai"	
Qing Dynasty 2nd year in Daoguang period （AD1822）	The ancient town becomes a fixed market	
Late Qing and Early Republic	Business prosperity and become an important business market town	

3rd year in Republic of China (AD 1914)	The leader of the civil crusade, Bai Lang, marched into Fenghuang Mouth, broke the wall, burnt down the house, the barren fields, and the commercial depression	Third Destroyed
17rd year in Republic of China （AD 1928-1931）	Three years of drought in Shaanxi, the victims settled here.	Third Rebuilt
1930s	Decline in water transportation, development of highways, decline of Fenghuang ancient town	

Table 1.2 Name Changes and Development of Fenghuang Ancient Town
(Elaboration by author based on *Lu Peng. 'Research on the spatial form characteristics of streets and alleys and houses in Fenghuang ancient town'. Master Diss., Chang'an University. 2018.*)

TIME	NAME OF THE TOWN	REASON
Tang and Song Dynasty	Sancha Hekou	Shechuan River, Zao Rive, Shuidigou River, three rivers connect
Yuan Dynasty	Shechuanhe Township Capital	Because of the Shechuan River
After 15th year in Chenghua period of Ming Dynasty （AD 1479）	Shehcuan Li、Shangmeng Li	Because of the Shechuan River
During Jiaqing period of Qing Dynasty	Fenghuang Mouth	Because of the Fenghuang Mountain
1949-1984	Fenghuang Township (Commune)	Because of the Fenghuang Mountain
1985	Fenghuang Town	Because of the Fenghuang Mountain
2010 to present	Fenghuang Ancient Town	China National Cultural Heritage Administration named it as a famous historical and cultural town in China

1.2.2. The Urban Texture Evolution of Fenghuang Ancient Town

Combining the historical formation and development process of Fenghuang Ancient Town in Zhashui County, the spatial pattern evolution of Fenghuang Ancient Town can be summarized into four stages: 'point distribution-linear connection-framework growth-block

filling'.[8] *(Fig.1.21)*

1. Tang Dynasty period--point distribution. The spatial pattern of point distribution is the shape of the ancient town in the eighth year of Tang Wude period(625). The first batch of residents who came here to settle down were called by the 'Average system' to build houses in scattered places in the ancient town. The idea of "unity of man and nature" and "advocating nature" urged the immigrants to conform to the mountain and water during construction, thus laying the rudiment of the ancient street.

2. Ming and Qing Dynasties--linear connection. Commercial activities have taken shape on commercial old streets, and the sporadic dot arrangement has developed into a linear connection with ancient streets as one.

3. From the Qing Dynasty to the Republic of China--skeleton growth. At this time, the Fenghuang Mouth business was prosperous, business activities increased sharply, North-South trade exchanges were close, and the residents who settled here increased. The ancient town began to expand linearly around, forming a fish-bone shape.

4. Since the founding of the People's Republic of China--block filling. The resident population is rapidly expanding at this time, and the ancient town is expanding through the original foundation. But the overall development is based on the original S-shaped fish bones and radial form of the ancient town.

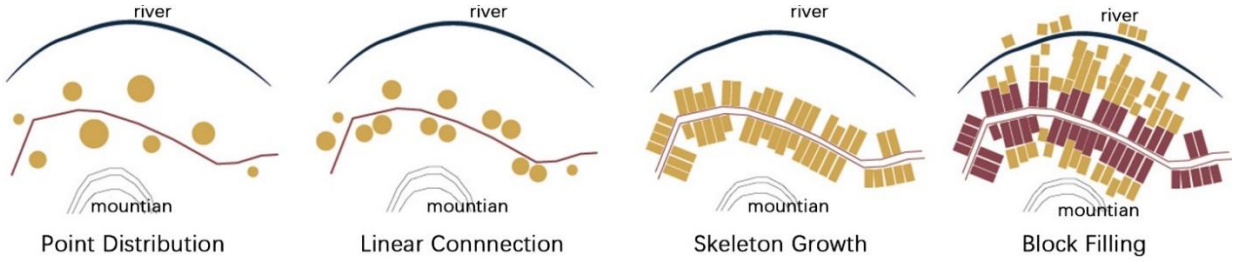

Fig. 1.21 Urban texture evolution of Fenghuang Ancient Town
(Elaboration by author according to Gao Lin 'Study on Ancient Villages of Fenhuang Town, Zhashui County'. Master Diss., XAUAT. 2008.)

8 The four stage comes from Gao, Lin. 'Study on Ancient Villages of Fenhuang Town, Zhashui County'. Master Diss., XAUAT. 2008.（高琳. '柞水凤凰镇古村落研究'. 硕士论文, 西安建筑科技大学. 2008. Gao Lin. 'Zhashui fenghuangzhen gucunluo yanjiu'. Shuoshi lunwen, Xi'an jianz keji daxue. 2008.）

1.2.3. The Mapping of the Buildings after Evolution

(1) Function Mapping

The two major functions of the architecture of Fenghuang ancient town are commercial and residential. The ancient town has a long history of commercial culture. Therefore, both sides of the ancient street retain the commercial functions in history, and maintain the mode of store in front of the living. The buildings along the new commercial street is a mode of the living on the store. In addition to the commercial function, the remaining buildings are mainly residential functions, spread all over the ancient town. There are also hospitals, schools, and cemeteries in the ancient town. *(Fig.1.22)*

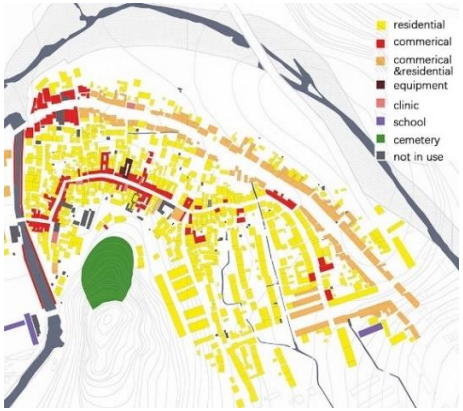

Fig.1.22 Function mapping of Fenghuang Ancient Town (Elaboration by Laura Pezzetti with Alberto Malabarba in Laura Anna Pezzetti. *'Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape'*. Tongji University Press, 2019.)

(2) Floors Mapping

The height of buildings along the ancient street is mainly 1-2 floors. The floors of newly-built houses are generally controlled at 3-4 floors. Most of these newly-built houses are built behind and closed to the traditional dwellings, which has a great influence on the style of traditional dwellings. Due to different needs, the new residential buildings on the southeast side and some buildings on the north side are higher than 5 floors. These higher buildings are distributed in the edge of the ancient town, which has little effect on the

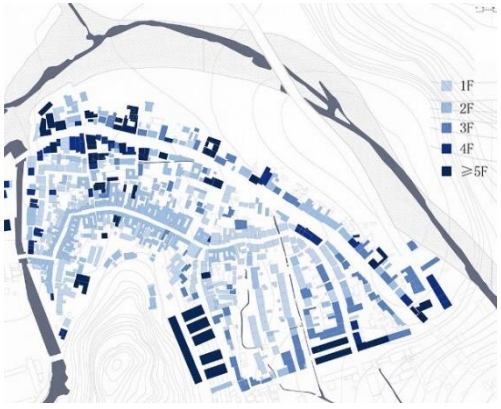

Fig. 1.22 Floors mapping of Fenghuang Ancient Town (Elaboration by Laura Pezzetti with Alberto Malabarba in Laura Anna Pezzetti. '*Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape'*. Tongji University Press, 2019.)

overall style of the ancient town. *(Fig.1.22)*

(3) Material Mapping

The main construction materials and structures of Fenghuang ancient town are civil structure, rammed earth structure and concrete frame structure. The buildings along the two sides of the ancient street are relatively old civil structures and rammed earth structures, mainly distributed on the southeast side of the ancient town. The buildings that have been completed in recent years are mainly concrete frame structures, mostly located on the edge of the ancient town. *(Fig.1.23)*

Fig. 1.23 Materials mapping of Fenghuang Ancient Town(Elaboration by Laura Pezzetti with Alberto Malabarba in Laura Anna Pezzetti. '*Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape'*. Tongji University Press, 2019.)

1.3. Features of Historical Building Influenced by Natural and Cultural Factors

1.3.1. The Natural Factors Influence the Form and Structure

(1) Water system influence the 'front store, back house' form

The Fenghuang ancient town is close to Yingpan Mountain in the south and the Shechuan River in the north. The Shechuan River crosses the east and west of the ancient town. The Zao River and the Drip River meet at the north and south to form the Sancha Hekou. Although the ancient town is deep between mountains and rivers, its transportation is still developed. At the same time, the convenient water transportation has also laid the foundation for the commercial life of the ancient town. In the first year of Tang Wansui Tongtian (AD 696), the Sancha Hekou became a distribution center for goods and a distribution center for commerce and trade.

Although there was no market at that time, there was a collection day every day. [9]In the thirteenth year of Jiaqing (1808 AD), business was extremely prosperous for a while, and it was known as "Little Shanghai". [8]In the second year of Daoguang, it opened the Mule Horse Post Road from Fenghuangzui to Xi'an. Business trips frequently took place in Fenghuang Mouth. Until the Republic of China, the ancient town still maintained the characteristics of commercial life.

In order to satisfy people's most basic residential functions and solve the commercial functions facing the street, the two-in-one commercial and residential "front store and back house" layout model is adopted. The layout and spatial organization are relatively limited, and the width direction is relatively fixed. The courtyard is mainly changed in the depth direction. It is processed into one or two entrances according to the terrain, and a patio(Tianjing, 天井) is set. Usually, in order to make full use of the high-value commercial land, the commercial houses are densely arranged side by side, and the first part is used as the storefront. Limited financial resources are only a single courtyard, both business and residence.

At present, both sides of the old street are still the commercial center of the entire ancient town. Most of the traditional residential shops still maintain their original appearance and are still used as shops. They mainly serve tourists and sell some local specialties, such as mountain products, tofu products, toys, and homemade wine. There are some large-scale transformations into restaurants, such as Changshengxiang, Shengfa Inn, and Meng Family Yard There are also public buildings with traditional houses converted into village hospitals. In the daytime, the shopkeeper opens the wooden row of doors to reveal the dazzling array of goods. At night, the shop closes and rests, and the ancient town enters a quiet and peaceful atmosphere.

The superior geographical location in the historical period has not only provided the natural conditions for doing business in Fenghuang Ancient Town, but also contributed to the distinctive commerce and market life of Fenghuang Ancient Town. This played a crucial role in the formation of ‘Front Store, Back House’.

9 Li, Chenxing. ‘The Traditional Residence Protection and Development—To the Ancient City of Shangluo Zhashui Fenghuang Town as An Example’. Master Diss., XAUAT. 2016. （李晨星. ‘陕西传统民居保护与开发——以商洛柞水凤凰古镇为例’. 硕士论文，西安建筑科技大学. 2016.）

(2) Local climate influence the 'narrow courtyard' type

The Fenghuang Ancient Town is located in the southern foothills of the Qinling Mountains, and belongs to the warm temperate subtropical climate zone in the low mountain area. In winter, the natural barrier formed by the high mountains in the north blocks the influence of the cold air from the north, and the average temperature is warmer than the flat areas at the same latitude and the same altitude; in summer, as a result of the mountain topography structure of the Qinling Mountains extends from north to southeast, a bag-shaped space was formed in the geographical area, allowing the humid and hot air from the southeast to penetrate northward, and the area was warm and rainy in summer. As it is located in a mountainous area, the rainfall variability is relatively large, how heavy rain and continuous rainy weather in summer and autumn.[10] *(Fig.1.24)*

The form of the narrow courtyard in Fenghuang Ancient Town can help the building to adjust the microclimate environment and obtain a more comfortable indoor living environment without the external equipment. *(Fig.1.25-1.26)* The narrow courtyard actually came from the north, similar to Guanzhong narrow courtyard. The length-to-width ratio is often greater than 3: 1,[11] so it is called a narrow courtyard or patio courtyard.

Patio courtyard, due to its narrow and long flat form and surrounding high buildings, the patio courtyard in summer is often located in the shadow, forming a natural air-conditioned room. The cool wind through the hall forms convection and can take away the excess heat in the room, thereby achieving ecological cooling. During the rainy season, the roof of the east and west houses slopes to discharge rainwater into the sink yard in the patio yard. The open drain system and the well pool are set reasonably. The humidity and water in the yard are provided with certain solutions.[12]

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10 Dong, Guangquan. 'Study on the Interaction and Integrate Preservation of Traditional Residential Buildings and Crafts in the Phoenix Town, Zha Shui County'. Master Diss., XAUAT. 2007. （董广全. '柞水县凤凰镇传统民居与传统手工艺的互相影响及其保护研究'. 硕士论文，西安建筑科技大学. 2007.）

11This data is based on the geometric surveys of traditional dwellings in Fenghuang Ancient Town in the Polimi-XAUAT Heritage-Led Design Workshop in 2018.

12 Sun, Shengzhen. 'Morphological Analysis of Courtyard Space in Guanzhong Region'. Master Diss., XAUAT. 2011. （孙笙真. '关中民居院落空间形态分析及应用'. 硕士论文，西安建筑科技大学. 2011.）

Fig. 1.24 The 'front store, back house' and 'narrow courtyard' type
(Source: drone survey made during the PoliMi-XAUAT Workshop, May 2018)

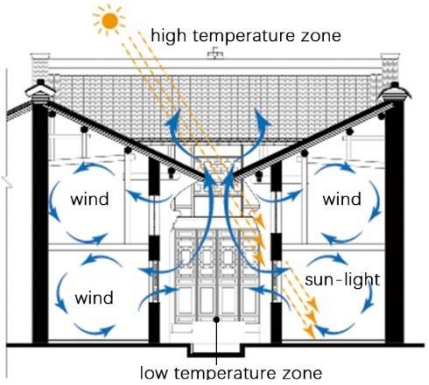

Fig. 1.25 Microclimate environment
(Elaboration by author)

Fig. 1.26 Patio drainage system
(Source: the author,2018)

(3) Natural resources influence the building material and structure

The county has a good ecological environment, with 2.12 million mu of forest land, a vegetation coverage rate of up to 88%, a forest coverage rate of 65%, and a variety of forest resources. It has 1.8364 million cubic meters of protective forests, 121,600 cubic meters of timber forests, 53,800 cubic meters of economic forests, 937,000 medicinal tree species, 102,000 acres of bamboo, 1.38 million ornamental tree species, 1.38 million vines, and many imported famous tree species suitable for planting Such as Mulan, Wen Guan Guo, etc. [6]

The beaches of Fenghuang Ancient Town with silt benefit to agricultural planting, and acid soils are developed in the hilly areas of low mountains, which are suitable for the growth of subtropical plants such as masson pine and oak forest. The spread of palm and Chinese-specific fir also makes Fenghuang Ancient Town become one of the northernmost growing places where these two plants are naturally distributed.[6]

The rich forest resources provide basic materials for the construction of the ancient town. Therefore, the traditional residential houses of Fenghuang Ancient Town mostly use wooden structure systems, and there are also a few brick-wood or earth-wood buildings. In the Ming and Qing Dynasties, Chinees architecture has made significant progress in terms of wooden structure, making wooden structure widely used in residential buildings. The skillful technology has also established a good foundation for the ancient town to use wooden structure.

Due to the wooden structure system, the traditional residential houses are mostly two floors. The ground floor is used for living and shops. The height is about 2.66 meters. The second floor is usually an attic for storage and few people live. The highest point can reach 3.08 meters.

In addition to wood, the raw soil is easy to obtain because of the surrounded mountains around the town, so it has become one of the traditional building materials of the ancient town. The internal walls, fire walls, courtyard walls of the traditional residential buildings in the ancient town are all earth walls, which are yellowish, and occasionally the walls are painted white; there is a stone foundation under the wall, which is light blue; The gated wooden boards along the street facade are usually painted with dark brown earth paint, which is darker in color; most of the wooden frames in the house are painted with dark brown paint, and the wooden frames in many transformed buildings are reddish brown. The doors and windows in the courtyard are

in ochre or reddish brown, and the newer windows are dark green. The folk house is decorated with red lanterns and green potted plants, and the colors are rich. *(Fig.1.27)*

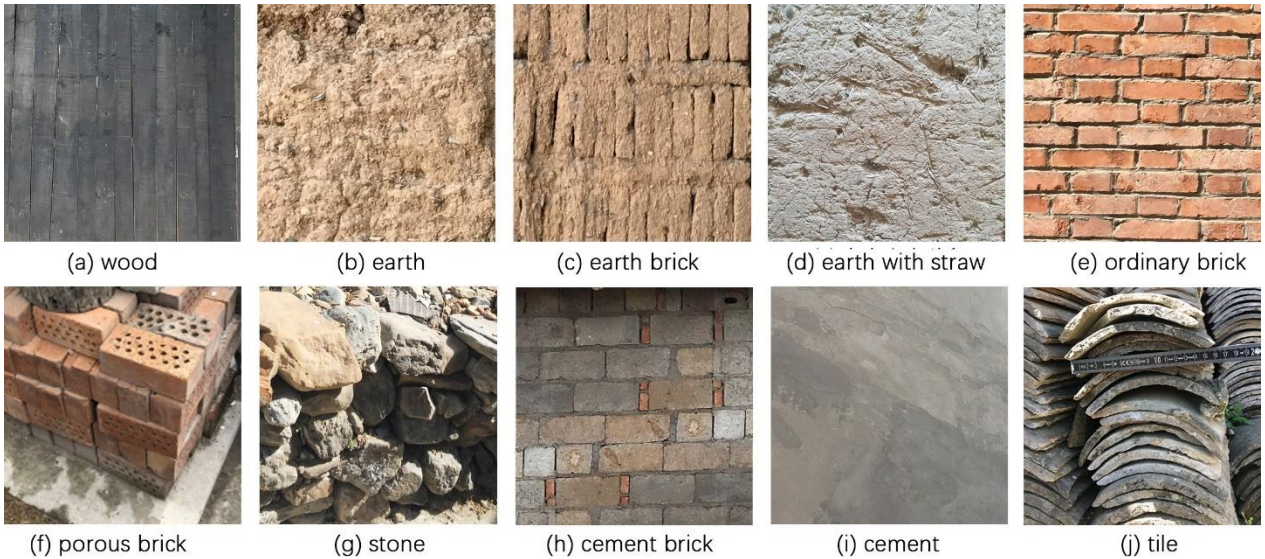

Fig. 1.27 Local material of Fenghuang Ancient Town
(Source: the author,2018)

1.3.2. The Mixed Culture Influence the Special Elements: Fire Wall and Lantern Roof

Fenghuang Ancient Town is located in the southern area of Shaanxi, on the south side of Qinling Mountains. Out of the border between north and south, people from south to north have been walking through here, and they have also attracted people from different places to settle here. Especially during the Ming and Qing Dynasties, with the large-scale relocation activities of "Huguang filling Sichuan", a group of residents from Hubei, Hunan, Anhui, etc. migrated to southern Shaanxi.[7] The cultural exchanges , and Qin culture, Chu culture, and Central Plains culture are all reflected here. Here, the cultures of the North and the South are intermingled, and the folk culture, town construction, and architectural features are very local.

In the early Ming Dynasty, in order to balance the development of various regions, Zhu Yuanzhang(the emperor) issued a policy of immigration and relocation, and moved rich residents from many southern areas such as Hunan, Hubei, and Jiangsu to central and western

regions such as Sichuan, Henan, and Shaanxi. In the Zhengtong period of the Ming Dynasty, there were too many migrants. In order to stabilize social order and complete the task of reclaiming wasteland, the government ordered these migrants to be arranged in southern Shaanxi, where they would live and cultivate. This policy lasted for nearly 10 years, and it reached its peak in the years of Zhengde period of the Ming Dynasty. In the process of resettlement and migration of people, nearly 120,000 people have been settled at the border of Shaanxi, Hubei and Henan provinces, social production has been steadily developed, and the economy is booming. The movement of people during this period laid a solid foundation for people in southern Shaanxi, and brought local customs, customs, and customs here.[13]

In the late Ming Dynasty and early Qing Dynasty, severe hunger and poverty swept across southern Shaanxi, which severely affected local agricultural activities and stalled economic development. At the same time, the political situation was chaotic, peasant uprisings occurred frequently, traditional production relations were shaken, and land divisions changed. After the Qing Dynasty was completed, in order to start production, the "Reclamation Order" was promulgated, and land reclamation and personnel relocation were carried out again. The social economy of southern Shaanxi has developed to a certain extent. During the Xianfeng period, the Taiping Rebellion caused a great social upheaval. A large number of people moved in exile. A group of people from the Anhui came to southern Shaanxi and settled in various towns and villages.[14]

In the early period of the Republic of China, the “citizen crusade army” of Henan Province entered the “Fenghuang Mouth” from Henan, wreaking, burning and looting, resulting in a large number of villagers fleeing to survive, and the ancient town was in disarray. In the 20th year of the Republic of China, due to natural disasters and man-made disasters, hungry people from all over Shaanxi entered the Qinling Mountains in order to survive, and many exiles took

13Chen Liangxue. The migration of Hakka in Fujian and Guangdong during the Ming and Qing Dynasties and the development of Qinba Mountains [J]. Journal of Hanzhong Normal University (Social Science), 2001(02):81-88（陈良学.明清时期闽粤客家人内迁与秦巴山区的开发[J].汉中师范学院学报(社会科学),2001(02):81-88. ）

14 Wang Zhenhong. ‘Research on the protection of traditional houses and folk art in Fenghuang Town, Zhashui County’ Master Diss,. Xi’an University of Architecture and Technology, 2007. (王振宏. 柞水县凤凰镇传统民居及民间艺术的保护研究. 硕士论文. 西安建筑科技大学,2007.)

root here. Since then, the ancient town of Fenghuang has welcomed a group of residents from the north, forming a mixed state of the north and the south.[14]

Mixed culture mainly affects the traditional dwellings in the Fenghuang Ancient Town to form the Matou qiang, the Fire Wall and the lantern-like transparent roof.[15]

Before the fire walls were used in residential buildings, the outer walls of ordinary residential buildings were only wooden boards or mud walls. The fireproof performance was poor. In the case of tight land and dense houses, the fire hazard was serious. The fire wall exists to improve the fire resistance of the entire building. Therefore, the fire wall rises above the roof, completely dividing the residential houses next to each other, especially blocking the connection between the wooden structure, thereby closing the fire area and reducing losses.[8]

The fire walls in Fenghuang Ancient Town are mainly of Matou('horse head')type and ladder type. *(Fig.1.28)* The number of Matou wall type fire wall is relatively large, and the gable wall is like the shape of the head of the horse. The Ma Tau wall is all uplifted, thus enhancing its upward momentum. Another form is a ladder type fire wall. The shape of the gable is stepped, and layers fall.

The lantern-like transparent roof is a form from Hubei after cultural fusion. *(Fig.1.29)* The lantern-like transparent roof is called Tiandou in Hubei. Tiandou is a special method of covering the roof above the patio. Transparent roof tiles are often set on the roof, leaving gaps for ventilation around, which has the performance of lighting and ventilation.[16] Tiandou is transformed from a patio, so it is mostly used between two-entry houses, and can transform outdoor space into semi-outdoor space, and under it are public spaces such as restaurants and halls. Moreover, in the combination of commercial and residential buildings, Tiandou can also be used as a transitional space, forming a transition from commercial public space to residential private space. The folk houses in Fenghuang Ancient Town also use this method to transform the patio courtyard, so as to obtain space suitable for living.

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15 It is summarized from Prof. Laura Anna Pezzetti's book which is Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape, Tongji University Press, 2019.

16 Yang, Mengyu, and Wang Xiao. 'Analysis of the Characteristics of Traditional Dwellings in Hubei: Tiandou and Liangdou'. Architecture & Culture 2(2018); 215-217. (杨梦雨，王晓. '湖北传统民居特色之天斗与亮斗解析'. 建筑与文化. 2(2018); 215-217.)

Fig. 1.28 Fire wall of Fenghuang Ancient Town
(Source: drone survey made during the PoliMi-XAUAT Workshop, May 2018)

Fig. 1.29 Lantern-like transparent roof of Fenghuang Ancient Town
(Source: drone survey made during the PoliMi-XAUAT Workshop and author, May 2018)

In summary, the morphological composition of the traditional houses in Fenghuang Ancient Town is mainly composed of sealed fire walls, dry shingled roofs, removable wooden door panel, wooden structure, patios, and decorative features. *(Table 1.3)*

Table 1.3 Elements of Traditional Dwellings of Fenghuang Ancient Town
(Source: drone survey made during the PoliMi-XAUAT Workshop, May 2018; the author)

IMAGES	ELEMENTS	FEATURES
	Fire wall	The fire walls are arranged along the street, enhancing the overall feelings of the market.
	dry shingled roofs	Northern roofing practice, the eaves are deep, forming a gray space
	removable wooden door panel	Facade under the background of business characteristics, has regional characteristics
	Wooden structure	The wooden structure preserved in the Ming and Qing Dynasties

	patio	The core of the residential space, other spaces are arranged around the patio
	decoration	Wood carvings, stone carvings and brick carvings

1.4. The Current Policy and Planning as a Threat[17] to Landscape, Radial Structure[4] and Buildings

1.4.1. Listed as 'Famous Historical and Cultural Towns and Villages of China

Here, first of all, we need to have a simple understanding of the protection of famous historical and cultural cities and towns in China. The development of cultural relics protection

17 The point of threat was made by Prof. Laura Anna Pezzetti in her book in 2019.

in China was relatively late. After a decade of cultural revolution, Chinese society "has to be build." As 1982, the State Council approved the "Notice on the Protection of Historical and Cultural Cities in China", which was proposed by the State Construction Commission and other departments, and proposed the protection of historical and cultural cities, marking the proposal and protection system for the concept of Famous Historical and Cultural Cities of China, and the beginning of establishment. However, at this time, there are no clear regulations on the content and provisions of the protection plan, and there is no mention of the protection of traditional rural settlements.[18]

As early as 1983, the Ministry of Urban and Rural Construction and Environmental Protection issued the "Notice on Strengthening the Planning of Famous Historical and Cultural Cities", which also emphasized in-depth investigation and research to highlight the characteristics of famous cities and accurately grasp the characteristics of famous cities. National historic and cultural cities should prepare protection plans and report them together with the city's overall plan in accordance with the approval authority. On the basis of the preparation of the overall plan, detailed plans for key areas, projects, and scenic spots should be prepared as required, and specific implementation plans for protection and construction should be proposed.[18]

From the end of the 20th century to the beginning of the 21st century, the protection of Chinese historical and cultural villages and towns took the lead in local governments. Zhouzhuang, Wuzhen and many other ancient towns were listed as provincial historical and cultural towns. During this period, in-depth research was conducted on settlement landscapes, value characteristics, and protection planning.[19] In 2003, the Ministry of Construction and the State Administration of Cultural Heritage announced the first batch of 22 famous historical and cultural towns and villages in China, marking the official entry of the historical and cultural towns and villages into the Chinese cultural heritage protection system.

From the perspective of the protection of Chinese urban and rural cultural heritage in recent years, the protection system can be divided into three levels: cultural relics protection units,

18 Wang, Lingling. 'Research on Evolvement of the Conservation Plans of the Historic Cities'. Master Diss., CAUPD. 2006.（王玲玲. '历史文化名城保护规划的发展与演变研究'. 硕士论文，中国城市规划设计研究院. 2006.）

19 Zhao, Yong, Tang Weilong, Long Limin, Wang and Zhaofang. 'The Retrospect and Prospect of the Protection of Famous Villages, Historic Cities and Towns'. Architectural Journal 6(2012); 12-17. (赵勇，唐渭荣，龙丽民，王兆芳. '我国历史文化名城名镇名村保护的回顾和发展'. 建筑学报. 6(2012); 12-17.)

historical buildings (micro), historical and cultural blocks (middle view), historical and cultural cities and famous towns and villages (macro) .[18] Among them, the concept of historical buildings was not formally put forward until the State Council promulgated the "Regulations on the Protection of Historical and Cultural Cities, Famous Towns, and Famous Villages" in 2008. Compared with a few cultural relics protection units with high protection value, the scale of historical buildings is large and constitutes the main body of the Protection of Historical and Cultural Cities, Famous Towns and Famous Villages.

The traditional dwellings on Old Street is the only relatively well-preserved ancient town building cluster found in Shaanxi Province at the end of the Qing Dynasty and the beginning of the Republic of China. As of 2003, "Old Street Residence" was listed as the fourth batch of cultural relics protection units in Shaanxi Province. This means that the value of Fenghuang Ancient Town is beginning to be noticed. By 2010, Fenghuang Ancient Town was given the status of "Qingjiang Ancient Town Living Fossil" with mixed culture. The recognition of the value of Fenghuang Ancient Town has risen from the provincial level to the national level, and has been effectively improved. [20]The Ministry of Housing Construction of the People's Republic of China and the State Administration of Cultural Heritage named it as a famous historical and cultural town in China. *(Fig.1.30-1.31)*

1.4.2. The Current Policy and Planning as a Threat in Three Different Levels

As Prof. Laura Anna Pezzetti stated, the designation to "Famous Historical and Cultural Town" as a threat to Fenghuang Ancient town. [21]After being named as a historical and cultural town in China, *the Heritage Conservation Planning of Dwellings in Fenghuang Ancient Town for Zhashui County* issued in 2012 (HCP 2012)[22] and *the Conservation Plan of Dwellings in Fenghuang Street Zhashui County* issued in 2013 (HCP 2013),[23] Mainly for the protection of

20 Laura Anna Pezzetti. Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape. Tongji University Press, 2019.

21 This point was made by Prof. Laura Anna Pezzetti in her book in 2019.

22 People's Government of Fenghuang Town, and Zhejiang Yuanjian Tourism Plannning and Design Institute, The Heritage Conservation Planning of Fegnhuang Ancient Town, Shaanxi(2012), (HCP 2012).

23 People's Government of Zhashui County, and Center for Urban Construction and Regional Planning of Northwestern

historical buildings and the environment. In the same year, *Zhahsui County Fenghuang Old Town Tourism Development Masterplan* (TDP 2013) and *the Zhashui County Fenghuang Town Regulatory Detailed Plan* (DP 2013) were promulgated.

Although these plans have formulated specific measures for the protection and development of Fenghuang Ancient Town, there are also some problems that destroy the characteristics of the ancient town, mainly reflected in the settlement landscape, radial structure, and architecture.[24]

First, in terms of settlement landscape. In the HCP, the protection of Fenghuang Ancient Town is limited to the Drip River in the west, the S307 Provincial Highway in the north, the Farmers Market in the east, and Yingpan Mountain in the south. The protection of the mountains and water systems around the town is directly missing. For Zhashui Fenghuang Ancient Town, the settlement structure of the whole ancient town depends on the mountain and water potentials. Therefore, Yingpan Mountain, Fenghuang Mountain and other mountain ranges and Shechuan River and Zao River should also be included in the protection planning of the ancient town. Article 21 of the Regulations on the Protection of Famous Historic Cities, Famous Towns, and Famous Villages promulgated in 2008 states that "overall protection should maintain the traditional pattern, historical features, and spatial scale, and the natural landscape and environment that are interdependent with it must not be changed." [25]Therefore, it was supplemented in the 2013 DP and the planning scope was expanded. Unfortunately, although the scope has been expanded, the types of landscape elements such as mountains and water systems have not been analyzed, and the relationship between mountains and rivers and ancient towns and buildings has not been analyzed and planned.[20]

Secondly, at the level of radial structures. Due to the lack of natural landscape analysis of the formation of ancient town settlement space at the macro level, the interpretation of the radial structure of the ancient town is also lacking at the meso level.[20]The HCP has always emphasized the protection plan for the S-type ancient street structure in the core area of cultural relics

University, The Heritage Conservation Planning of Fenghuang Street and Dwellings (2013). (HCP 2013)

24 It is summarized from Prof. Laura Anna Pezzetti's book which is Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape..

25 Article 21 in the Regulations on the Protection of Famous Historic Cities, Famous Towns, and Famous Villages promulgated in 2008. http://www.gov.cn/gongbao/content/2008/content_987913.htm

protection, which directly leads to the subsequent TDP effect map to see the ancient town texture with the S-type ancient street as the core, and other architecture does not follow the logic of radioactive structures. *(Fig.1.32)* Especially in the design of the field area on the north side of the S307 provincial road, first of all, the consideration of the historical field is ignored, and it is used as a tourist activity area. Secondly, the texture and structure of the building are still based on the horizontal axis of the street, without considering the radial structure. *(Fig.1.33)*

Finally, at the architectural level. The protection of buildings in HCP is divided into three levels of protection: cultural relics protection units, historical buildings, and general buildings. For cultural relics protection units, the main focus is on restoration and preservation, to maintain the original style, and the principle of repairing as old and historical authenticity. In the example map of cultural relics protection units, the current situation of cultural relics protection units is relatively superficial, mostly described in words, lacking in-depth surveying and the protection schemes proposed are more general. Taking the protection and restoration of Meng Family House as an example, after the renovation in 2018, although the principle of repairing as old is adhered to, it is still impossible to avoid the problems caused by the neglect of authenticity, such as painting the walls without thinking Later, and all traces of history left on the wall were completely erased. The newly replaced doors and windows were painted with the same paint as the original doors and windows, making it impossible to distinguish the old from the old. In other protection and restoration practices, the problem of replacing the original detachable door panels with ordinary swing doors has also been found. This method completely erases an important traditional element, which is a huge threat to cultural relics protection units and ancient towns.

The renderings in the TDP show the neglect of traditional materials and elements. The façade effects on both sides of Fenghuang Old Street completely contradict the historical style. Rough material, absence of the traditional door, and unified façade forms erase the original history of Fenghuang Ancient Town.

As for historical buildings, HCP mentioned the choice of valuable preservation and coordination with the style of cultural relics protection units. But there is no specific description of the evaluation criteria for the valuable historical buildings in Fenghuang Ancient Town.

For general buildings, if they affect the cultural relics protection units in the core protection

zone, they shall be repaired or demolished. The general buildings with the greatest impact in the core protected area are the new buildings located behind the cultural relic protection units on both sides of the old street. These buildings are mainly because the traditional buildings in the front are not suitable for living but cannot be demolished and rebuilt. If these buildings are demolished rashly, it will directly affect the lives of residents, but there are no specific repair measures to make the buildings in this transition area affect the overall appearance, and they just maintain the status quo. Instead of protecting the general buildings in the core area, the facade and roof are renovated, and then unified with the style of the cultural relics protection unit. This is mainly aimed at the new reinforced concrete buildings on both sides of the new street on the north side. The fake facades and roofs of these buildings not only did not maintain a unified style, but also greatly damaged the landscape of the ancient town.

Fig. 1.30 Aerophoto of the present town
(Source: drone survey made during the PoliMi-XAUAT Workshop, May 2018)

Fig. 1.31 Situation of the Old Street
(Source: http://blog.sina.cn)

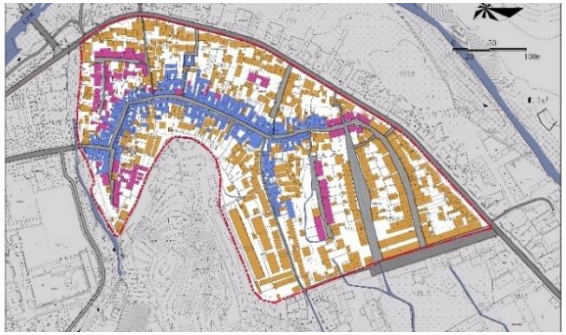

Fig. 1.32 Protection core and buildings type
(Source: DP, 2013)

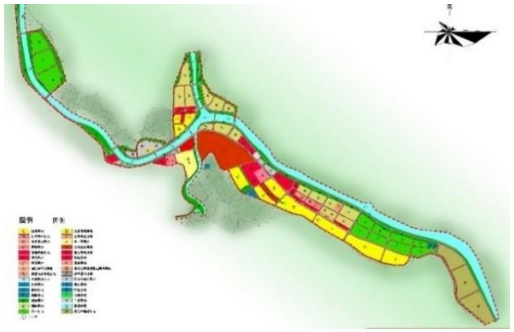

Fig. 1.33 Land use
(Source: DP, 2013)

Fig. 1.34 Render of the town
(Source: CTP, 2013)

Fig. 1.35 Render of the Old Street
(Source: CTP, 2013)

1.5. Residential Needs and Prospection to Fenghuang Ancient Town

1.5.1. The Needs of Commercial Life

The first is the demand for commercial tourism development in Fenghuang Ancient Town, Zhashui County. In the income survey of residents in 2018, it can be found that the development of tourism business in Fenghuang Ancient Town has not brought the expected economic benefits to residents.

At the same time, the opinions and feedbacks of tourists are crucial to the tourism business. The author conducted a questionnaire survey of tourists who came to this ancient town. In terms of tourism experience in ancient towns, 12% of tourists expressed disappointment, 80% of tourists indicated that they were average, and 8% of tourists expressed satisfaction; whether they would choose to stay in ancient town, 73% of tourists said they would not stay overnight, and 27% said will stay overnight; in the overnight accommodation environment option, 90% of tourists choose to experience traditional residential homestay, and 10% of tourists choose to build a new residential accommodation; and in the option of whether to revisit the ancient town, 69% of tourists expressed unwillingness, 31% of tourists expressed their willingness. *(Fig.1.36)*[26]

26 This data is based on survey during PoliMi-XAUAT Workshop,2018

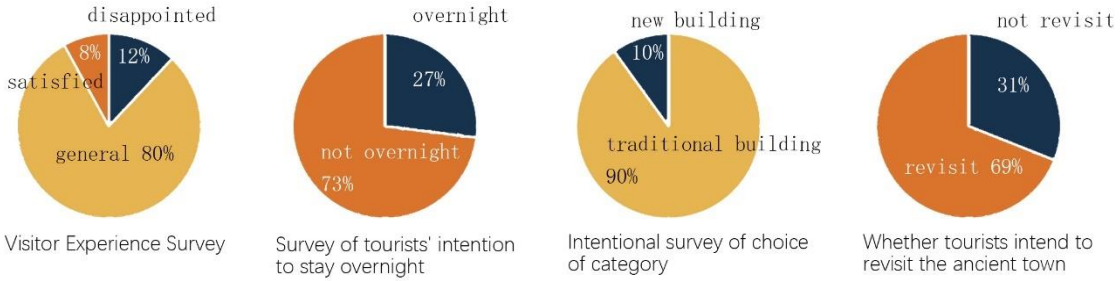

Fig. 1.36 The result of questionnaire
(Elaboration by author based on survey during PoliMi-XAUAT Workshop, May 2018)

From the questionnaire, we can see that the tourism business of the ancient town of Fenghuang is not successful. From the perspective of tourists, the tourism business of the ancient town has the following problems: the tourism project is single and uninteresting, the lack of experience and appreciation of the unique craftsmanship, the style of the century-old building is not highlighted, and Incomplete facilities and other issues. For tourists, they need more tourism services, better environment hotels, good old town style viewpoints, perfect public facilities, some commercial spots that attract contemporary tourists and a rural experience different from the city.

Due to the special form of 'front store and back house' in Fenghuang Ancient Town, the study of residents' daily life can be divided into two parts: commercial life and residential life. The first is the analysis of the commercial life of the residents of the ancient town. By visiting and investigating the commercial types of the Fenghuang ancient town, the businesses of the ancient town can be divided into four categories: retail, handcraft workshop + retail, service and catering. The retail industry in the ancient town is mainly local specialty foods (such as bacon, tofu, tempeh, twist, etc.), handmade products (such as bamboo baskets, straw shoes, straw hats, etc.), local handmade products (such as bamboo barrel wine, fruit wine, ale, etc.) , mountain goods (such as pepper, spicy and other large materials), industrially produced commodities (such as snacks, clothes, daily necessities, etc.). The handcraft workshop + retail industry is a major feature of the ancient town's commerce. It often attracts tourists to stop and watch. There are specific iron workshops, bacon workshops and wine workshops. However, the iron-making activities of the iron-making workshops are more demonstrative to the outside, and the production of bacon and winemaking are more introverted. The service industry mainly

includes barber shops, dentists, and tourism development service stations. The catering industry is the mainstream format in the ancient town, mainly providing local specialties and tea.

Taking the one-day business life of Boshengrong Wine Shop *(Table 1.4; Fig.1.37)* and Fanji Blacksmith Shop *(Table 1.5; Fig.1.38)* as an example, one day's observation of these two shops found that the owner's one-day activity range is not large. The blacksmith hit the iron in the shop but the shopkeepers will not make wine during the day, and the two shopkeepers are mainly selling. From the layout of its commercial space, it can also be found that the commercial activities of residents are relatively simple. They are mainly storage behaviors and sales behaviors, and they also have production behaviors for workshops. Combined with the observation and investigation of other shops, it can be seen that the business life of residents in Fenghuang Ancient Town is generally simple and tedious. *(Fig.1.39-1.41)*

Combined with the income survey of local residents, *(Table 1.6)* it can be found that the per capita annual income of local residents is 9854RMB, but the gap is larger than the disposable income of Chinese rural residents in the same year of 14617RMB.[27] Moreover, these incomes of local residents are not entirely dependent on local business, and many families have migrant workers. In summary, the commercial and economic benefits of Fenghuang Ancient Town are poor, and the business life is tedious. As a historical and cultural town, the overall tourism business needs to be improved.

27 The data of annual income comes form http://finance.sina.com.cn/china/gncj/2019-08-08/doc-ihytcitm7646160.shtml

Table 1.4 Commercial Daily Life of 'Boshengrong Wine Shop
(Elaboration by author during the PoliMi-XAUAT Workshop, May 2018)

TIME	BEHAVIOR	SPACE
07:00	Remove the mobile door panel, clean it and prepare to open for business	Entrance platform
08:00	Place the wine jar and officially start business	First part space
09:00	Sitting at the cash register in the shop	First cash register
10:00	Selling wine under the eaves of the entrance to let passers-by taste	Entrance platform
11:00	Introduce visitors to the variety of different wines in the shop, and lead a visit to the wine workshop	First and Second part space
12:00	Have lunch at the cash register and rest	First cash register
13:00	Lunch break at the cash register	First cash register
14:00	Chat with the owner of the opposite shop at the door of the store	Entrance platform
15:00	Introduce visitors to the variety of different wines in the shop, and lead a visit to the wine workshop	First and Second part space
16:00	Sitting at the cash register and playing with mobile phone	First cash register
17:00	Solicit the last business of the day	Entrance platform
18:00	Take back the stall outside the shop, install the door panel and prepare to close the door	Entrance platform

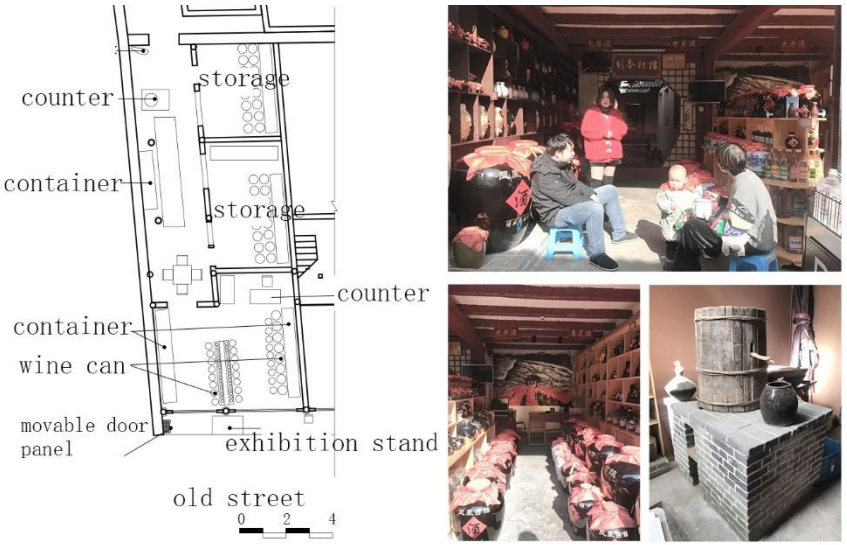

Fig. 1.37 Commercial plan and images of ‘Boshengrong Wine Shop
(Elaboration by author; Source: the author,2018)

Table 1.5 Commercial Daily Life of 'Fanji Blacksmith Shop
(Elaboration by author during the PoliMi-XAUAT Workshop, May 2018)

TIME	BEHAVIOR	SPACE
07:00	Remove the mobile door panel, clean it and prepare to open for business	Entrance
08:00	Set up stalls, put irons, and start business	Entrance
09:00	The shop owner hits the iron in the store, and his wife sits in front of the stall to sell	Inner and Entrance
10:00	The man hits the iron in the shop, the woman shouts and sells in front of the stall, attracting tourists	Inner and Entrance
11:00	The man hits the iron in the shop, the woman shouts and sells in front of the stall, attracting tourists	Inner and Entrance
12:00	The man and woman are sitting in front of the stall for lunch	Stall at entrance
13:00	The man and woman sit in front of the stall to rest, and chat with the shopkeeper opposite the shop	Stall at entrance
14:00	The man started to hit the iron, and the woman sold in front of the stall	Inner and Entrance
15:00	The man hits the iron in the shop, the woman shouts at the stall	Inner and Entrance
16:00	The man and woman are resting at the stall	Inner and Entrance
17:00	The man extinguished the iron stove and cleaned the iron workshop	Inner
18:00	The man and his wife tidy up the stalls and close the business	Entrance

Fig. 1.38 Commercial plan and images of 'Fanji Blacksmith Shop'
(Elaboration by author; Source: the author,2018)

Fig. 1.39 Commercial plan and images of goods-store
(Elaboration by author; Source: the author,2018)

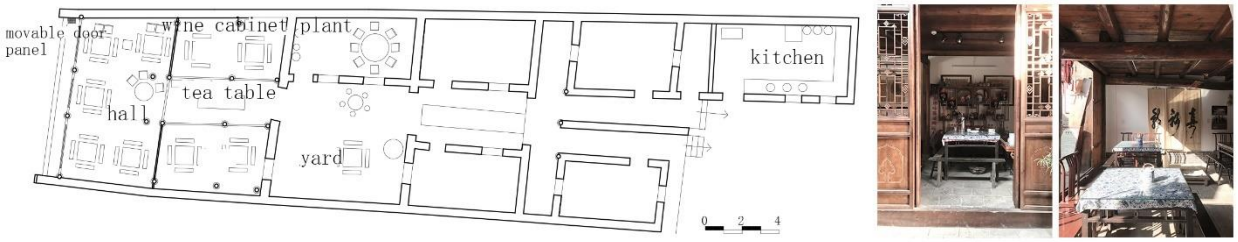

Fig. 1.40 Commercial plan and images of Meng Family House
(Elaboration by author; Source: the author,2018)

Fig. 1.41 Commercial plan and images of 'Bacon Shop'
(Elaboration by author; Source: the author,2018)

Table 1.6 Financial survey of residents (Elaboration based on the PoliMi-XAUAT Workshop, May 2018)

N	Family structure	N of people	Average age	Economic sources	Average annual income
1	Old couple	1	58	Shop owner	15.000 yuan
2	Couple+ 2 children	4	28	Miner	25.000 yuan
3	Couple + 1 child	3	20	Miner	25.000 yuan
4	Old woman	1	67	Work in a shop	15.000 yuan
5	Old man+ young man	2	37	Freelance (in Xi'an)	45.000 yuan
6	Old woman+ young couples+2 children	5	46	Shop owner	45.000 yuan
7	Old woman + young couples	2	44	Shop owner	15.000 yuan
8	Young woman	1	31	Shop owner	15.000 yuan
9	Old couple	1	68	Pension	90.000 yuan
10	2 Couples +6 children	8	20	Restaurant owner	110.000 yuan
11	Couple + 1 child	3	40	Freelance	25.000 yuan
12	Couple	2	57	Teacher	65.000 yuan
13	Couple	2	51	Government employee	75.000 yuan
14	Old woman	1	71	Baby sitting	/
15	Couple+ 2 children	3	24	Miner	35.000 yuan
16	Young woman	1	29	Shop owner	15.000 yuan
17	Couple+ 2 children	4	17	Part-time job	15.000 yuan
18	Couple+ 2 children + young man	5	35	Shop owner+ Part-time job	45.000 yuan
19	Old couple	2	65	Pension	/
20	Couple + 1 child	3	33	Shop owner+ Part-time job	25.000 yuan
21	Couple+ 2 children	4	19	Shop owner+ Part-time job	15.000 yuan
22	Couple+ 2 children	4	30	Restaurant owner	110.000 yuan
23	Old couple+ 5 children	7	25	Part-time job	15.000 yuan
24	Old couple+ 5 children	7	23	Shop owner	15.000 yuan
25	Old couple	2	69	Pension + rental fee	7.000 yuan
26	Old couple	2	86	Pension	45.000 yuan
27	Old couple + young couples +2 children	6	38	Government employee	55.000 yuan
28	2 couples + 3 children	5	32	Part-time job	45.000 yuan
29	Woman + 1 child	2	24	Part-time job	55.000 yuan
30	Old man	1	72	Baby sitting	30.000 yuan
31	Couple + 2 children	4	29	Rental fee + Part-time job	9.000 yuan
32	Old couple + young couple	4	47	Rental fee + Part-time job	/
33	Couple+ 2 children	4	21	Freelance	15.000 yuan
34	Couple+ 2 children	4	26	Rental fee	45.000 yuan
35	Old couple	2	65	Pension	45.000 yuan
36	Old couple+ young couples+2 children	6	37	Shop owner	15.000 yuan
37	Old couple+ young couples+2 children	6	49	Shop owner+ Part-time job	25.000 yuan

1.5.2. The Needs of Living Life

There is also a lot of demand from the residents of the ancient town. In the above, it has been found that there are many problems in traditional houses, such as indoor lighting, thermal insulation, lack of indoor toilets, and poor kitchen environment. These problems have been unable to meet the daily needs of contemporary people. At the same time, residents of different ages in the ancient town also have different needs for the ancient town. For 10-year-old children, the ancient town lacks public play space; young people 20-30 years old need attracting points and sports field and more services; for middle-aged people 40-50 years old, they need to be able to green area of social activities, good quantity inner space, earn more money, more stores, exercise facilities and so on; for the elderly over 60 years old, they also need a good living environment. *(Fig.1.42)*

On the other hand, there are also many problems in the residential life of Fenghuang Ancient Town in traditional dwellings. The first is living life. *(Fig.1.43-1.44)* The space that carries the daily living of the residents is relatively simple. It is generally in a shop, a *Xiafang*(厦房, rooms on both sides of the patio), or the corridor space between the *Xiafang.* The living room in the shop is generally relatively rudimentary, mostly based on commercial space requirements, but with additional tables and chairs to meet the needs of living. Since the living space is located in the Menfang(门房，the room directly in front of the patio), and the door is generally open in the daytime, which is more public and less private. The living room formed by a *Xiafang* or corridor space often uses furniture to form a stable space on one side and a fluid walkway space on the other side.

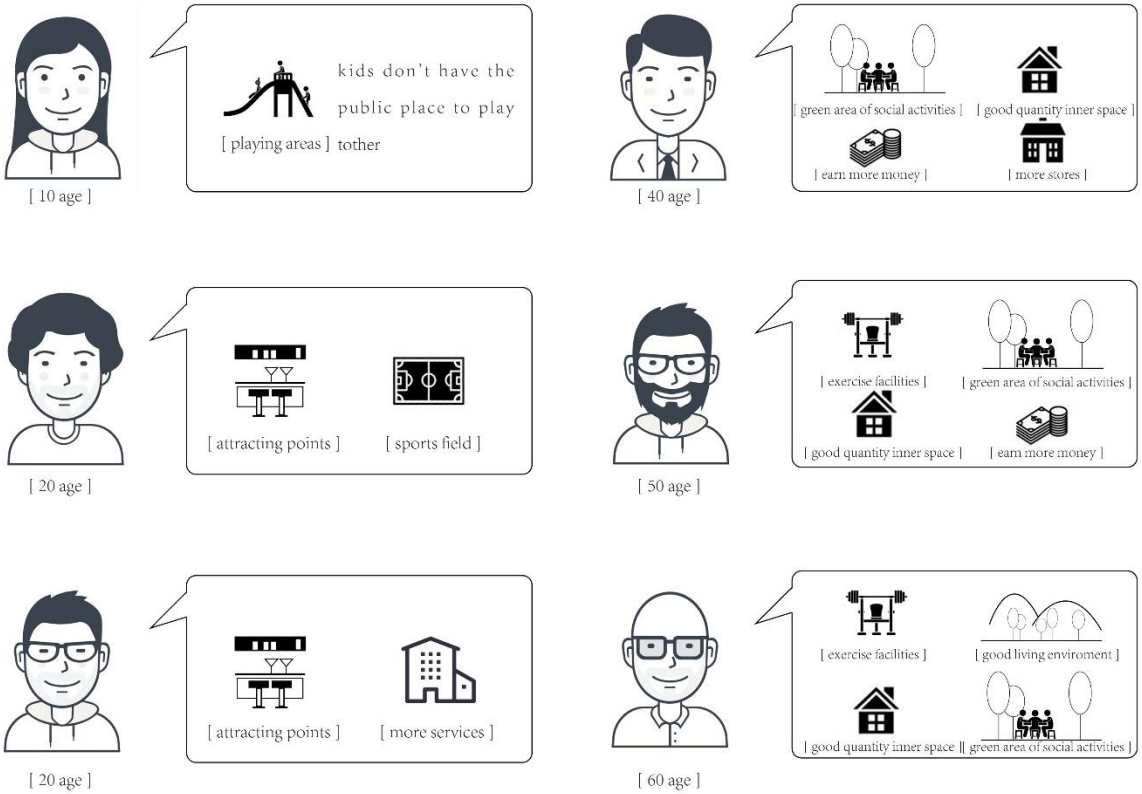

Fig. 1.42 the needs of different age residents
(Elaboration by author based on survey during PoliMi-XAUAT Workshop, May 2018)

The daily bedrooms of residents in ancient town mainly have mixed functions. *(Fig.1.45)* Not only should they meet the functions of daily sleep, but most of them also have the functions of washing, eating and even living. The kitchen mainly uses firewood and electricity as cooking energy. *(Fig.1.46)* There is no natural gas. Due to the long-term burning of firewood, the kitchen walls become black, and most kitchen interiors are dark and untidy. The space that the residents of the ancient town are lacking is the bathroom space for washing and excretion. Due to the poor waterproof performance of traditional residential buildings, there is no indoor toilet.

(Fig.1.47) Residents often build simple dry toilets in the backyard, while residents without rich space use Yehu(夜壶, Excretory appliance) at night to solve physiological problems. And usually take a bath to go to the public bathing center in the ancient town. The daily washing is directly solved in the patio courtyard or bedroom, which also makes the patio courtyard one of the important daily living spaces for residents. *(Fig.1.48)*

The biggest problem with the traffic space in the traditional houses of the ancient town is the lack of comfortable vertical transportation, which is one of the reasons why the first floor space of the traditional houses in the ancient town has been waste for a long time. *(Fig.1.49)* Most residents can only have ladders to get up and down, but there are many elderly people, women and children in ancient towns, and ladders cannot guarantee their safety, so the utilization rate is low.

Fig. 1.43 the living room images of the traditional dwellings
(Source: the author,2018)

Fig. 1.44 the living space plan of the traditional dwellings
(Elaboration by author based on survey during PoliMi-XAUAT Workshop, May 2018)

Fig. 1.45 the bedrooms images of the traditional dwellings
(Source: the author,2018)

Fig. 1.46 the kitchen images of the traditional dwellings
(Source: the author,2018)

Fig. 1.47 the toilet images of the traditional dwellings
(Source: the author,2018)

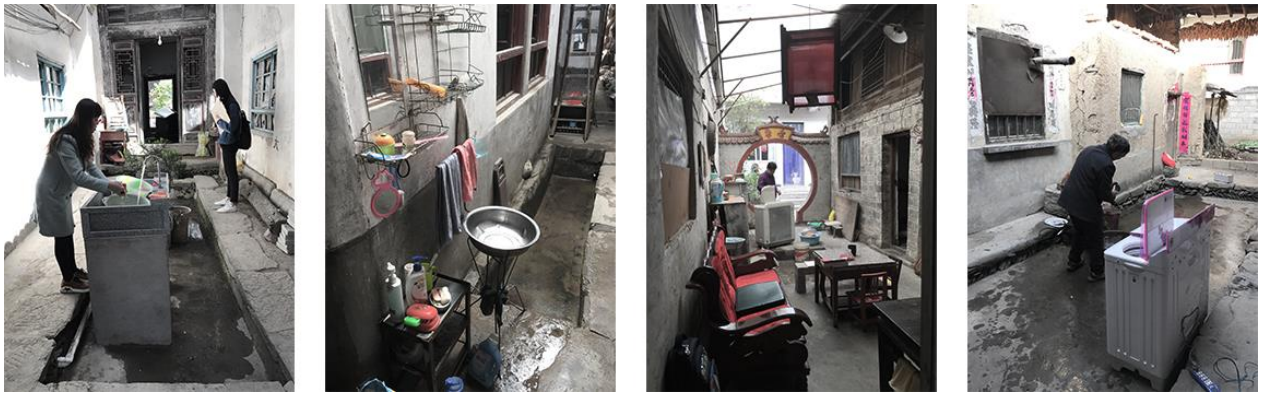

Fig. 1.48 the living life in the patio/courtyard
(Source: the author,2018)

Fig. 1.49 the ladders in the traditional dwellings
(Source: the author,2018)

02

Case Study and General Strategy

2.1 Theory and Case Study

2.1.1 Conservation and Reuse of Castelvecchio Museum in Verona
2.1.2 Overwriting and Palazzo Arese di Seveso
2.1.3 Revitalization and Falck Area in Milan

2.2 The General Strategy Based on Revitalization and Overwriting

2.2.1 The Accessibility Problem of Fenghuang Ancient Town
2.2.2 The Revitalizing Urban Strategy of Fenghuang Ancient Town
2.2.3 The Overwriting Strategy of Area Project

2.3 The Conservation and Reuse Methods of the Historical Building

2.3.1 Optimization and Reorganization of External Space of Historic Buildings
2.3.2 Enrichment and Replacement of the Internal Space of Historic Buildings

2. Case Study and General Strategy

2.1. Theory and Case Study

2.1.1. Conservation and Reuse of Castelvecchio Museum in Verona

(1) Theory of Conservation and Reuse

The conservation and reuse of architectural heritage have a close internal connection. When talking about the reuse of historic buildings, we have to mention the architectural protection and restoration movement that originated in 19th century Europe. This movement began with Viollet-le-Duc's "style restoration" of architectural heritage, and gradually transformed into a limitation of its theory and a criticism of historical authenticity in practice. The focus of attention during this period was changed to distinguish the historical authenticity of architectural heritage.[1]

The basic idea of the theory of "style restoration" is to try to restore historical buildings or monuments to the "possible original" state, as explained by Viollet-le-Duc: "imagine yourself in the position of the original architect, imagine what he would do if he returned to this world and faced with this building." [1]When the theory of Viollet-le-Duc was popular in Europe, Italy accepted his ideas as well as those of other countries, thus forming a situation of coexistence of multiple theories. Camillo Boito, the leader of Italian architectural protection theory, put forward the theory of "Restauro filologico". [2]He believes that architectural heritage should be regarded as a historical document, and each part of it reflects history. Boito's serious and devout respect for the historical documents of architectural heritage mentioned a theoretical height. He even criticizes the theory of Viollet-le-Duc and believes that it is more impossible to repair from the position of the original architect. All assumptions are lies and falsifications.[2]

Following the further development of documentary restoration, the 'historical restoration' (restauro storico) advocated by Luca Beltrami appeared. The theory believes that on the basis

1 He, Yaoxuan. 'The History and Development Trends of Academic Research in Architecture Renewal Field'. PDH Diss., Tianjing University. 2011. (贺耀萱. '建筑更新领域学术研究发展历程及其前景探析'. 博士论文, 天津大学. 2011.)

2 Jukka Jokilehto. A History of Architectural Conservation. Beijing: Zhonghua Shuju. 2011

of historical respect for the authenticity of history, it is possible to break through traditional concepts in structure and materials, boldly adopt new structures and new materials, and do not need to be limited to traditional construction methods and materials in order to achieve history and unification of structure, form and materials.[2] The restoration of Castello dello Sforza in Milan and the reconstruction of the clock tower of Piazza San Marco in Venice are the successful and classic examples of Luca Beltrami. Both are based on the information that Beltrami can find to restore the architectural heritage.

How to deal with the relationship between history, truth, form, materials and contemporary, Gustavo Giovannoni put forward the theory of "restauro scientifico". Giovannoni introduced the concept of "anastylosis": the most probable attachments were used to reassemble the existing fragmented components. The material properties of these attachments should be neutral, and their dependence on the entire protected object should be minimal. Facing the damage caused by the war after World War II, the principle of building restoration was again debated. The “restauro critico” developed by Cesare Brandi from the common artistic attributes of painting, sculpture and architecture, it is aimed at a wide range of artworks, more considering the social and cultural background, and the protection of buildings is more guided not a demonstration.[2]

After World War II, with the gradual enrichment of material life, people began to seek historical memory again. For this reason, the protection of architectural heritage has been popularized and developed on a large scale, and the scope of protection has begun to expand from a small number of cultural relics and precious buildings to a large number of general buildings, from a single building to a group to a block and town. The recognition scope of architectural heritage is expanding, and large-scale architectural protection is more and more conducive to the revival of its architectural life, active participation in urban construction, and promoting the internal demand of social rejuvenation, which makes the architectural protection not only have the attribute of historical and cultural heritage protection, but also have the shape of large-scale social architectural practice. At the same time, new architectural thoughts, materials and new techniques began to penetrate into the practice of reuse of historical

buildings.[3]

But there are also some problems in the expanding protection movement. The most prominent problem is the life and death of architectural heritage - survival or death, which is a problem; how to survive, which is a problem. People gradually realize that although the static protection method has frozen the architectural heritage to the maximum extent, it is only a negative preservation.[4]

With the practice, people gradually realize that the fundamental purpose of building protection is to make use of its rich heritage resources to better serve the diversified social needs of the present or future. Fundamentally, protection is for use. A conservation that is not intended for reuse cannot be persisted.

(2) Fragment[5] of Verona Castelvecchio Museum

After the Second World War, the modern architectural concept quickly became the mainstream, and the critical and thoughtful protection and restoration of historical buildings became the leading. In the face of the economic reality of destruction and embarrassment caused by the huge war, the reconstruction of Castelvecchio Museum in Verona by Italian architect Carlo Scarpa is a typical reuse of historic buildings. This castle has been used as a barracks for a long time in history. After several repairs and transformations, it has become totally different. On the rebuilt battlements and facades, the decorative elements of the late Gothic and Renaissance have added historical pseudo-masks to the castle, confusing the authenticity and readability of history. When Scarpa was going to repair and reuse it, he considered that everything in the ancient castle of Verona is false after the historical research. He thought that we should clear away the magnificent and hypocritical decoration of the ancient castle, and clarify and restore the historical face of the ancient castle.[6]

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3 These points are summarized from Lu Di's book which is 'Rebirth of Historic Buildings – the Research on the Reuse of Historic Buildings'.

4 Lu, Di. Death and Rebirth of Historic Buildings – the Research on the Reuse of Historic Buildings. Southeast University Press. 2004.

5 The idea of 'fragment' comes from Li Ji, 'The Whole behind the Fragments in Carlo Scarpa's Architecture: The Restoration of Verona Castelvecchio Museum', and the case study base on this paper and author's survey.

6 Li Ji. 'The Whole behind the Fragments in Carlo Scarpa's Architecture: The Restoration of Verona Castelvecchio Museum'. New Architecture 2(2011); 11-16. (李霁. '断片之后的整体——析卡罗·斯卡帕的维罗纳古堡艺术博物馆修复工程'. 新建筑. 2(2011)

Scarpa is famous for its fine and unique detail node design. Unlike the general architect who chooses to start from the overall idea, Scarpa goes the opposite way. In order to obtain creative space nodes and details, he often pays attention to each node first, believing that the process of dialogue between nodes will naturally produce a sense of wholeness. Scarpa's architecture is a kind of discontinuous form, which seems to be a series of fragment permutations, but in essence is a complex interactive landscape of recognition and re-composition, and a network system composed of many possible routes. Scarpa can always push the design layer by layer to every detail. The sense of fine weaving brought by dense fragments dissolves the sense of entity of general architecture, and the fragments are related to each other.[6] *(Fig.2.1)*

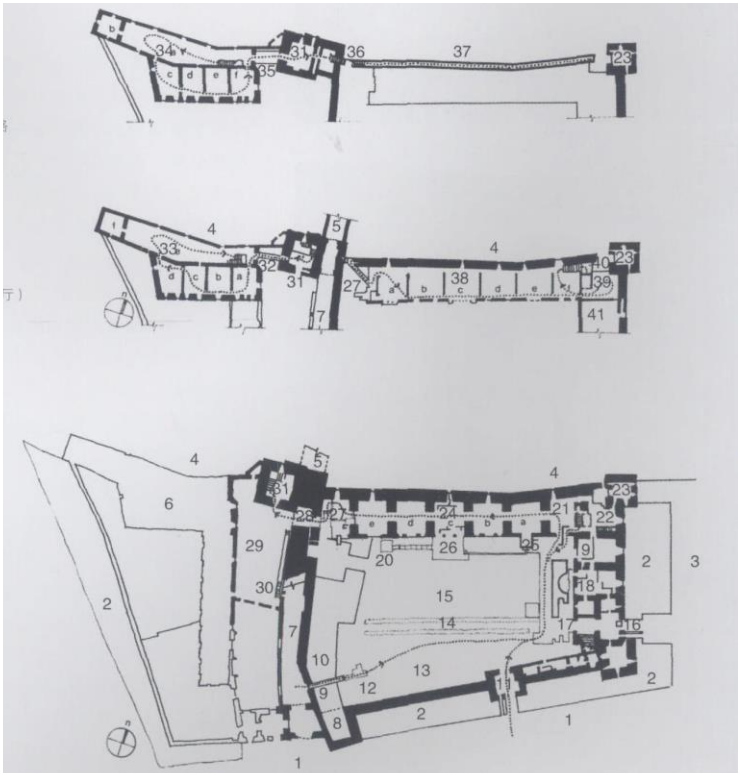


Fig. 2.1 Plan of Castelvecchio Museum (Source: Li, Ji. 'The Whole behind the Fragments in Carlo Scarpa's Architecture: The Restoration of Verona Castelvecchio Museum'. New Architecture 2(2011))

At the same time, in the face of the renewal of historical buildings, the history can fully show the existence significance and aesthetic feeling of history in the dialogue and even conflict with modern times.[7] And Scarpa's fragmented architecture is not only the deconstruction of multi-level history, but also the breaking of the complete and static space form of traditional architecture to achieve the dialogue between modern and history.[5] As a result, Scarpa has embedded a "crack" in the Castle Museum, the most famous 'Cangrande Space' of the project. *(Fig.2.2)*

Fig. 2.2 The 'Cangrande Space'
(Source: Li, Ji. 'The Whole behind the Fragments in Carlo Scarpa's Architecture: The Restoration of Verona Castelvecchio Museum'. New Architecture 2(2011))

Because of its long history, the historic sites of the ancient castle were discovered slowly during the construction process, and as an important design of 'cangrande space', they were constantly adjusted. In the original scheme, the statue was set on the east side of the barracks in the north, that is, the entrance is now backward, the corner is broken but the roof remains unchanged, creating a striking high entrance space. The barracks on the north side serve as the exhibition hall and the barracks on the east side serve as the office. From the perspective of practical logic, the corner fracture here conforms to the logic. But from a historical point of view, it implies that this place seems to have been separated, which is illogical.[8]

7 Zhou Wei. 'Protection and Reuse of Historic Building-Study on Theories and Modes of Relationship of Old and New Space', Beijing: China Architecture & Building Press, 2009.

8 It is proposed by Li Ji.

Along with the excavation of the remains of the ancient castle, the moat of Scarkeri period in 1962 was found, which promoted the location of today's 'cangrande space'. In order to show the gate of the 12th century and the moat of the 14th century, and to expose multiple historical levels, and to achieve dramatic historical display effect, Scarpa demolished the last room on the west side of the barracks on the north side. The statue of Cangrande della Scala was deliberately slanted on a heavy concrete beam drawn from the second floor. New elements such as the steel overpass and viewing platform are worn out from the old buildings, like the historical fragments on both sides of which are sewn with modern knitting thread. *(Fig.2.3)*

The top of the open space here is supported by two pairs of beams. The roof is divided into three levels. The roof truss composed of two ridge wooden beams was preserved when the barracks were demolished, extending from the barracks to the wall. A new copper roof is set over the ridge, and the original tile roof extends over the copper roof. The whole roof gives the illusion of peeling off. *(Fig.2.4)*

Fig. 2.3 Overlook of 'Cangrande Space'
(Source: the author,2018)

Fig. 2.4 Layers of the roof
(Source: the author,2018)

Cangrande space', an open, transparent space with vertical depth and complex composition, contains almost all the information of the historic period of the castle. Scarpa's fractured approach [8]is not only a way to talk about history, but also an effective way to show history. With the separation of layers, Scarpa uses spatial streamline organization to guide people to the destination gradually, and then displays the multi-level historical interface one by one.

2.1.2. Overwriting and Palazzo Arese di Seveso[9]

(1) continuity and overwriting of Historic Block

In the middle of the 20th century, with the rapid development of industrialization, great changes have taken place in the city. The modern design concept has made the traditional old city rapidly changed by the wide and straight road, the tall and simple concrete building, the clean and open green square and the orderly 'order', which has made the fundamental tone of the whole city completely changed. People also gradually realize that the development of modern cities has posed a threat to the survival of historical buildings.

Under this condition, the protection or renewal of a single building can't achieve its real purpose. If we want to save the 'life' of historical buildings, we must first save the 'environment' on which they live. It is for this purpose that the field of building protection extends outward from the building itself, and the concept of 'historical block' protection is also spread.

Based on the recognition of historical block protection, the relevant protection theory has gradually developed. After the Second World War, the urban environment of Italy was broken. As an old city with a long history, Milan has a large number of historical buildings and blocks waiting for protection and renewal. In the face of modernism abandoning historical context, Ernesto Nathan Rogers proposed the concept of "pre-existing environmental conditions",[10] which built a theoretical bridge between modern design and historical environment, and then extended the "Continuity"[11] theory. "Continuity" not only refers to the continuation of the form of historical buildings, but also refers to the deep understanding of the historical context, so that the new design can continue and inherit the historical spirit. This means that, on the basis of respecting history, design is the interpretation of historical context rather than imitation, and creative design is carried out through translation. "Continuity" is not only applicable to the protection and reuse of historical blocks, but also applicable to single buildings and even urban levels. It is an attitude between tomorrow and yesterday, between the future and the past, a

9 The concept of 'Overwriting' is learned and come from Prof. Laura Anna Pezzetti. Overwriting the Urban Palimpsest:: A Regeneration Structure for Historic Public Spaces and Buildings.2017

10 It is proposed by Emesto N. Rogers. Author got from the lecture of prof. Fulvio Irace in Polimi.

11 The concept of 'continuity' comes from Emesto N. Rogers, which author got from the lecture of prof. Fulvio Irace in Polimi.

lever that can maintain a dynamic balance.[12]

Under the theoretical guidance of "continuity", overwriting[9] the urban palimpsest can be said to be a more specific design concept for the protection and reuse of historical blocks. Palmsest's symbol and meaning are based on the time stratification reflected in the architectural form. Its appearance has restarted the discussion of not determining the architectural protection with the short historical value. It believes that the complex relationship among history, site and design should be combed to decide whether to protect or not.[13]

According to Prof. Laura Anna Pezzetti, before overwriting, it is necessary to analyze the historical stratification of the original landscape site and area. As the metaphor of Palimsest, the existing material environment in reality is the product of the accumulation of history at different time levels, with a certain degree of stratification. At the same time, it is necessary to read and promote the context of the site in order to reconstruct the relationship between the new and old nodes, because it is a multi-level text composed of symbols, traces, memories and covers.[13]

The historical development is a spiral movement, which makes the urban structure and texture can't show a complete continuity, so there will always be some historical fractures and fragment memories in the historical block. In the face of faults, the strategy of overwriting is adopted to cover the new part into the old urban landscape, so as to connect the relationship between the old and the new, and achieve the purpose of site reuse.

(2) Overwriting Strategy of Courtyards in Palazzo Arese di Seveso

Cesano Maderno, located in Brianza province in the north of Milan, Italy, is one of the towns with a long history in Italy.The semicircle porch is facing the Palazzo Arese Borromeo, forming the urban semi-public space at the entrance, which is affectionately known as the "theater", thus strengthening the axis focus. In the other axis, Palazzo Arese BoIrromeo is taken as the axis to form the North-South short axis. Laura Anna Pezzetti, the architect, put forward the strategy of strengthening public use and intermittent for this short axis, which created the

12 Author 's understanding of the 'continuity' received after listening to lecture from Prof. Fulvio Irace.

13 Laura Anna Pezzetti. Overwriting the Urban Palimpsest:: A Regeneration Structure for Historic Public Spaces and Buildings.2017

opportunity for the urban structure to renew around the old city center and then get the chance of re gathering, making this short axis become the civic center.[13] *(Fig.2.5 -2.7)*

Palazzo Arese di Seveso is located on this short axis, on the south side of Palazzo Arese Borromeo. It is a U-shaped building with a regular garden, a farm yard and an adjacent orchard. Before they were rebuilt, they were left in a state of desolation due to their indifference. Later, Laura Anna Pezzetti, the designer, was responsible for the renovation. Palazzo Arese di Seveso has become a multi-functional building through protection and reuse. As part of the town hall complex, it has a library and a small museum inside.

Fig. 2.5 The two axes
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

In the view of Prof. Laura Anna Pezzetti, the Arese square, its courtyards, and the surrounding urban spaces were all renovated with respect for material authenticity, civil reuse, dialogue with contemporary languages, and the insertion of new elements into the historical layering, thus comprehending the true nature of architecture and urban landscape as a compositional palimpsest and a long term process of transformation and evolution in use and meaning.[14]

14 Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.

Fig. 2.6 Palazzo Borromeo Arese (17th -19th century) (Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

Fig. 2.7 Palazzo Arese di Seveso (17th -19th century) (Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

For the courtyard design here, the designer adopts the method of overwriting fragments and grafting, [15]which makes the two abandoned and independent courtyards transform into open spaces with different themes. A courtyard is a farm style courtyard built in the 17th century. It is surrounded by the earliest core part of the building, the extension of neoclassical style, the old church and the far away town hall. The other is lack of encirclement, but its original characteristics are well preserved. In the face of historical differences, designers adopt different landscape treatment methods, transforming the two into formal garden and equipped garden respectively. *(Fig.2.8 Fig.2.9)*

Based on the original irregular shape, formal garden has carried out an enhanced design. The design method of "overwriting" outlines the hidden order of the site, while retaining its long-standing green space image, endowing the historical stratification with an internal role, so as to increase the possibility of reading, understanding and reusing this historical rewriting. Such Palimses of an interrupted, incomplete and hard to restore order is a new beginning.[13]

15 The methods of overwriting fragments and grafting are proposed by Prof. Laura Anna Pezzetti.

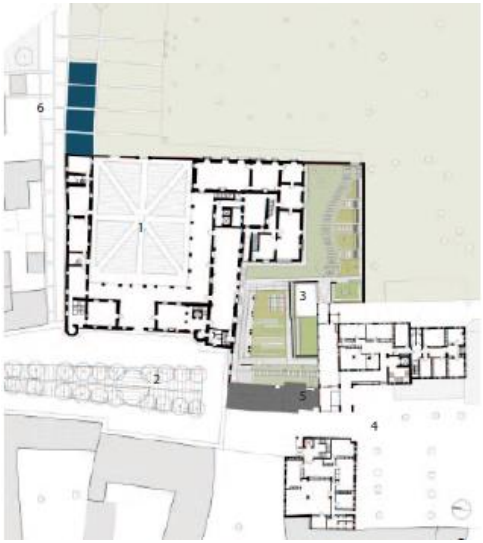


Fig. 2.8 Plan of Palazzo Arese di Seveso
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

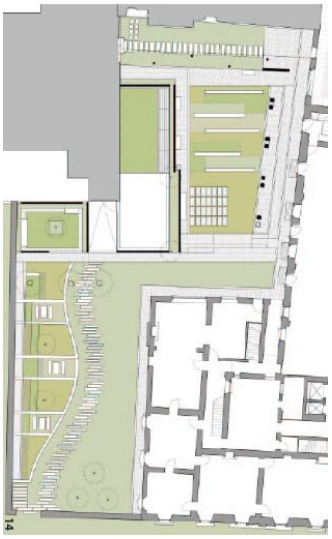


Fig. 2.9 Two courtyards of Palazzo Arese di Seveso
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

In formal garden, there are unknown but long-standing double columns, which are kept in the courtyard as historical fragments. In the design of overwriting, it is inevitable to retain the double columns. *(Fig.2.10)* Although the double columns can be reinterpreted through the treatment of the ground layer, materials and texture, it is necessary to match the new and old space with the reconstructed environment. On the side parallel to the baroque church, the designer set up an air corridor independent from the old building. The modern column structure supporting the corridor forms a contrast and echo with the double columns in the courtyard. *(Fig.2.11)*The new and the old, simple and complex form a sharp contrast, which makes the original double columns appear less abrupt in the courtyard. At the same time, a steel plate is set in the entrance hall to provide a clean background for the double columns. *(Fig.2.12)*

Fig. 2.10 Formal garden
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

Fig. 2.11 New and old columns
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

Fig. 2.12 The steel wall
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

In order to maintain the connection between the historic landscape and the extension of neoclassicalism, an open-air 'secret room' was set up at the junction of the two, which was enclosed by wooden screens. *(Fig.2.13)* Stone chairs and wooden tables are also set in the equipped garden to serve the library, so that the library's functionality extends outward. *(Fig.2.14)* The natural ground texture flowing in the courtyard responds to the old trees, making the equipped garden have the characteristics of nature and provides a good outdoor landscape environment.[16] *(Fig.2.15)*

Fig. 2.13 Secret room
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

Fig. 2.14 Chairs and desks
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

Fig. 2.15 Natural landscape
(Source: Laura Anna Pezzetti. The old and the new: Designs to Enhance Cesano Maderno Old Town through a Regenerative Structure.2017.)

16 The interpretation of yard is based on the lecture of Prof. Laura Anna Pezzett.

2.1.3. Revitalization and Falck Area in Milan

(1) Revitalization and Vitality

Since the birth of a city, its continuous development process is a process of continuous renewal, so it can be said that urban renewal is accompanied by the whole process of urban development. Ernest Burgess, an urban sociologist at the Chicago School, believes that if a city is regarded as an organism, then the process of its dynamic change will appear as growth, maturity, decline, decline or renewal. The essence of the urban renewal movement has evolved from the improvement of the pure material environment to the renaissance of society and economy, and then to the improvement of the competitiveness of the city, gradually maturing.[17]

In most countries, the development from single building protection to regional protection has shifted from focusing on simple, controlled protection strategies to focusing on the revitalization, development, and strengthening of historical block functions. Since the late 1940s, the western concept of urban renewal has undergone many obvious changes, resulting in several concepts related to urban renewal, such as Urban Reconstruction, Urban Revitalization, Urban Renewal and Urban Regeneration. Although these vocabularies are different, they belong to the scope of urban renewal in essence, but they only use different expressions to solve and target different problems.

Based on the renewal of Fenghuang Ancient Town in this article, the strategy of urban revitalization is adopted, and new vitality is inserted into Fenghuang Ancient Town to achieve the purpose of renewal and revitalization of ancient town. 'Vitality' originated from the concept of biology and ecology, and the concept of vitality was introduced into historical blocks and urban revitalization. There are two main meanings: First, historical blocks and towns have experienced long-term historical development and rise and fall, and have a metabolic process and exuberant vitality; second, historical blocks and towns are themselves full of vital elements such as spatial form and social interaction. With the development of society, the indifference to the historical city has lost its original popularity and vitality. Therefore, we should re-energize

17 Zhang Wei. 'Studies of the Culture Industries Development within the Process of the Urban Regeneration in the West, as well as the illumination for China's Practice'. PDH Diss., Shandong University. 2013.（张伟. '西方城市更新推动下的文化产业发展研究——兼论对中国相关实践的启示'. 博士论文, 山东大学. 2012.）

to renew and revitalize the historical blocks and urban areas.[18]

After 'The Image of City', Kevin Lynch used 'vitality' as the primary index for evaluating the quality of urban spatial form in 'City Form'. He believes that a good urban form should include: 'a series of elements such as vitality and diversity (including life and ecology).' In the actual urban renewal, vitality refers specifically to the characteristics of historical blocks and historical urban areas, which are built to meet the living needs of contemporary people, and can attract people, display historical heritage and values, and then achieve the purpose of sustainable development.[19]

(2) Transformation of Falck Area in Milan

The reconstruction of the Former Falck steel factory site requires master planning to reunify the divided city of Sesto. Today, there are two 'cities' sitting side by side: the densely populated historic Sesto and 'Sesto of Factories', once home to large industries, were once proud the collective memory area is now abandoned and vacant. The reconstruction project is based on the main green area with symbolic significance and has an open and clear layout, which will provide the structure and the existing industrial buildings to be reused. The site will be reconnected to the surrounding environment with a new active urban structure.[20]

Fig. 2.16 Masterplan of Falck Area (Source:http://www.rpbw.com/project/masterplan-for-the-ex-falck-area)

Milan has always been home to some of the most famous brands in the world. As the manufacturing center of many factories, the city now finds that its factories have been decommissioned, closed, abandoned, and often forgotten, leaving considerable space unusable and often ugly. The Falck steel factory in Sesto San Giovanni in northern Milan is such

18Long Wentao. 'Revitalizing Traditional Urban Districts Viability'. Master Diss., Kunming University of Science and Technology. 2008.（龙文韬. '城市传统街区活力的复兴'. 硕士论文，昆明理工大学. 2008.）

19 It is summarized from Long Wentao's Master Diss.

20 The information about Falck Area comes form http://www.rpbw.com/project/masterplan-for-the-ex-falck-area

a place, leaving many old social housing, industrial skeletons and a gray landscape.[21]

Renzo Piano's master plan aims to restore it to a vibrant museum, library, research center, university, houses, shops, and a 1 million square meter park-and tightly integrate it-planned to be completed in 2018. The north-south axis will contain commercial and residential plans and will add approximately 1270 new housing units. The east and west datums will carry the above public functions and merge with the new green landscape[21]. *(Fig.2.16)*

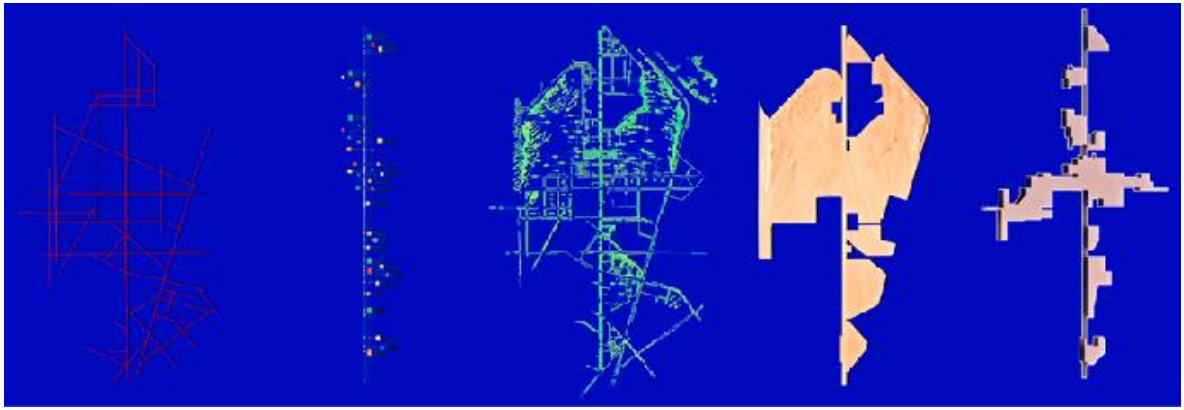


Fig. 2.17 Urban strategy of Falck Area
(Source: https://www.designboom.com/architecture/renzo-piano-masterplan-for-the-ex-falck-area/)

As can be seen from the figure, the Revitalization Strategy of Falck area mainly includes the following steps: building road network, inserting attractive points, activating green space, merging areas and improving functions.[21] Among them, the improvement of road network structure is the starting point for the revitalization of the whole Falck area. In the book 'The Death and Life of Great American Cities', Jane Jacobs studies from the urban streets, and believes that it is the process of interweaving of people's activities and living places, the diversity of urban life, which makes the city obtain vitality. She pointed out that the order hidden in the streets ignored by modern architects contains rich and diverse urban life, which includes the mode of daily life and the network of interpersonal communication. The

21 Getting and summarizing from the lecture of prof. Fulvio Irace in Polimi.

maintenance of the existing value of these cities is the key to the planning.[22] *(Fig.2.17)*

Only with the improvement of the road network can the historical heritage values in the historical blocks and urban areas be displayed. On this basis, attractive points and green landscape are inserted into attract people. The continuous gathering of people will bring vitality to the area, and then achieve the revitalization of the whole historical urban area by improving the infrastructure in the area.

2.2. The General Strategy Based on Revitalization and Overwriting[9]

2.2.1. The Accessibility Problem of Fenghuang Ancient Town

The first is the behavior. The unique "front store and back house" mode of the ancient town restricts the tourists' behavior path. It is difficult to go deep into the inside of the ancient town to understand and feel, which is one of the reasons for the low satisfaction of tourists.

The second is accessibility. The ancient town has two main roads, commercial old street and new street. The commercial old street is the main gathering place for tourists. This is due to the weak accessibility between the two main streets, and only three are not suitable for tourists. The path is accessible. In order to improve the development of commercial tourism in the ancient town, it is necessary to expand the tourist path and experience. Therefore, it is necessary to guide tourists from the ancient commercial street to the new commercial street, thereby bringing more business opportunities. In the survey, it was found that there are many potential paths between the two streets to divert tourists.

Finally, greenery, backyards and open spaces have an impact on each other in the ancient town. They penetrate each other and attract tourists, but they are not excavated and used. A small piece of green space will affect the surrounding buildings, which can enhance the landscape environment of the surrounding buildings and have a certain level of radiation. These green spaces are also important nodes connecting the two main streets. *(Fig.2.18)*

22 Jane Jacobs. 'The Death and Life of Great American Cities', Nanjing: Yilin Press, 2005.

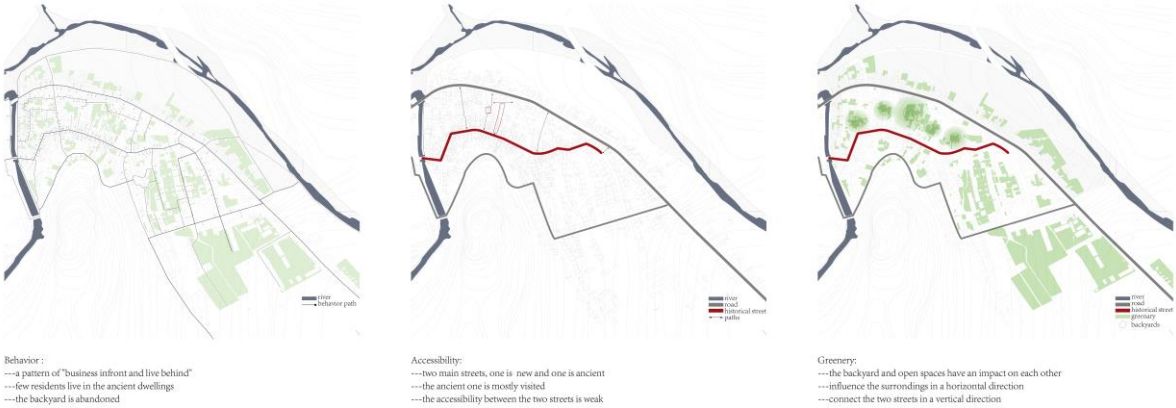


Fig. 2.18 Behavior, accessibility, greenery of the Fenghuang Ancient Town
(Elaboration by author)

2.2.2. The Revitalizing Urban Strategy of Fenghuang Ancient Town

Step 1 Improve Connection (Fig.2.19)

Breaking the unachievable of the two streets to guide people to the new street to active the whole town.

Step 2 Enhance Main Points (Fig.2.20)

Activating and making use the yards which are waste but the value for the Fenghuang ancient town, in order to let people to find the hinden value.

Step 3 Develop the Secondary System (Fig.2.21)

Connecting the two main streets by the new paths, and some of these paths would go through the yards to make the yards can be used well.

Step 4 Transform Historical Dwellings to Attractive Points (Fig.2.22)

Finding the potential traditional dwellings and transforming them into some attractive points to effective the secondary road system and make the urban strategy more enforceable

In the final urban strategy drawings, several ancient town structural nodes are arranged in conjunction with the ancient town's overall road system to enhance the accessibility and purpose of the road. The old bridge is at the begin of the ancient street and the handcrafts square is at the end of the ancient street, and the museum along this street is at the turning points. These three points make the ancient street more interesting and guide the tourists.

Meanwhile, the viewing platform and the dock, the leisure club and the museum link the secondary paths to guide people go through the inner part. With the reuse of the courtyard and the improvement of the road system, it can stimulate the east-west secondary roads in the ancient town development, which in turn activates the commercial development within the ancient town. *(Fig.2.23)*

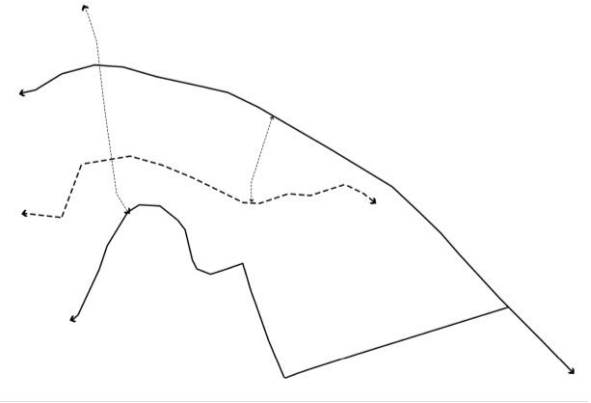


Fig. 2.19 Step 1: improve connection
(Elaboration by author)

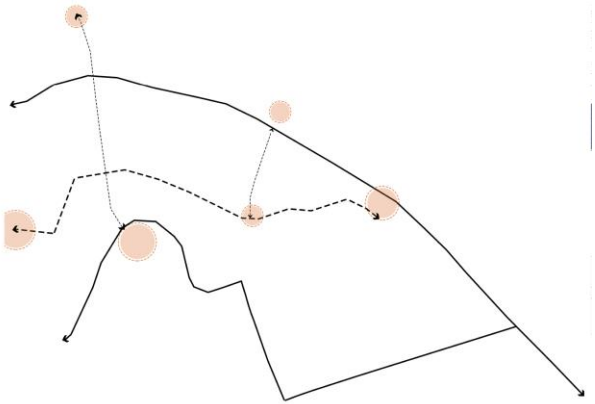


Fig. 2.20 Step2: enhance main points
(Elaboration by author)

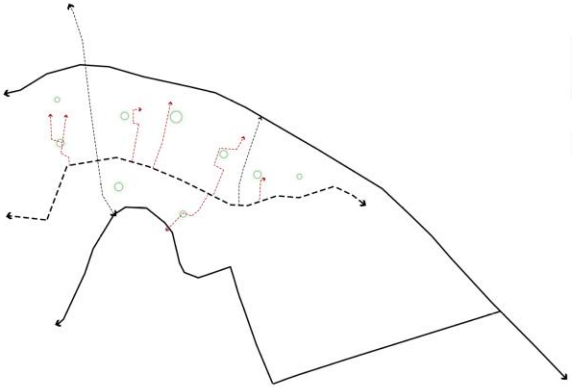


Fig. 2.21 Step3: develop the secondary system
(Elaboration by author)

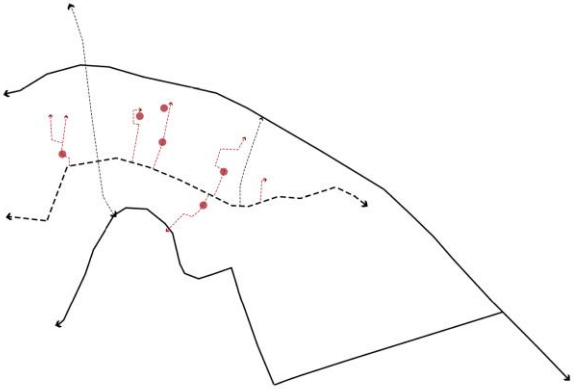


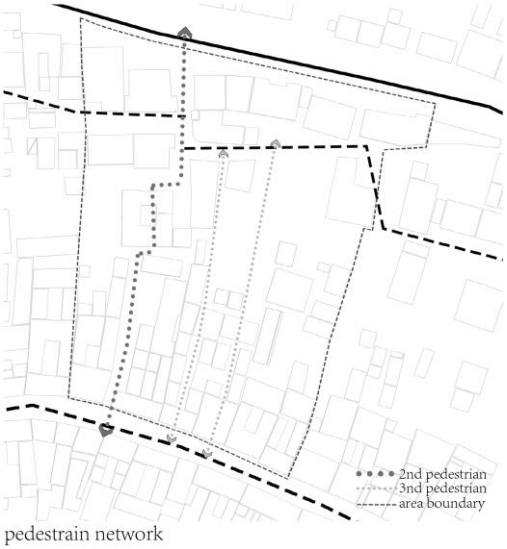
Fig. 2.22 Step4: transform historical dwellings to attractive points
(Elaboration by author)

Fig. 2.23 General strategy of the Fenghuang Ancient Town
(Elaboration by author)

2.2.3. The Overwriting[9] Strategy of Area Project

After learning from Prof. Laura Anna Pezzetti's overwriting, the step 1 of the strategy of area is made which is improving connection. The existing pedestrian network is weak. According to the survey of the area to find and plan the pedestrian network especially the 2nd and 3rd system. The step 2 is enhancing the main points. There are some activity points in the area project but it's not enough. Combine the pedestrian system to make more potential activity points. The next two steps are developing the secondary system and transforming historical dwellings to attractive points. Based on the surveying of each building in the area, transforming the Dang Yard and some other related buildings to the homestay hotel. And add two new buildings to support the new function. Meanwhile, Planting plants in the waste greenery and the open space and let them provide good effects to the whole area. Inserting new function, like swimming pool, in the yard to attract the tourists. *(Fig.2.24-2.25)*

After that, the road system in the area is enhanced by the attractive points, like the reused Dang Yard, the added new buildings, the heritage buildings and the reused greenery open space. This complete structure benefits the area, but also the surroundings and the town. *(Fig.2.26)*



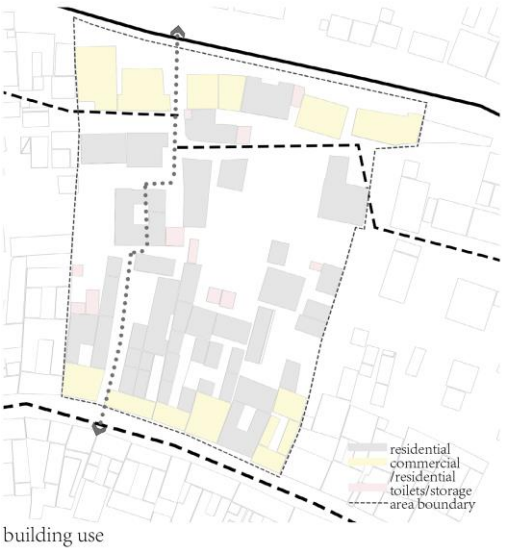


Fig. 2.24 Survey and analysis of the morphological unit
(Elaboration by author)

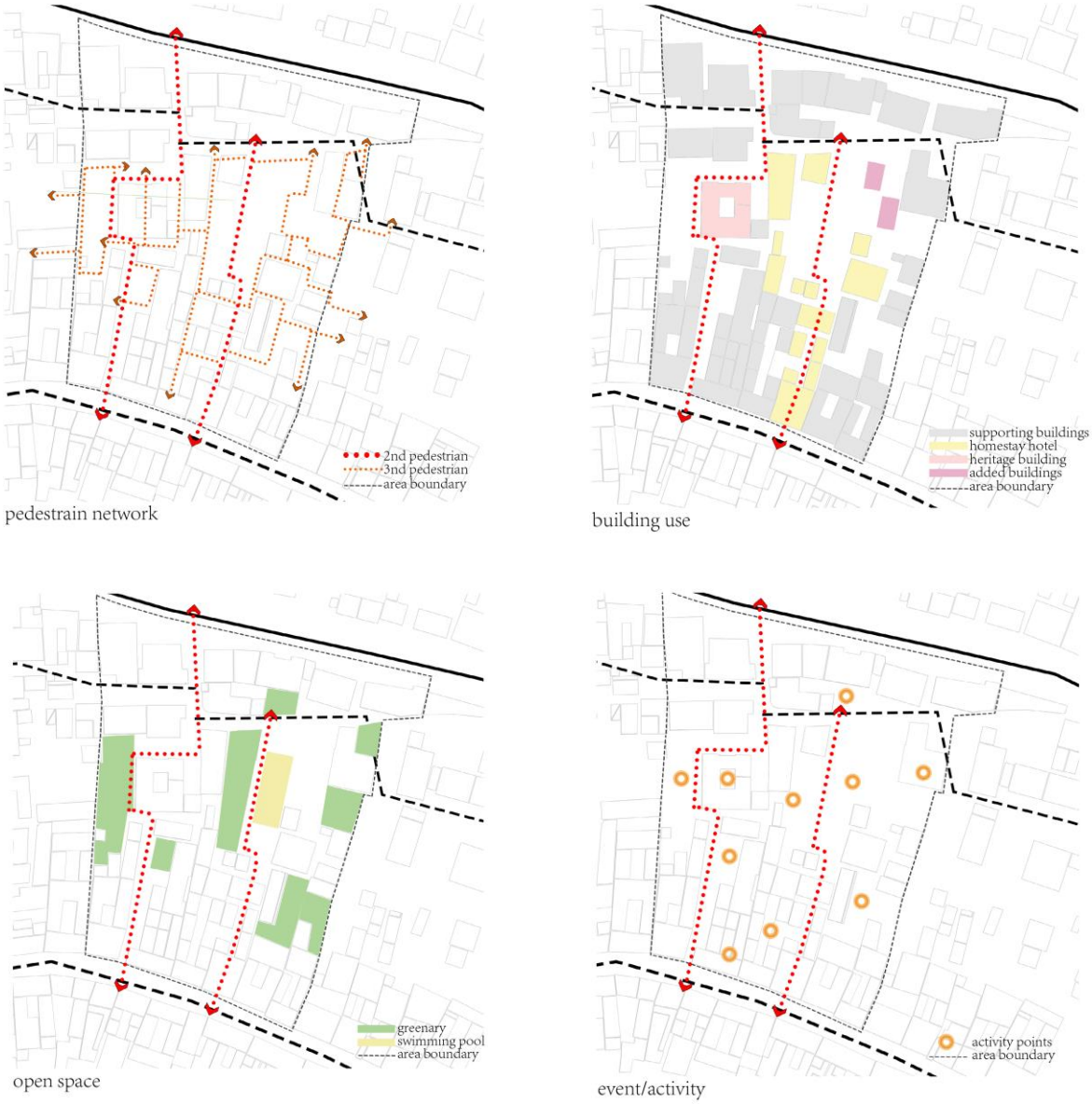


Fig. 2.25 Strategies towards the morphological unit
(Elaboration by author)

Fig. 2.26 Whole general strategy of the morphological unit
(Elaboration by author)

2.3. The Conservation and Reuse of Methods of Historical Building

2.3.1. Optimization and Reorganization [23] of External Space of Historic Building

The optimization and reorganization of external space is a very important aspect for the reuse of historic buildings.[23] The scope of the external space here is the area or even the city level. Because the historical buildings have been in the large urban environment for a long time, the environment here is often messy, narrow roads and messy after many disordered expansion, which often makes the accessibility of the historical buildings weak. This has a great impact on the external display of historical buildings, while reducing the historical and cultural atmosphere of historical buildings. Therefore, the renovation of the external space first needs to dredge the traffic, improve the accessibility of the building, and then create a more human, characteristic and well-equipped external urban space, such as green space, open space, etc. In fact, these two points coincide with the urban strategy mentioned above, which further illustrates the close relationship between the building monomer and the city as a whole, and the interaction between the two.

Another purpose of optimizing and reorganizing the external space is to obtain clearer and purer historical and cultural information and atmosphere. The disordered external environment buried a lot of historical information carried by historic buildings. One of the most important information carried by the external space is the urban texture and pattern. Only by dealing with the external disordered environment, can the historical buildings and their external space environment be coordinated and unified with the whole urban space order.

For Fenghuang ancient town, radial structure is the logic of the growth of the whole ancient town. The historical buildings and new buildings follow and continue this clear historical and spatial logic. However, due to the long history of the ancient town, the external space between the new and old buildings is in a state of waste and disorder, which also disappears and

23 The methods of optimization and reorganization of external space of historic buildings are proposed by Lu Di's book which is 'Death and Rebirth of Historic Buildings – the Research on the Reuse of Historic Buildings'. Southeast University Press. 2004.

weakens the original radial structure. Therefore, in the reuse of historical buildings, whether for repair and reuse or for new construction, the order of radial structure should be followed.

2.3.2. Enrichment and Replacement[24] of the Internal Space of Historic Building

The renovation and adjustment of internal space is the core of the reuse of historical buildings. In practice, there are many ways to operate the internal space. Combining the methods of enrichment and replacement[24] which is proposed by Lu Di, and according to the characteristics of the internal space of traditional houses in Fenghuang ancient town, Zhashui County, this paper discusses the space operation from three aspects: courtyard, attic and internal facilities.

The first is the treatment of courtyard space. Courtyard is one of the powerful means of space adjustment. It can make the old building obtain necessary internal public space, bring active internal activities, and solve the problems of traffic, lighting, ventilation, etc. In many cases, courtyard is also an effective way to increase the use of space. There are many ways to create courtyard space in the old buildings, such as demolition, merger and so on, but these should be based on the historical context of the old buildings for reasonable evaluation and decision-making.

In Verona Castelvecchio Museum, Scarpa opened the west side of the barracks in the North reasonably according to the historical logic to form an open space. It not only put the statue of Cangrande della Scala here to form the climax of the building space, but also solved the problems of lighting and ventilation of the building itself. At the same time, the formation of courtyard space also creates more interesting spaces for the old buildings, such as cantilevered and through height space which is different from the traditional space.

The second is the reuse of the first floor or attic. The reuse of the first floor loft space not only transforms the original storage or abandoned loft into a living and working space through reuse, which meets the lack of space area at that time. At the same time, the attic space is also the historical memory space of historical buildings. The reuse of the attic makes the historical

24 The methods of enrichment and replacement of the internal space of historic buildings are proposed by Lu Di's book which is 'Death and Rebirth of Historic Buildings – the Research on the Reuse of Historic Buildings'. Southeast University Press. 2004.

memory better preserved and continued. In the reuse of Verona Castelvecchio Museum, Scarpa also uses the first floor space as the exhibition hall, and sets up new stairs to meet the use needs.

In the Fenghuang ancient town, the first floor was used as a storage space in history, and even today, it is still reached by using ladders. However, due to the function transformation and the lack of comfortable and safe stairs, the first floor space of traditional residential buildings in Fenghuang ancient town is mostly abandoned. If it is no longer protected and reused, the attic space will gradually disappear in the daily life of residents, and the ancient town will lose important historical memory space. At the same time, the daily living space of ancient town residents is relatively narrow, and the first floor space can be used as an expansion space to meet the needs of residents and make full use of existing resources.

Finally, the improvement of the internal infrastructure of the building. Most of the historical building materials in the west are stone or materials with better waterproof performance, so when they are reused, there are fewer problems in putting new equipment, such as toilets, kitchens and so on. In China, most of the historical buildings are made of wood and earth, which have poor waterproof and moisture-proof performance. In order to meet the requirement of putting clean kitchen and toilet indoors, box-in-box mode can be adopted. The light steel keel double wall can be used for the reuse of the kitchen, which not only can be used for dry construction, but also has the advantages of fast construction speed, good fire prevention and waterproof performance.*(Fig.2.27)* There will be a certain installation of equipment and pipes in the kitchen. Because there are a lot of gaps in the light steel keel, the pipeline can be buried in it to ensure the cleanliness of the kitchen. *(Fig.2.28)*

The integral toilet can be used for the placement of the toilet.[25] *(Fig.2.29)* The waterproof performance of the integral toilet is good. Because of the closed structure, the moisture in the toilet rarely penetrates into the surrounding wall, so the partition wall of the surrounding room will not be affected by moisture. The integral toilet has many specifications, which can meet different space and residents' needs. At the same time, the installation is convenient and simple.

25 Fu Fei. Study on Renovation Design of Kitchen and Bathroom Space in Sunk-yadong-A Case Study of Shanzhou District, Sanmenxia, Henan Province. Master Diss. Mechanical Engineering Architecture School. 2019.

The dry operation construction not only protects the original building, but also reduces the construction interference to the surrounding residents.

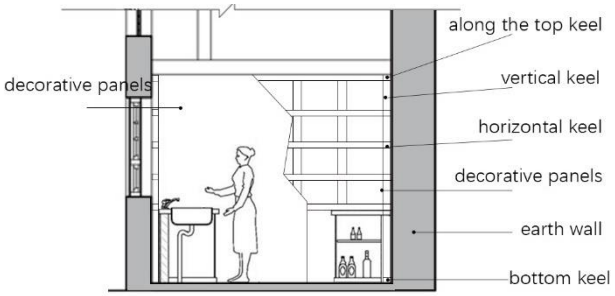


Fig. 2.27 Sketch of the kitchen double wall (Elaboration by author based on Fu Fei 'Study on Renovation Design of Kitchen and Bathroom Space in Sunk-yadong-A Case Study of Shanzhou District', Sanmenxia, Henan Province. Master Diss. Mechanical Engineering Architecture School. 2019.)

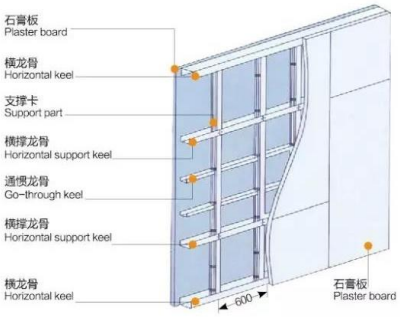


Fig. 2.28 Details of the light steel keel wall (Source: http://www.tfsxjc.com/Article/qglggqsggy.html)

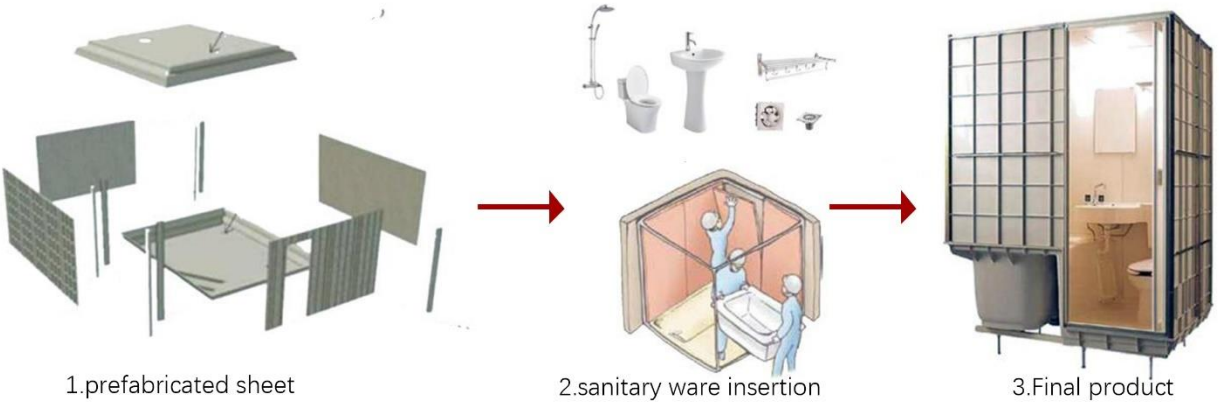


Fig. 2.29 Installation flow chart of the integral toilet (Source: Fu Fei, 2019)

03

Reading the Urban Area in Fenghuang Ancient Town

3.1 Historical Traces: Restore Signification Old Elements

3.1.1 Paths
3.1.2 Courtyard and Boundary
3.1.3 Walls
3.1.4 Landscape
3.1.5 Greenery

3.2 Features of the Architectures in Area

3.2.1 Roof Type
3.2.2 Building Material
3.2.3 Floors
3.2.4 Age and Numbering
3.2.5 Function
3.2.6 Facade

3.3 Typology Study on Buildings in the Morphological Unit

3.3.1Historical buildings
3.3.2Old buildings
3.3.3Modern buildings

3. Reading the Urban Area in Fenghuang Ancient Town

This research area is located in the middle of the old street of Fenghuang Ancient Town. It is centered on Dang Yard and Meng Yard, and extends westward to changshengxiang Inn, No. 347 traditional dwelling of Xinchun village, eastward to tongxinghe Inn, No. 325 in Xinchun village, north to Luozha Road ,which is also called Provincial Road 307, and south to the old street. *(Fig.3.1)*

Fig.3.1 Survey and analysis of the morphological unit
(Elaboration by author)

3.1. Historical Traces and Radial Context:[1] Restore Signification Old Elements

3.1.1. Paths

Roads in this Region can be divided into two types which is the main roads and secondary roads. These two types of roads correspond to the roads from the outside towards to the area and the roads inside of the area.

(1) Main Roads

There are two main roads from the outside to the area. *(Fig.3.2)* One is Luozha highway, which is also called 307 provincial highway, on the north side of the area which was opened to traffic around 2002. It is not a historical road, but its completion has made many modern buildings built on both sides of it, which has an important impact on the development of the texture of the town. This road is the only one that can reach the area under study by cars. Two parking lots are set at both ends of the road, including the parking lot around the village committee building at the east end of new street and the bridgehead parking lot at the west end of new street.

Another way to reach this area is the famous Fenghuang Street inside the ancient town. This road has been developed since the Tang Dynasty, with a total length of about 1200 meters.[2] It conforms to the form of mountain and water, and meandered in the form of "S". It is a main pedestrian road, starting from the old bridge of the ancient town on the west side and ending at another entrance on the east side. It organizes the traditional buildings of the town and is an indispensable historical road in the texture of the ancient town.

1 It is summarized from Prof. Laura Anna Pezzetti's book which is Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape..

2 Gong Yan. Fenghuang Town, Zhashui County, Shaanxi Province—National Historical and Cultural City Research Center Historic District Investigation[J].Urban Planning,2012,36(08):97-98. (龚龑.陕西柞水县凤凰镇——国家历史文化名城研究中心历史街区调研[J].城市规划,2012,36(08):97-98.)

Fig.3.2 Two mean streest in the morphological unit
(Elaboration by author)

(2) Secondary Roads

There are three urban secondary roads A、C and D in the area. *(Fig.3.3)* Urban secondary road A is the only horizontal road inside this area, parallel to S307 provincial highway; secondary road D is longitudinally distributed, located in the east of No.344 historical dwelling in Xinchun village. Road C extends from the river to the town and connects with S307.

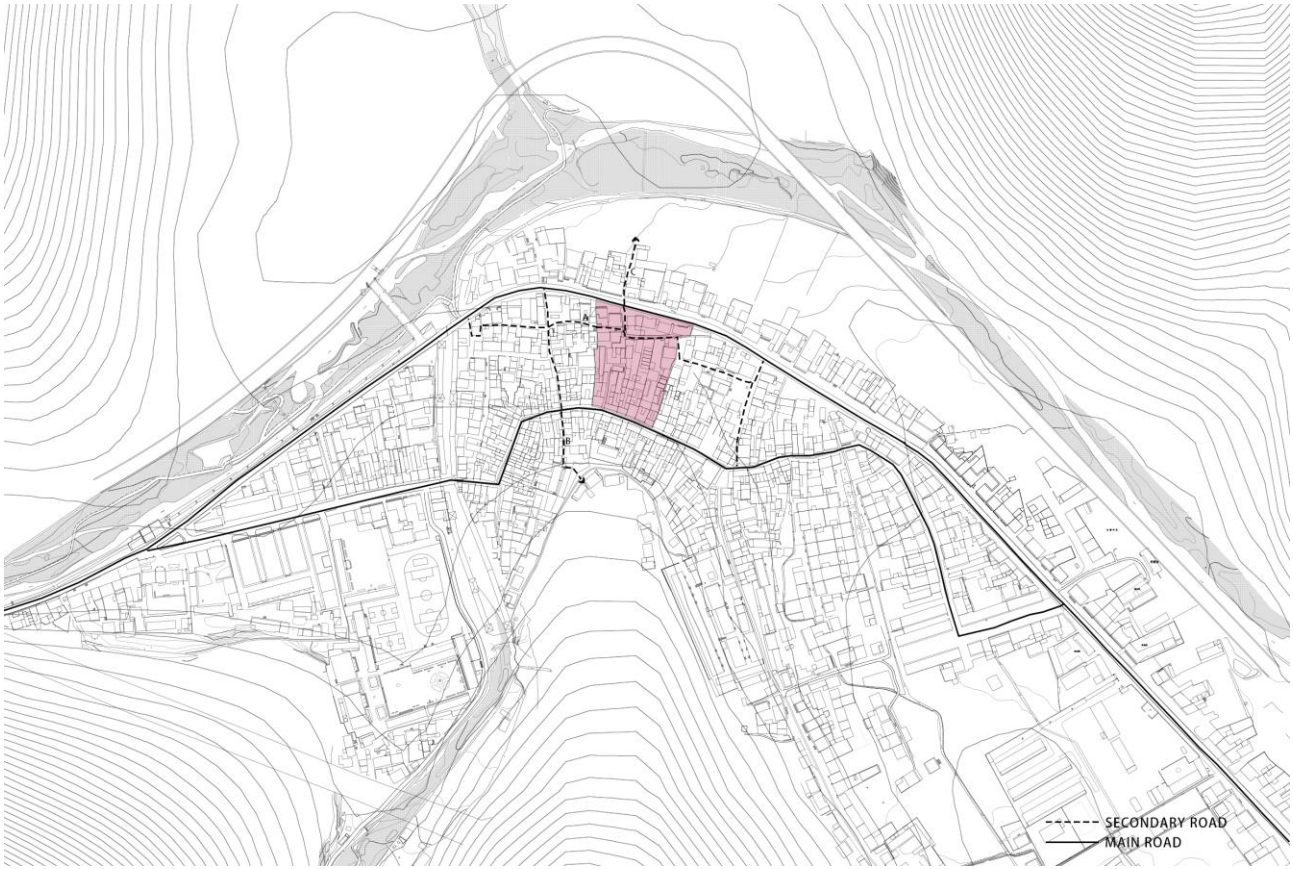


Fig.3.3 Secondary roads
(Elaboration by author)

Road D on the east side of No.344 dwelling in Xinchun village is a historical alley, which has a long history according to the photo of 1958[3]. The first half of the road connecting the old street is village level II Lane D-1, and the follow-up half needs to pass through the square traditional building. Usually only local villagers pass through. Few foreign tourists know about it, almost all of them think it is a blocked road. [4]Through the square historic building, you can reach the intersection point O of D-2 and east-west road A, and then you can cross the new

3 See the photo of Fenghuang Ancient Town in 1958. (Fig 1.17)

4 This information comes from the investigation and survey.

street road and secondary road C to the river.

Fig.3.4 Secondary roads in the area
(Elaboration by author)

The urban secondary road A between the new building and the traditional building is the boundary of the traditional building in history. Later, due to the completion of the New Street, S307, and the expansion of the town, it was transformed into an internal secondary road. This road runs through two traffic nodes in the area: the yard front space P formed by the East Road turning point and the intersection node O of the West two-way road. In section A-2 of this road, there is a canal in the south which separate the road from the building courtyard, forming a natural division; in the north, the terrain is higher, and a fence wall is built to separate the road from the building. *(Fig.3.4)*

3.1.2. Courtyard and Boundary

The space in the area is composed of roads and buildings. *(Fig.3.5)* Architecture includes traditional residential dwellings (historical buildings), old buildings, contemporary buildings (new buildings) that contains multiple periods. Among them, traditional houses and old buildings are mostly composed of building itself and back courtyard, and courtyard space is enclosed by courtyard walls. The remaining space forms roads and nodes, connecting the

various solid parts. Building themselves form the urban entity space, while the courtyards form the virtual space, but it is shaped and defined by the limitation of the courtyard wall. At the same time, the roads and nodes form the urban public virtual space. As an integral part of historical buildings, the private courtyard space conforms to the logic of the formation of urban form, continues the vertical texture of historical buildings, strengthens the radial texture[5] of cities and towns, and reflects the historical development characteristics of cities and towns.

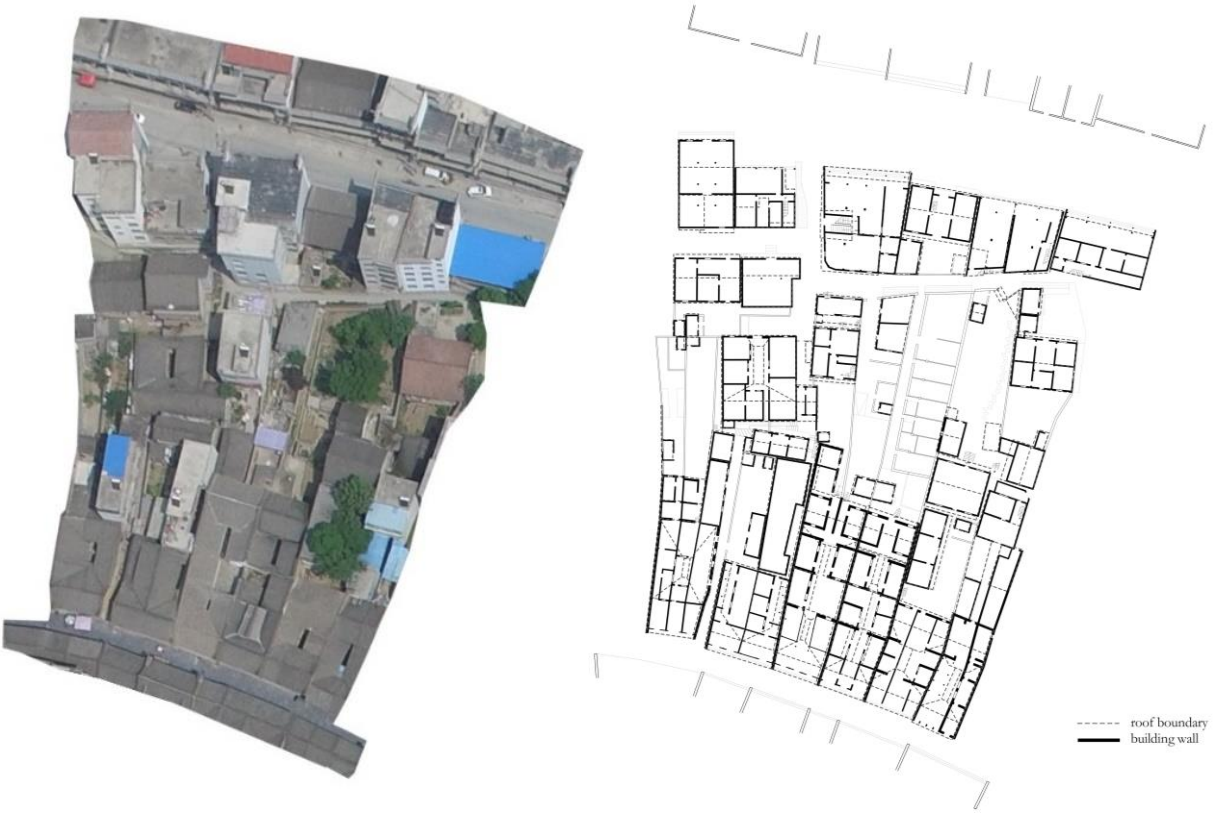


Fig.3.5 Aerophoto and boundary
(Elaboration by author)

5 It comes from prof. Laura Anna Pezzett.

3.1.3. Walls

The long narrow courtyard and the continuous fire sealing gable are two important elements to form the longitudinal radiation texture of the town, which also be of great significance in the development of the town form. In the process of urban protection and development, it has a strong historical and guiding value that should be paid attention to and protected.[6] *(Fig.3.6)*

Fig.3.6 Essential walls in the unit
(Elaboration by author; Source: the author, 2018)

Through field investigation and comparison with historical photos of the area, it can be seen that the wall shown in the red line has a long history and is an important part of texture. Among them, walls A, C and D were seriously damaged, and were rebuilt at the original location using

6 This point is guided by prof. Laura Anna Pezzeti.

modern materials - concrete blocks. Walls B and E are still the original rammed earth walls, which are severely weathered and partially damaged. But most of them are still preserved. Wall E, in particular, has formed a patchwork pattern with both historical and ornamental values.

3.1.4. Landscape

We can understand the current situation of the landscape in the area from the sight gallery of looking up, looking down and overlooking. There are two types of landscape in the perspective of looking up: the first is the landscape interface formed by skyline of roof, the sky and mountains. As the ancient town is surrounded by mountains and the floor height of traditional dwelling is relatively low, except for the rooftop skyline and the blue sky, the landscape of mountains will inevitably appear in the perspective of looking up. In this kind of landscape, the roof and the mountain often form a rhythm. In the horizontal direction, the double slope roof and the mountain form a continuous skyline, (as shown in the figure) while in the vertical direction, different heights of the roof and the mountain form a layered rhythm. (as shown in the figure) The second is the landscape interface formed by the roof skyline and the sky. Because the ancient town is surrounded by mountains, this kind of landscape interface mainly appears inside the courtyard. The narrow courtyard covers the mountains from the perspective of people's looking up, which encloses the square sky landscape. (as shown in the figure)

There are mainly three kinds of landscape in the perspective of looking forward: the first is street landscape, which is divided into Fenghuang street landscape and small street landscape. Fenghuang Street's landscape is mainly composed of *Matou Qiang*, the sky and mountains. The *Matou Qiang* is orderly distributed along the street, forming a light rhythm. (as shown in the figure) The small streets are relatively narrow and long, the landscape elements are mainly rammed earth walls and sky on both sides. (as shown in the figure) The second is the architectural landscape, which is mainly the landscape corridor formed by the patio yard (*Tianjing*). The typical case is the Dang Yard. Dang's courtyard is a longitudinal multi-parts (*Zongxiang duojinshi,* 纵向多进式) residential building, which is composed of five parts, including two patios. At the entrance, you can see the backyard through the patio, forming a special landscape corridor. The third is the backyard landscape. (as shown in the figure)

There are two kinds of landscape in the perspective of overlooking: the first is canal landscape. There are not many open channels in Fenghuang Ancient Town, which are mainly distributed in the northwest corner of the area. (as shown in the figure) The second is the roof landscape. There are new multi-storey buildings behind the traditional houses. Standing in the multi-storey buildings, you can overlook the low traditional houses' roofs, forming a unique landscape. *(Fig.3.7)*

Fig.3.7 Landscape
(Elaboration by author; Source: the author, 2018)

3.1.5. Greenery

Fig.3.8 Greenery
(Elaboration by author; Source: the author, 2018)

The green space in the area includes the public green of the street node space and the green of the courtyard interior. *(Fig.3.8)*

The number of node public greenery is just a bit, inside the area, only have one corner P on the east side of road A. There are flower beds to separate the front space from the road, and trees are used to form a miniature space under the trees, so that people could gather here for communication and conversation.

The main greenery in the area is concentrated in each courtyard space, mainly used for three purposes. The most commonly used is to plant vegetables, such as courtyard F behind the Dang's courtyard, courtyard C behind the old building, etc. As well as few courtyards are used as garden, such as courtyard D from the Meng's courtyard and courtyard B behind the old building along the new street, with potted plants or a small amount of flowers and plants placed by the residents. Unwarranted courtyard are idle or just used to build toilet and storage room. No matter what kind of functional courtyard, a certain number of trees are planted inside, some of which are connected to form a good landscape. It is worth mentioning that there is a row of trees planted in courtyard H, which are adjacent to courtyard F of the Dang's courtyard and correspond with the historical walls in a staggered way. From the front of the Dang's courtyard through the multi-layers of courtyards, you can see the bright green, forming a bright landscape. *(Fig.3.9)*

Fig.3.9 Dang Yard
(Source: the author, 2018)

3.2. Features of the Architectures in the Areas

Fig.3.10 Roof boundary
(Elaboration by author)

Fig. 3.11 Building material
(Elaboration by author)

Fig. 3.12 Building floor
(Elaboration by author)

Fig. 3.13 Building function
(Elaboration by author)

3.2.1. Roof Type

There are two kinds of building roofs in the area: sloping roof and flat roof. *(Fig.3.10)* While the sloping roofs could also be divided into two different kinds according to their characteristic: most of them are small tile sloping roofs of historical buildings, whose color is green gray and distributed on the north side of the old street; a few of them are the results of "flat sloping" treatment of modern buildings in the transformation process, including reddish brown, dark black or blue roofs, which are distributed on both sides of the new street ,Provincial Road 307. Flat roof buildings can be seen in modern buildings, mainly on both sides of the new street, and few of them are built in the courtyard of traditional dwellings, deep into the area of traditional buildings.

3.2.2. Building Material

The building materials used in the area include rammed earth, concrete block, brick and wood. *(Fig.3.11)* Investigation on the walls and courtyard walls of all buildings in the area are shown in the figure. The old buildings usually use rammed earth and wood as the enclosure structure, which are basically located in the north of the old street, i.e. the south part in the area, with a large number; there are a few concrete buildings and structures, which are distributed in the middle of the area, mostly used for the construction of courtyard walls, and few temporary warehouses or toilets. Brick buildings are mainly four-stories-up buildings built along the new street in recent 20 years,[7] located in the north of the area.

3.2.3. Floors

The historical buildings on the south side of the area are one or two floors, the buildings added to the central courtyard space are three or four floors, and the buildings along the new street on the north side of the area are basically four or more stories with high height. The whole plot, from south to north, has gradually increased the number of floors and height.

7 The building construction time comes from the local people.

(Fig.3.12)

3.2.4. Age and Numbering

Based on the real photos of 1958[3] that can be found at present as the reference standard, combined with the records of the implementation of land reform and other policies around 1980 and the results of the interview and inquiry, this paper makes a general classification and analysis of the age of the buildings. *(Fig.3.14)* The historical buildings and square houses along the street were built in Ming and Qing Dynasties, which were classified as historical buildings before 1958. The remaining buildings with a relatively long age were built between 1958 and 1980, which were old buildings. The brick and concrete buildings were built gradually in recent years, that is, after 1980, with the construction of new streets and large-scale urban construction policies, which were classified as new buildings.

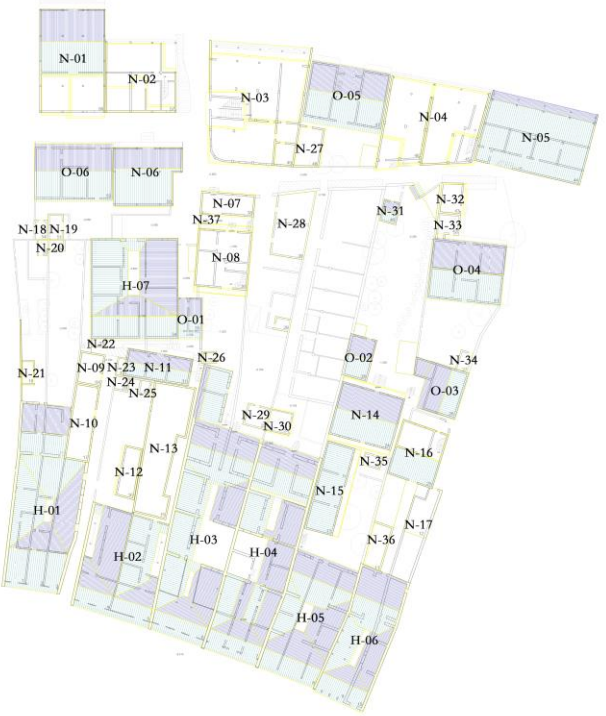


Fig.3.14 Numbering of buildings
(Elaboration by author)

Buildings in the area are numbered based on the building age for later use. The historical building is H-xx, begin from the lower left corner of the area, there are 7 in total; the old building number is O-xx, there are 6 in total; the new building number is N-xx, with a large number 36 in total.

3.2.5. Function

Through investigation, the current functions of each building and structure in the area are

recorded and are shown in the figure. *(Fig.3.13)* The historical buildings of the old street continue the characteristics of "front store and back house". At present, they are still engaged in commercial activities in the first house and the last few courtyards are used for living. The building functions in the middle of the area are more complex, and the complete buildings are mostly used for living, while the small temporary buildings and structures are used as kitchens, storage or toilets, which are randomly distributed in each courtyard. Most of the buildings on the north side of the area have more than four floors and are distributed along the street, so the bottom floor is used for commercial operation and the other floors are used for living. However, due to the loss of urban population, many rooms are vacant.

3.2.6. Façade

By taking photos of the building façade along the old street and using Photoshop to collage, the elevation of the historical building along the old street is as follows. *(Fig.3.15)* From it, we can summarize the characteristics of the traditional dwelling façade along the street in Fenghuang Ancient Town.

The most distinctive architectural style is the row door façade along the street. The formation of this façade is closely related to the nature of Fenghuang Ancient Town as a commercial market town. [8]The demand for shop space makes local residents use the first courtyard of the residential house as a shop, so it need a fully- opened door which you could see now.

One group of façade usually consists of three *Kaijian(开间)*, a few have four or five *Kaijian(开间)*,. Each group is separated and blocked by a Matou Qiang. Each *Kaijian* is divided by columns with column bases. Between the columns are movable row doors which can be removed and installed freely. When it is open during the day, the door panels are unloaded and piled on the wall of the Matou Qiang, and the first *Jinshen(进深)* of the dwelling are opened for sale. At night, the door panels are installed back in place. In case of special circumstances, only individual door panels can be disassembled to reserve the width of passing people, which can

8 Qi Jianqing, 'Yan Jinbiao. Cultural and Ecological Analysis of the Traditional Dwellings in the Mountainous Areas of Southern Shaanxi-Taking Fenghuang Town of Zhashui County as an Example'.Journal of Hengyang Normal University,2016,37(06):13-18.(祁剑青,颜金彪.陕南山地传统民居的文化生态学解析——以柞水县凤凰镇为例[J].衡阳师范学院学报,2016,37(06):13-18.)

be used as ordinary doors. In the old days, houses between every two fire walls belong to one family. For a three *Kaijian(开间)* house, rooms were often arranged in an axisymmetric way. Now, because of the housing policy and other factors, many three *Kaijian* houses are divided into three households. With the decline of Commerce, in order to make the space more suitable for living, many people built the façade of the *Kaijian* into a brick wall and opened windows on the row wall which makes it much different from original ones.

Fig.3.15 Building façade facing the old street
(Elaboration by author based on survey during PoliMi-XAUAT Workshop, May 2018)

3.3. Typology Study on Buildings in the area

3.3.1. Historical Building

The traditional dwellings in Fenghuang Ancient Town are mainly distributed on both sides of the ancient commercial street, which is the product of the combination of typical southern Shaanxi houses and Hui style houses. According to the different spatial layout of the courtyard, the traditional houses in Fenghuang Ancient Town can be divided into three types: single courtyard type (duyuanshi, 独院式), longitudinal multi-part type (zongxiang duojinshi, 纵向多进式) and horizontal multi-row type (hengxiang lianpaishi, 横向联排式).[9]

(1) Courtyard type

There are four types of traditional single courtyard houses in Fenghuang Ancient Town: '回' type, U type, L type and I type. Among them, '回' type single courtyard is the typical courtyard, but in the actual use and development process, '回' type gradually developed into "U" type (narrow courtyard), "L" type, "I" type (single row house courtyard), four kinds of courtyard form variants.

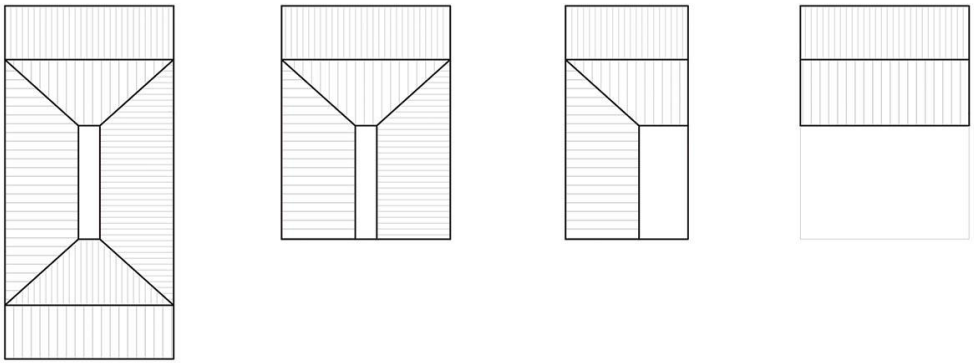


Fig.3.16 Courtyard types
(Elaboration by author)

9 Xu Yan. 'Analysis on the Architecture Characteristics of Guanzhong Traditional Residential', Master Diss, Xi'an University of Technology, 2010. (许岩，"关中传统民居建筑的型制研究"，硕士论文，西安理工大学，2010.)

The central axis of the ‘回’ single courtyard type is symmetrical, and the gatehouse, patio, main house and backyard are successively distributed on the central axis. *(Fig.3.16)* The two sides of the patio are *Xiafang(厦房)*, and the main house contains two wing rooms and one open room in the middle. In today's space use, the functional layout is different from that in the historical period.

Due to the historical and commercial characteristics of Fenghuang Ancient Town, almost all the gatehouses along the street are shops. During the commerical period, the shops are fully open to the outside world, which makes it a public space for residential dwellings. The shops are generally three *Kaijian* with a width of about 9 meters and a depth of about 5 meters. The ground floor is the core space of commercial operation, and the first floor is the storage space, which can be reached by ladder. But now most of the lofts are abandoned, some of them are used as the sundry rooms with low utilization rate, and some of them are completely abandoned after the ground floor is suspended. Because the atrium can be used for lighting and ventilation, it is generally used as the bedroom of the residents. However, due to the different living habits and needs of each family, some houses are also used for kitchen, storage, business and other purposes.

In the whole ‘回’ type traditional residential terrain changes, the gatehouse terrain is the lowest, the main house terrain is the highest with highest base, which highlights the main position of the main house in the space level. The main house is generally divided into three rooms, forming one bright and two dark space form. As a living room, *Mingjian(明间)* is a semi-private space, where the families gather for activities. However, nowadays most of the *Mingjian* in the ancient town are used as corridors, while the dark rooms on both sides are bedrooms or storage spaces, some of which are also used as kitchens and

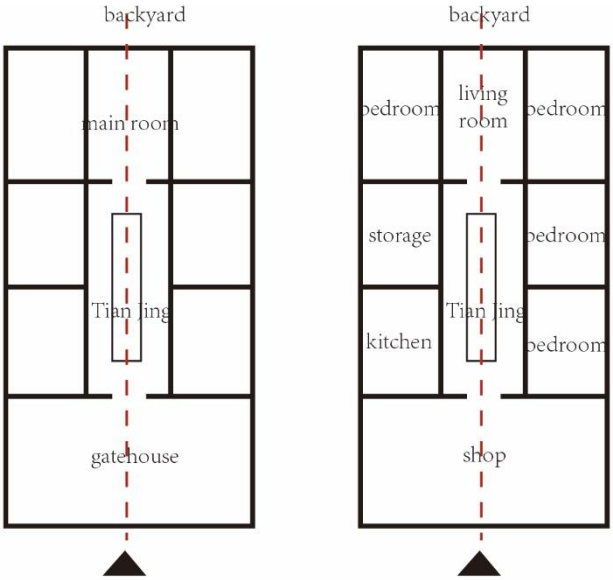


Fig.3.17 "Hui" single courtyard type
(Elaboration by author)

restaurants.

The "U" type single courtyard (narrow courtyard) is presented in two forms in the ancient town. The first type of plane form is in axial symmetry. *(Fig.3.18)* On the longitudinal axis, from the front to the back, there are gatehouses (shops) and courtyards, and on both sides of the axis are buildings with single slope roof. The second kind of plane form is non axial symmetry. On the longitudinal courtyard axis, from front to back, there are gatehouses (shops), courtyards and main houses. Only one side of the courtyard axis is *Xiafang*.

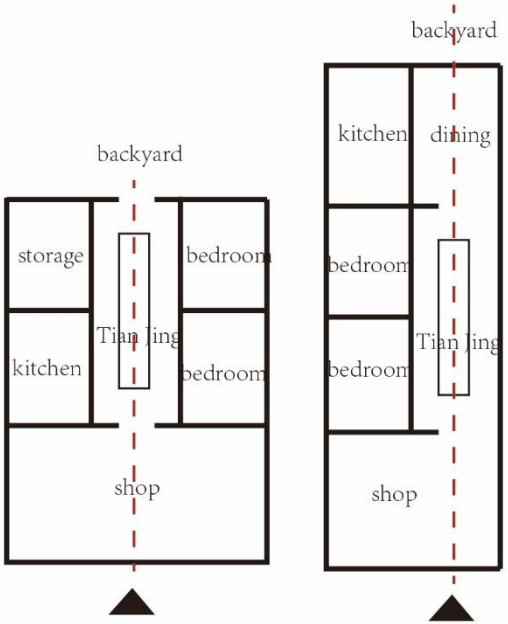


Fig.3.18 "U" type single courtyard
(Elaboration by author)

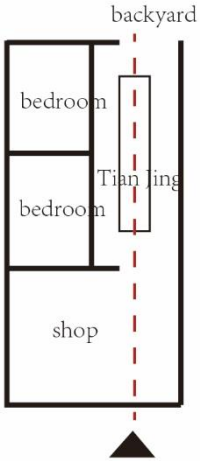


Fig.3.19 "L" type single courtyard
(Elaboration by author)

The central axis symmetrical "U" type single courtyard style has the same overall opening scale as the '回' type single courtyard style, except that there is no main room, only composed of the gatehouse and two rows of buildings *(Xiafang)*. The gatehouse is still used as the reception, bedroom, study, shop and storage, while the two rows of buildings *(Xiafang)* carry the residential and catering functions of residents, and the middle courtyard is the courtyard of daily life. The non axisymmetric "U" type single courtyard (narrow three courtyard house) is

generally two *Kaijian*, and the depth is determined by the wing room. Compared with the '回' type single courtyard, it lacks a row of buildings (*Xiafang*).

The plane form of "L" type single courtyard evolved on the basis of "U" type non axisymmetric single courtyard. *(Fig.3.19)* Its plane form feature is that on the longitudinal courtyard axis, from front to back, there are gatehouses (shops) and courtyards. Only one side of the courtyard axis is the mansion (wing room). The gatehouse is usually two rooms.

"I" type single courtyard (single row house courtyard) is the simplest single courtyard plane system, with only the gatehouse (shop) and the courtyard behind the gatehouse. *(Figure 3.20)* Most of the "one" shaped single courtyard traditional houses along the street in Fenghuang Ancient Town have evolved from other forms. The gatehouse space along the street has commercial value, and it is also an important part of the century old street. Therefore, it is well preserved by the residents, but the back street part is swallowed by the new buildings, so it becomes a "I" shaped single courtyard.

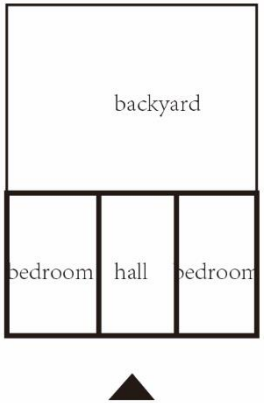


Fig.3.20 "I" type single courtyard
(Elaboration by author)

(2) Longitudinal multi-part type

The longitudinal multi-part type is a group of courtyard space formed by a courtyard or several courtyards connected in series in the longitudinal depth direction, with the single courtyard type as the basic unit and extending longitudinally. The plane feature is still a symmetrical layout with the courtyard as the axis. The Fenghuang Ancient Town has only four longitudinal multi-part type with complete plane form, which are Changshengxiang Hotel, Meng Yard, Dang Yard and Shanhuo store on the south side of Dang Yard.

(3) Horizontal multi-row type

In order to expand the building scale and make full use of the prime area along the street to form six or more storefronts, the two parallel courtyards are connected by public yards, thus forming this kind of parallel courtyard space.[10]

10 He Shuyuan. 'A Study on front Shop and back House of Courtyard Dwelling in Southern Shaanxi'. Master Diss., Shenyang Jianzhu University. 2012. (何书源. '陕南前店后宅式院落民居研究'. 硕士论文，沈阳建筑大学. 2012.)

At present, there is no horizontal layout in Fenghuang Ancient Town, but from the analysis of the plane shape and the interview with the villagers, it can be seen that the Meng Yard and Dang Yard should be horizontal layout in the early stage of construction. *(Fig.3.21)* First of all, according to the visit records of the villagers, the master of the Meng family and the Dang family is the same family, but the daughter is married in the later period, and the Dang family is sent out as a dowry, and then it is the living place for the two families. Secondly, in the plane form, the Meng Yard and Dang Yard are adjacent to each other. They are all five in-depth vertical *Jingshen* with the same total depth. The depth and opening of each courtyard are the same, and the way of opening windows and decoration are the same. The only difference is that the second courtyard is adjacent to the Meng Yard, while the Dang Yard has one more house. However, according to the survey, the building materials and construction methods belong to the later buildings, which are civil structures based on concrete. Therefore, it can be inferred that this house should not exist in the early years, and then it can be inferred that in the early years, the plane shape of the Meng Yard and the Dang Yard is the same, and the second entrance courtyard is the connection of the two vertical multi entrance courtyards. At the same time, from the north side, it can be found that the North facades of the two courtyards share the same wall, and the volcano sealing wall does not protrude from the wall.

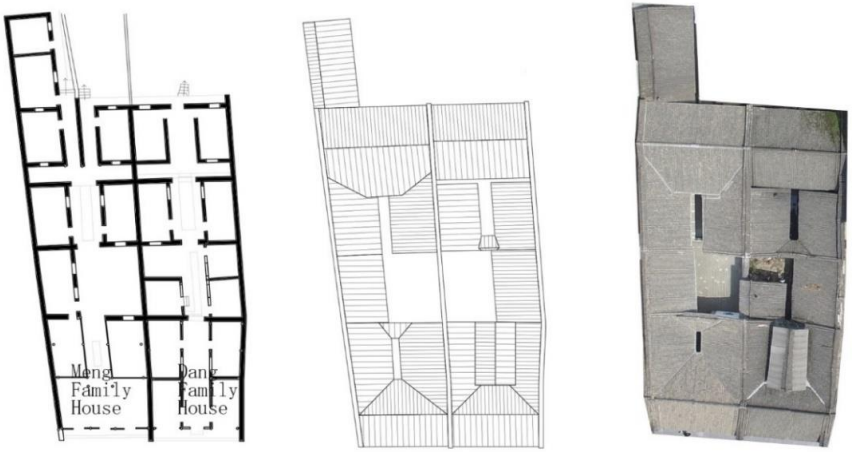


Fig.3.21 Horizontal row type
(Elaboration by author)

(4) Introduction to typical historical buildings

(a) The Ancient Bank

The ancient bank used to be called Fengyuan bank and zhangheting bank, built in Daoguang period of Qing Dynasty, which is a storehouse for the court. At first, it was built on a large scale, which was a courtyard building complex of rich people's residence. But later, due to the decline and division, only one courtyard courtyard existed.[11] *(Fig.3.22)*

The bank is located in the middle and back section of the old street, facing north. The shop has three rooms, about 11 meters in width, 6.5 meters in depth, and 12 meters in height. It adopts the inserted beam structure and brick wall masonry. There are two wing rooms on both sides, which are used as restaurants first. The patio space of this building is relatively open, about 12 meters long and 3.7 meters wide. There are wooden stairs behind the West Wing room, and the second floor space is used for storage. According to the field survey, the second floor space has traces of living, and the layout of the room is still reserved. There is a door opening at the back of the East Wing room leading to other courtyards, which is now idle. The hall is located on the third step. On both sides of the step, there are preserved boulders with rich and clear lines. At present, the caution room is from the hall to the backyard, and the secondary rooms on the left and right sides are used for living. A kitchen and toilet were added to the backyard. The whole building has many decorations and is well preserved.

The ancient bank is well preserved, but the later transformation is relatively large. The wall has been changed to brick wall masonry, and the facade has been replaced by modern doors and windows. There is a white ceiling treatment in the interior, and the structure is hidden in the ceiling. Wood and brick carvings are well preserved, and the building components around the patio are well preserved, especially the style.

11 Lu Peng. 'Research on the spatial form characteristics of streets and alleys and houses in Fenghuang ancient town'. Master Diss,. Chang'an University. 2018. （卢鹏. 凤凰古镇街巷及民居空间形态特征研究. 硕士论文，长安大学. 2018.）

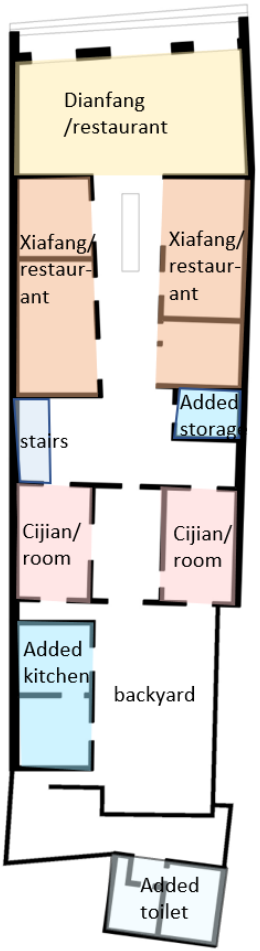


Fig. 3.22 Photos and plan of The Ancient Bank
(Source: the author,2018; Elaboration by author)

(b) Shengfa Inn

Shengfa inn is located in the middle of the old street, opposite the Meng Yard. It is built under the Yingpan Mountain. The courtyard, which was built in the Kangxi period,[12] was located in the south and facing the north. The whole building adopts the mode of front store and back house. The first entering house is a shop, and the side rooms on both sides are for living. *(Fig.3.23)*

Although the building only contains one courtyard, it has a large scale, high specification with exquisite and gorgeous decorative components.

There are three steps in front of the whole building, with higher height than usual. The main body of the building is of slotted beam structure. The shop has three kaijian, about 11.2m in width, and the depth is about 5.6m. After that, there are two wing rooms on the both sides. The patio space is narrow, long and compact. Now the owner adds a staircase to the second floor, which is used as a tea house. The floor height is relatively low, and the space under the beam is about 1.7m. Back to that, one could step up to enter the hall, which is equipped with two-story stairs where can be used to store goods. After the hall, it will arrive at the backyard. Now, the kitchen and toilet are added, and the ground is paved with cement.

Shengfa inn is well preserved with intact walls and facades. The indoor roof truss is slightly distorted and deformed, but the overall quality of the building is not affected, and the interior decoration is basically in good condition. However, the addition of stairs in the building destroys the integrity of the patio space. The second floor space has been greatly changed. It was originally a relatively closed storage space and now serves as a tea house. In the renovation of these years, the color of the building has been greatly changed. The original wood components are painted black, but now they are transformed into yellow brown.

12 This information comes from the owner of the 'Shengfa Inn'.

Fig. 3.23 Photos and plan of Shengfa Inn
(Elaboration by author; Source: the author,2018)

(c) Kang Yard

Kang Yard was built by Kang Yongsheng in the early 19th century, located in the middle of the old street. *(Fig.3.24)* At the beginning of establishment, he took advantage of the prosperity of its commercial culture to carry out silk business. He settled down here and carried out trade between the two sides of water and land, which made the business prosperous. Later, war, famine and other serious issues blow to the Kang family business which gradually decline. The mansion is also changing hands and running different businesses. Today's owners run him as a restaurant.[11]

Kang Yard faces south and has a large scale. The width of house is three *Kaijian*, in the longitude way it is divided into the lower Hall (shop room) ,the middle hall (Hall)and the upper hall. The *Dangxinjian（当心间）* of the shop is 4.6 meters wide, and the left and right rooms are slightly narrow, 3.4 meters and 3.3 meters respectively, with a depth of 5.5 meters. There are two wing rooms on both sides, with one door and one window. The hall is also three *Kaijian* wide, with a total of one floor and a high height. The wing room of the second entrance courtyard is long, 11.2m wide and 4m deep. The roof of the shop room and the hall are double sloped (two pi of water, i.e. full water), the wing rooms on both sides are with single sloped roof, the whole building is wood structure building, the wall adopts brick wall, and the fire sealing gable is set on both sides. Nowadays, the whole house is used for food and drink. The dining table is set in the hall, and the side room is closed for storage.

At present, the Kang Yard is well preserved, but some wing rooms on both sides of the East and West are idle. The façade is reinforced on both sides of the central column, and the short wall is built with blue bricks, which has a great impact on the façade style.

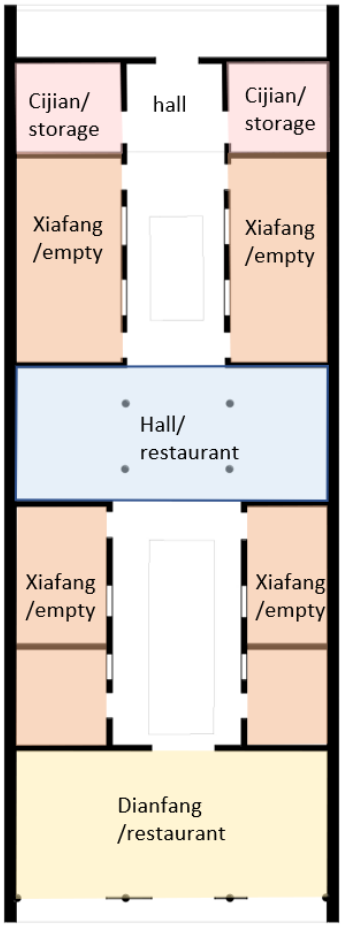


Fig. 3.24 Photos and plan of Kang Yard
(Elaboration by author; Source: the author,2018)

(d) Meng Yard

Meng Yard is also located in the north side of the middle section of the old street. It was built by Meng Tianyuan in 1820. It was originally used for living but began to operate shops in the 1840s, mainly engaged in silk and wine making businesses. Now it's renamed Meng Yard to do catering business.[13] *(Fig.3.25)*

Meng Yard is also relatively large in scale, with the whole courtyard facing south and three courtyards separated by doors. The first courtyard is composed of the shop room and the wing rooms on both sides. The shop room is three rooms wide, the middle room is about 2.5m, the width of the two rooms is the same, both of them are 3.5m, and the depth is 5.2m. The wing rooms on both sides face the patio and set up the partition. After passing through a door to the second courtyard, there were wing rooms on both sides. Later, due to the connection with the Dang Yard, the inner courtyard was demolished. Further inside is the third courtyard. The base of third courtyard is about 0.2m higher than the second one. The wing rooms on both sides of the East and the West are located on three steps. The upper hall is three kaijian wide and the middle room is 3.6m wide with a door leading to the backyard. The two side-rooms are 3.2m and 3.8m respectively, with a depth of 5.2m, which are used for living.

At present, the internal framework of the building is basically intact, new interior decoration is carried out, old doors and windows are replaced, the antique windows made today are used, and the interior walls are plastered.

13 The information about Meng Yard is come from the board in Meng Yard.

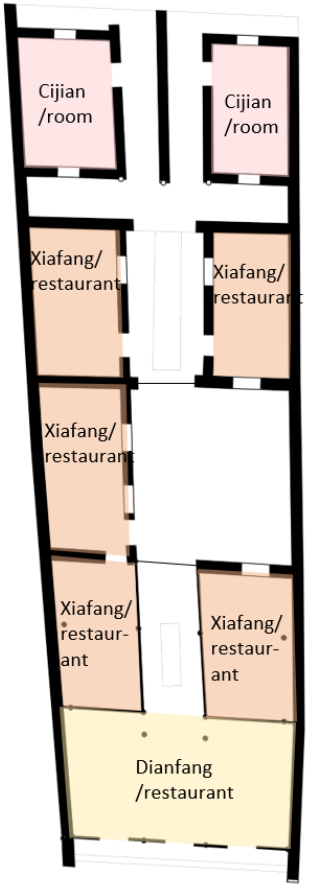


Fig. 3.25 Photos and plan of Meng Yard
(Elaboration by author; Source: the author,2018)

3.3.2. Old Buildings

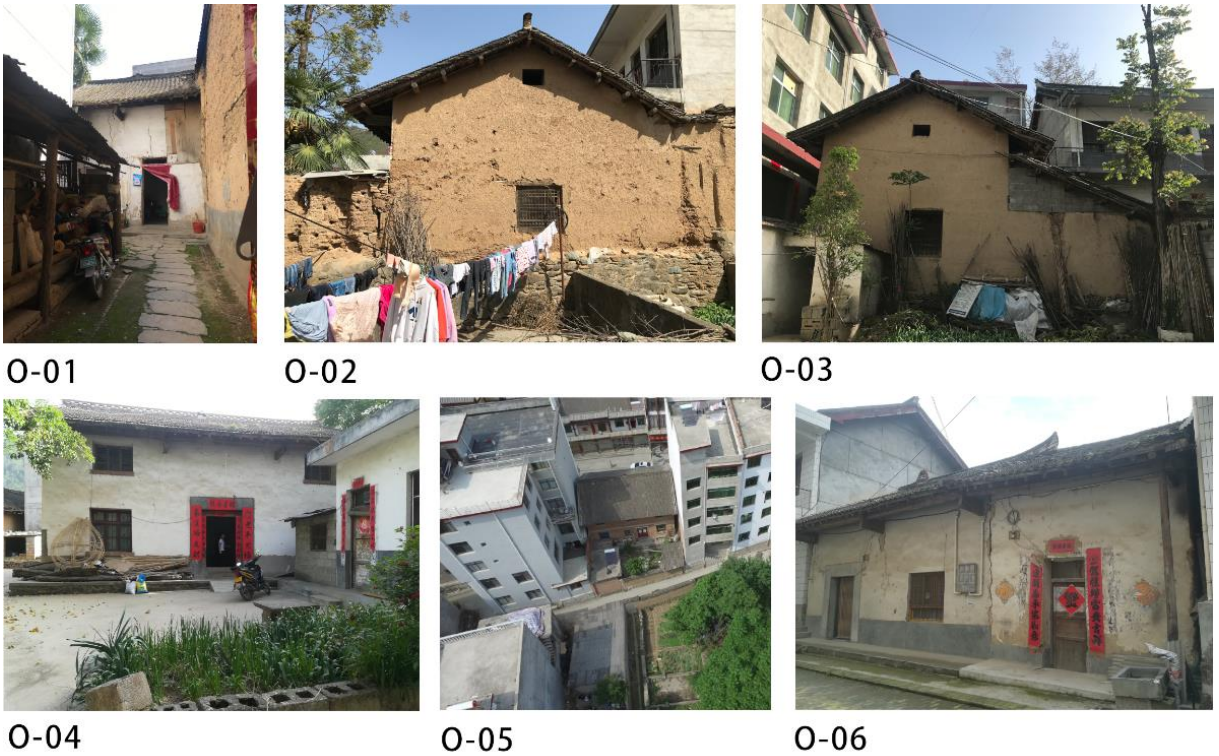


Fig. 3.26 Six old buildings in the unit
(Source: the author,2018)

The old buildings in the area were built between 1958 and 1980. *(Fig.3.26)* At present, it remains 6 buildings, all of which are rammed earth buildings. Three of the buildings O-04, O-04 and O-06 are still used for living. The remaining three buildings O-01, O-02 and O-03 are only used for kitchen and

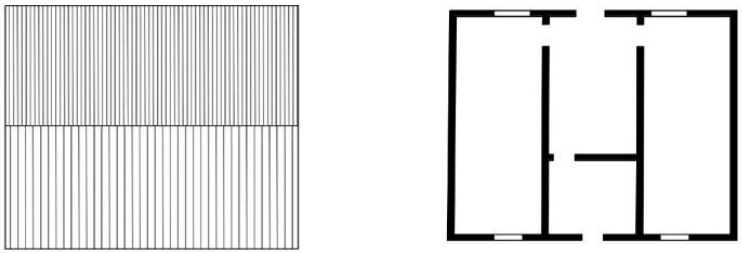


Fig. 3.27 Plan of the general old building
(Elaboration by author)

other auxiliary functions.

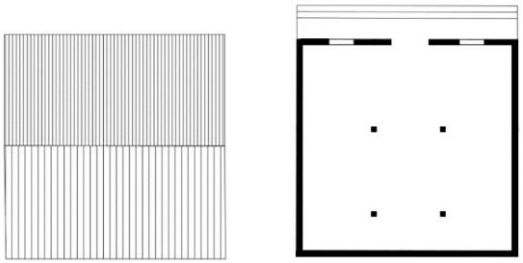
The architectural space layout of the old building is very simple, most of which are three kaijian single depth. *(Fig.3.27)* The gate and the back door leading to the courtyard are opened in the middle room. The houses on both sides are used to live while the middle one has the functions of living and dining room. Limited by rammed earth structure and technical level, the way of opening the window is relatively simple. From the photos, it can be seen that the window is located in the middle of the wall, and the size is generally less than 1.5m square.

3.3.3. Modern Buildings

There are a large number of new buildings in the area with complex forms. There are not only multi-storey modern houses, but also temporary toilets, storage rooms and other structures.

With the expansion of urban scale, the lack of existing buildings and people's pursuit of quality of life and other reasons, multi-storey modern buildings are rising rapidly in cities and towns. Most of these buildings are concentrated on both sides of the new street. They adopt frame structure and brick walls. The size of the room is determined by the size of the plot. Generally, the width of the three spans and the length occupy the whole plot without courtyard space. The architectural style and form are the same as the urban architecture, which is totally different from the traditional architectural style of the ancient town. Later, around 2010, after the government's unified planning and design for façade reconstruction, the street facade was antique treated, with tile eaves, decorative columns, covered with slope like roofs and horse head walls.[14]

For the demand of living space, there are many sporadic single room buildings built in the courtyard space. *(Fig.3.28)* These buildings are extremely simple. They are built with concrete block bricks or red brick bricks, or covered with colored steel tiles, asbestos tiles and other



(Elaboration by author)

14 Information obtained from local residents during PoliMi-XAUAT Workshop survey in May 2018.

materials. Most of them are used as kitchens, bathrooms, storage rooms and so on. The sanitary conditions are poor, and the safety performance is difficult to guarantee. The construction of these buildings is built by the residents themselves. Their location, shape and size are determined by the convenience of users, and there is no unified planning and design. *(Fig.3.29)*

Fig.3.29 New buildings in the area
(Source: the author)

04

Area Design and Courtyard Design

4.1 Overall View on area design

4.1.1 Paths redirection
4.1.2 Evaluation of buildings
4.1.3 Active nearby courtyard

4.2 Design of main courtyard

4.2.1 Enhance the historical wall as the focal point
4.2.2 Overwriting the backyard based on original usage
4.2.3 insert leisure facilities

4.3 Integrate rehabilitated and new-built houses

4. Area Design and Courtyard Design

Fig. 4.1 Masterplan of the area design
(Elaboration by author)

4.1. Overall View on area design

Based on the detailed investigation of the area and the area design strategy proposed in the previous article, it focuses on the use of courtyard space in the center to activate the vitality of the area and promote the use of surrounding buildings.

In the area, first of all, open up the horizontal and vertical paths to make all parts of the area accessible smoothly. Secondly, evaluate the building, put forward the overall response strategy, demolish the inappropriate building, improve the building style, optimize the building function. Finally, take the central courtyard as the core of the activity, connect the surrounding green patches, form a horizontal green belt, and connect the activity sites, strengthen the connection of all parts, and promote the overall vitality. *(Fig.4.1)*

4.1.1. Paths redirection

In the current situation of the area, the vertical connection only relies on the secondary road D passing through the historic building of the square house. Due to the need to pass through the living buildings in the second half of the road, it is difficult for the urban outsiders to find out, and often stops in front of the square houses, which seriously hinders the North-South accessibility of the area.

In the process of dredging regional roads, the first consideration is to open the North-South channel. For this section of road, the first half of the road connecting Old Street has strong guidance, and the main problem lies in the blocking of the second half. In the design process, the abandoned courtyard on the west side of the road is opened, making the courtyard space as a public space, using its public openness to guide the passage of people, and closing the back side of the square house to avoid confusing guidance information.

Another problem in the area is that the horizontal connection is weak, and the vertical urban texture restricts the development of the horizontal road. There is secondary road A on the north side of the area, but the open space of the adjacent courtyard in the middle is independent of each other, the landscape is not penetrated, and the personnel are lack of interaction. In order to connect the green space to form a green strip, enhance the landscape

connection and stimulate the vitality of each part, no obvious road planning is selected in the design, but the minimum intervention method is expected to break through the barrier between each other. The specific operation method is not to damage the original historical buildings and intact buildings, only to partially disconnect the existing walls between the courtyards, remove the temporary structures that hinder, so that there are paths or doors between each part. Since then, it can greatly reduce the damage to the longitudinal texture of the town.

4.1.2. Evaluation of buildings

According to the actual situation, record the information of each building. Based on the analysis of all aspects of the building in the previous chapter, evaluate the buildings in the area. Taking the characteristics of urban form, urban planning, regional planning strategy and architectural characteristics as the consideration factors, the buildings that are transformed and demolished are distinguished.

The buildings that hinder the urban texture, poor building quality and have no historical value shall be demolished, and the required functions shall be put together and designed in the single building. This kind of building to be demolished is a small temporary new structure distributed in the courtyard, with small volume, usually used as a storage room, toilet or kitchen. The functional layout can be combined with the integrated equipment to be arranged in the building unit to which it belongs, such as O-05 and O-06.

For the large-scale buildings that destroy the traditional style and features of the town, the exterior transformation is carried out to integrate them into the historical style and features, such as the buildings N-10 and N-13 built in the courtyard space of the historical buildings. These buildings seriously damage the style and texture of the historical villages and towns, but because of their good quality, it is difficult to dismantle them, the exterior transformation design is carried out. The operation methods include volume reduction and roof grading.

There is also a kind of building in the process of transformation, which can be transformed and updated according to the functional strategy of the photo area to improve its use value and reduce the vacancy rate. For example, for buildings N-15 and N-14, they can be transformed into auxiliary rooms and accommodation rooms according to the functional

requirements of the accommodation. *(Fig.4.2)*

Fig. 4.2 Evaluation of buildings
(Elaboration by author)

4.1.3. Active nearby courtyard

As an important part of historical buildings, courtyard is the main place for people to carry out leisure, labor, viewing, breeding and other activities, and an indispensable part of rural life.[1] *(Fig.4.3)* Using each courtyard as the activity place can stimulate the occurrence of various activities and drive the vitality of the area.

1 Liu Ying. 'Re-recognition of the courtyard space of the traditional Chinese courtyard house in Guanzhong' . Xi'an University of Architecture and Technology, Folk House Professional Committee of the Chinese National Institute of Architectural Research. Professional Committee of Civil Architecture of Chinese National Architecture Research Society: Chinese National Architecture Research Society, 2007: 218-221.(刘瑛. 关中传统合院民居院落空间的再认识[C]. 西安建筑科技大学、中国民族建筑研究会民居建筑专业委员会.第十五届中国民居学术会议论文集.西安建筑科技大学、中国民族建筑研究会民居建筑专业委员会:中国民族建筑研究会,2007:218-221.)

The existing courtyards are independent of each other and exist as private sites, which can only be used by residents themselves. At present, most of the old people living in the historic buildings of the ancient town are not very convenient to move. A few people divide small plots of land in their courtyard for vegetable planting and careful management. But most of the courtyards are lack of management, there are many sundries in the site, and the waste and idle situation is serious.

In order to make full use of the courtyard space which accounts for a large proportion of the area, the current function of each courtyard is extended and expanded. The cultivation area, leisure area, viewing area, etc. are set up to open each courtyard into a semi-public space, so as to facilitate the foreign tourists to experience agricultural activities. For example, courtyard A now has a pair of elderly husband and wife taking care of vegetables and grapes. The enclosure on the north side of courtyard A is open, allowing outsiders to pick and plant. While activating the area, it can also bring certain benefits to the elderly. Area B is now a deserted site. After opening up, people passing through can enjoy flowers and get close to nature here.

Fig.4.3 Greenery yard in the unit
(Elaboration by author)

At the same time of opening the courtyard, strengthen the connection between the courtyards, so that people can shuttle between different functional areas, and make the whole area become active with the help of the flow of people.

4.2. Design of main courtyard

The Dang Yard and Meng Yard in the area once belonged to the same household in history. Later, affected by economy, policy and other aspects, they were divided into two households for operation, but their symmetrical buildings and courtyards still remain to this day.[2] In the design process, the two parts of the courtyard are treated as a whole. Because of its important position and characteristics in the area, the central courtyard is the core and focus of the design. In the courtyard, with the historical wall as the key landscape, combined with the historical functions of the two parts of the site and the conceptual planning of the homestay, a leisure and rich experience of rural life of the historical village homestay is created.

4.2.1. Enhance the historical wall as the focal point[3]

From the photos of 1958, it can be seen that the rammed earth wall on the east side of the fire wall of the Dang Yard and the wall between the Dang Yard and the Meng Yard have existed for a long time, and these two walls are also an important part of the radial texture of the town.[4]

At present, the rammed earth wall of the east courtyard wall of Dang Yard still exists, the south section of the wall is well preserved, and the upper part of the north wall is seriously weathered and damaged. At the tail part, the rammed earth part has completely collapsed, only the rubble wall base is reserved. Thus, the wall forms the landscape effect of step drop. At present, the historical wall between Meng Yard and Dang Yard no longer exists. Later generations rebuilt the wall with concrete block bricks on the original site, leaving historical rubble foundation at the bottom.

Due to the special historic and time-polished landscape of rammed earth wall in the courtyard of Dang Yard, the wall is taken as the main landscape object in the courtyard design, the existing main form and structure are retained, and the newly built wall in the east side of

2 Lu Peng. 'Research on the spatial form characteristics of streets and alleys and houses in Fenghuang ancient town'. Master Diss,. Chang'an University. 2018. （卢鹏. 凤凰古镇街巷及民居空间形态特征研究. 硕士论文，长安大学. 2018.）

3 This view was particularly emphasized by the prof. Laura Anna Pezzetti in the process of guiding the design.

4 See the photo of Fenghuang Ancient Town in 1958.

the courtyard is used to echo the scattered wall.

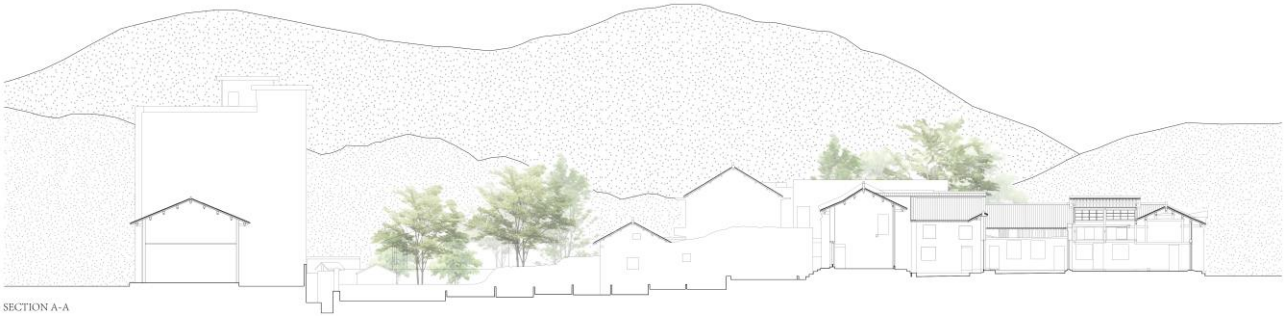


Fig.4.4 Section I of the situation
(Elaboration by author)

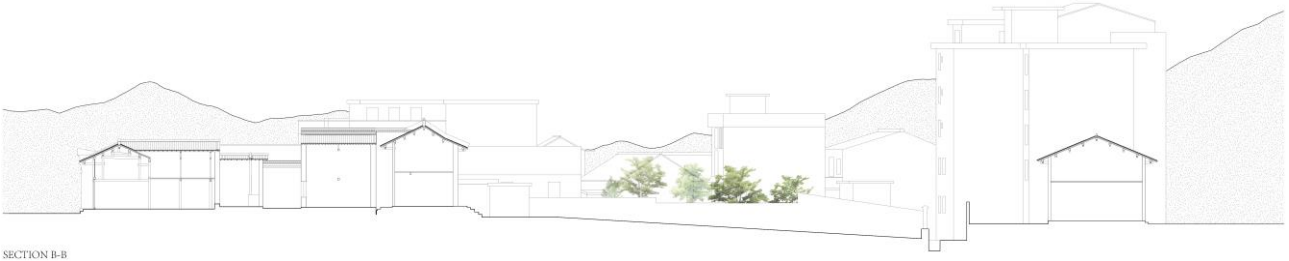


Fig.4.5 Section II of the situation
(Elaboration by author)

In the north section of the wall, *(Fig.4.4, Fig4.6)* the width of 1.5m is opened as a footpath to connect with the courtyard on the east side of the wall. At this time, the height of the original rammed wall is about 1.35M, which has the sense of enclosure, but the sight line is accessible, and there is no sense of closure. In order to maintain the continuity of the original wall, large pebbles are used to lay open wall sections to distinguish them from the footpath. An opening is set up in the middle part of the wall. The height of the wall is about 1.7m. Therefore, a door opening is built here by using the rubble structure to separate the courtyards with different functions on both sides. The rammed earth wall in the south section is relatively high, and a narrow door width hole is dug out on the original wall to connect the landscape courtyard and the living place.

Fig.4.6 Section I of the design
(Elaboration by author)

As for the wall between Meng Yard and Dang Yard*(Fig.4.5, Fig.4.7)*, since it has been rebuilt, the design focuses on how to maintain its historical characteristics under the condition of connecting the two sides of the courtyard, without destroying the important value of the wall in the urban texture shaping. First of all, in order to be able to open the courtyard on both sides, the wall needs to be cut and opened, and the south section, middle section and north section of the wall are respectively opened. Corresponding to the rammed earth wall on the east side, a pedestrian walkway is set aside in the north section of the wall, with a width of 2m, and the height of the wall here is about 1.7m. The middle part of the wall is disconnected so that people can freely pass through it. The south end of the wall is adjacent to the local building. In order to leave enough open space between the end of the building and the courtyard, a platform with a width of 5m is designed, so the wall is disconnected greatly. Secondly, in order to continue the traces of the historical wall, the location and width of the historical wall are displayed on the ground by using the material distinction, so as to divide the space and separate the plane. Finally, in order to avoid the sense of closure brought by the thick and tall wall, holes are made on both sides of the wall, so that the landscape on both sides can penetrate each other, and at the same time, the wall is landscaped, enhancing the interaction.

Fig.4.7 Section II of the design
(Elaboration by author)

4.2.2. Overwriting[5] the backyard based on original usage

In the investigation, we learned that vegetables and domestic animals had been planted in the courtyard of Dang and Meng Yard. Now in the courtyard of Dang Yard, two houses are built with concrete blocks in the north section for storage, but it seems to be idle at present; a toilet is temporarily built in the middle section, and a kitchen is also built with concrete blocks in the south section, because the kitchen and toilet are newly built in the west side of Dang Yard (the back courtyard of Dang Yard is divided into two sides by the wall, but belongs to the same one) , where has been deprecated. In the inner part of Meng Yard, only one piece of ground is left for vegetable planting, and other places are in a state of waste.

Based on the historical attribute of vegetable planting and the design concept of rural experiential homestay, vegetable planting sites are set up in the process of courtyard space transformation, so that people who come here to play can experience the fun of planting and picking. In the courtyard space on the west side, two planting areas are designed according to the terrain conditions, which are respectively located in the north and the middle of the courtyard. In the north, the terrain is low and gentle. The planting area covers the original storage area and is divided along the original wall to form three small sites. The terrain of the central part is gradually rising from north to south, so it is designed as a ladder like terrace, which is divided into small sites and solves the problem of elevation difference. In the site on the west side, the design of the route is to reconstruct the location of the original route, add

5 The concept of 'overwriting' comes from prof, Laura Anna Pezzetti and the backyard's overwriting design is guided by her.

stairs to the east side of the original steep slope to solve the height difference and slow down the steep slope to meet the current use requirements. *(Fig.4.8)*

Fig.4.8 The demolish and design of the aera
(Elaboration by author)

4.2.3. insert leisure facilities

In the east courtyard, in order to meet the leisure of the homestay, the design of leisure swimming pool is inserted. Combined with the existing site structure and site height difference, the leisure pool is arranged in the original structure frame, and the original road position is still used as the path. The leisure pool occupies the majority of the east side of the site, extending from the middle to both sides, about 17 meters long, and dividing the deep water area and the shallow water area internally. In order to make the leisure swimming pool and the road in the hospital not disturb each other, the green space is used as the separation between the two, and the original low column is used to divide the space. In the north of the pool, there is a 6m wide rest platform, which separates the pool from the road to form a complete pool leisure area. The footpath is designed along the east side of the historical ramming wall to avoid the impact of water on the historical wall. At the same time, it connects the leisure pool and the east residential area, so that people can directly reach the pool through the middle door. *(Fig.4.9)*

Fig.4.9 Design of the area
(Elaboration by author)

4.3. Integrate rehabilitated and new-built houses

The historical wall extended from the Dang Yard has not only extremely high historical value but also certain aesthetic value. In order to strengthen this historical wall, and at the same time active the backyard and meet the commercial needs, insert two new volumes. Compared to the homestay placed in the limited space of the Dang Yard, these two new volumes and the existing buildings next together to form a homestay with higher quality and more facilities. In this way, tourists can choose according to their own economic conditions or experience needs.

The placement of the new volume should also follow the radial structure and be arranged along the longitudinal direction of the historical wall. On this basis, in order to create a small courtyard environment, the two new blocks are laterally staggered. *(Fig.4.10)* The shape of the Historical wall and the double-sloping roof of the adjacent building, as well as the shape of the mountains in the distance, form a continuous twisty border, thus forming a beautiful skyline. The new mass should also continue and strengthen this aesthetic feature, so the form of a sloping roof echoes it.

The continuity[6] is not only the continuation of the radial structure[7] and the skyline, but also the continuation of the entire facade. There were two small square windows on the original historical wall. The square window is the main type of window in the ancient town, it can be said to be a prototype. Therefore, square windows are also mainly adopted in the form of window opening of the new block, which is adjusted according to the indoor function and the angle of view of the new building facade by the people in the courtyard. Thus, the building facade and the overall facade of the historical wall are continuous and unified. At the same time, the low part of the historical wall is used to position the windows on the facade of the new building closest to the historical wall above the low wall, thereby strengthening the relationship between the new block and the old wall and emphasizing the integrity.

Combined with the historical wall, the opening of the entire vertical facade looks like a star in the sky, echoing the stars in the sky at night, which is another expression of the rural

6 The concept of 'continuity' comes from Emesto N. Rogers, which author got from the lecture of prof. Fulvio Irace in Polimi.

7 The idea of 'radial structure' comes from prof. Laura Anna Pezzetti's book which is 'Layered Morphologies and Latent Structures—Reading, Decoding and Rewriting Enhance Historic Rurban Landscape' in 2019.

landscape. *(Fig.4.11)* In one of the new buildings, a skylight is combined with loft, which not only improves the indoor light environment, but also provides a new view for people living here, especially in the night room to appreciate the stars in the countryside, which is a difference interesting experience from the city.

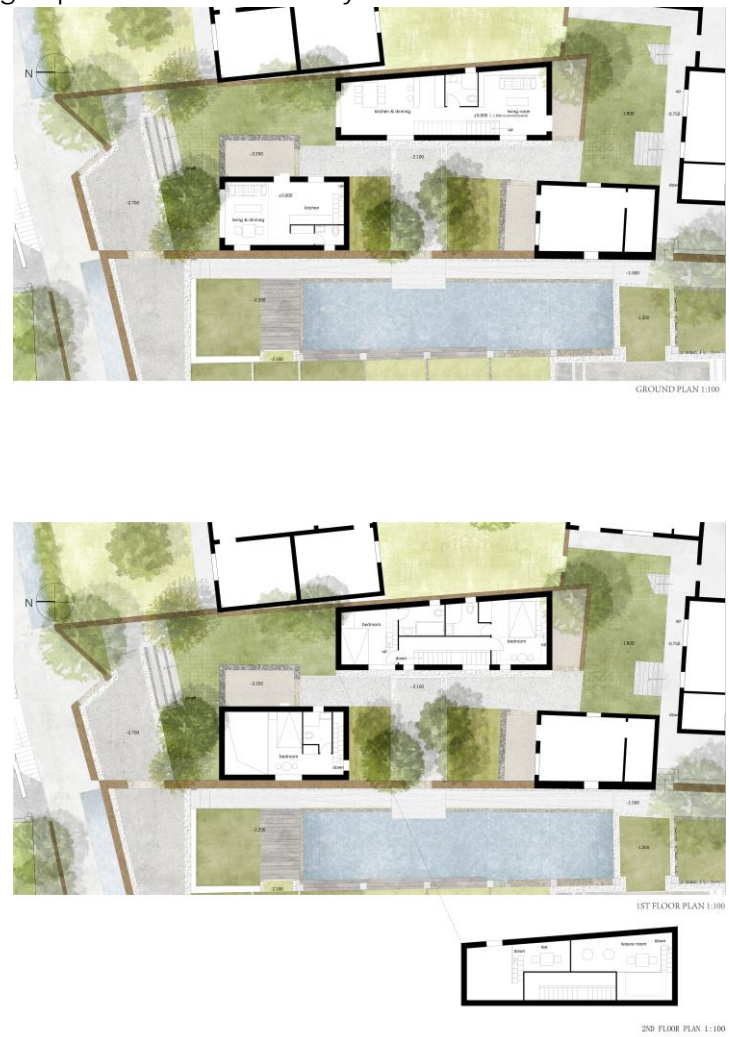


Fig.4.10 New building design
(Elaboration by author)

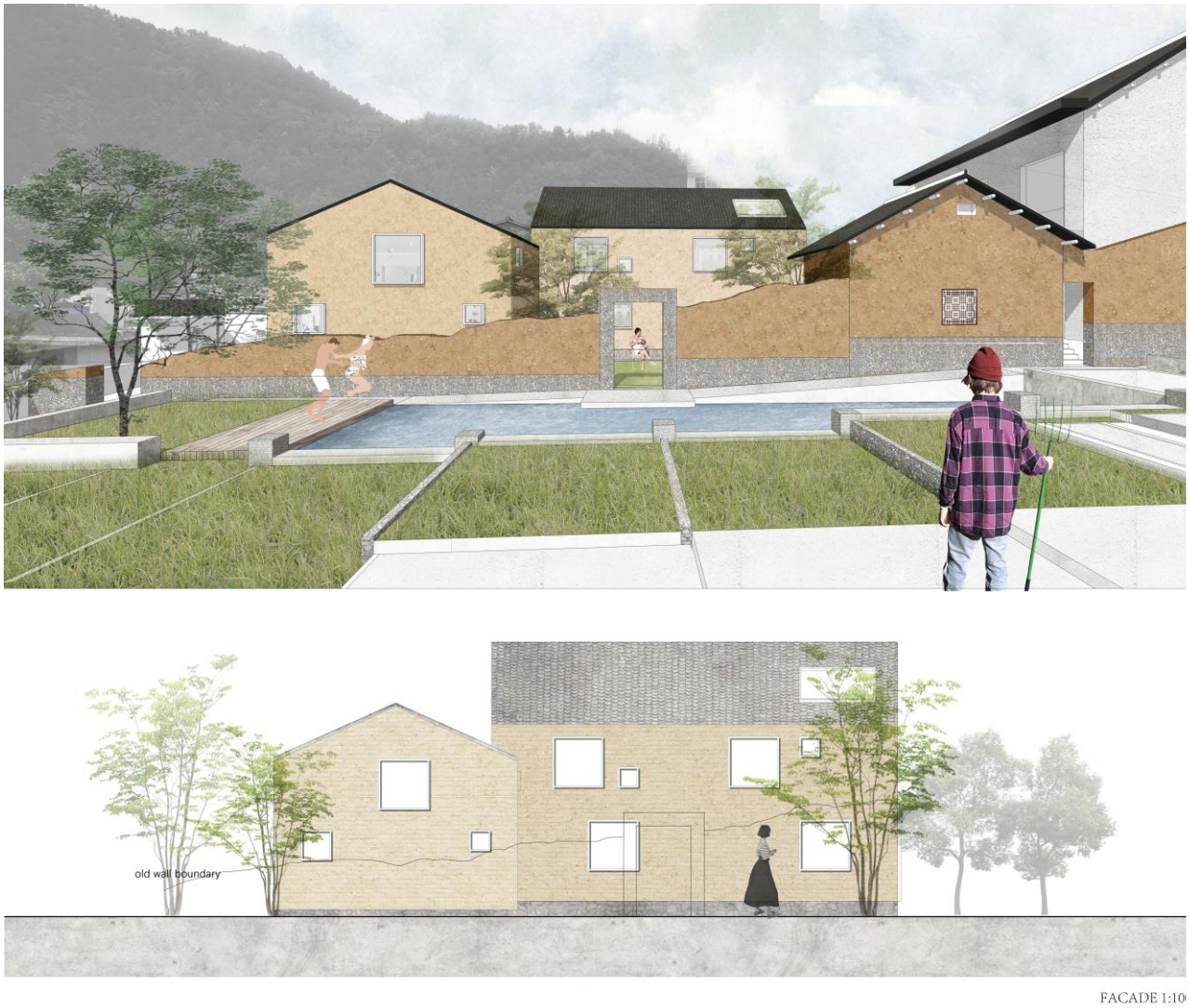


Fig.4.11 Views of the new building
(Elaboration by author)

05

Conservation and Reuse of Dang Yard

5.1 Conservation and Restoration of Dang Yard

5.1.1 The Situation of the Dang Yard
5.1.2 Conservation of the Dang Yard

5.2 Continuity of Use under Conservation

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5.2.2 Continuity the Form of ‘Front Store, Back House’
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5. Conservation and Reuse of Dang Yard

5.1. Conservation and Restoration of Dang Yard

5.1.1. The Situation of the Dang Yard

Dang Yard is located in the middle section of Old Street in the Town, which is the morphological unit composed by the Old Street houses and their radial backyards. [1]It was originally the same household as its west Meng Yard and was built in 1820. *(Fig.5.1)* Its brand name was "Changfaqixiang" silk store. During the Ming and Qing Dynasties, it focus on the main satin and winemaking industry. It had opened semicolons in Dongda Road of Xi'an City, Hancheng County of Weinan City, Hankou City of Hubei Province, Gucheng County, Zhen'an County, etc. The D Dang Yard has three courtyards with a depth of 100 meters. Later, due to various reasons, the building was transformed and used, and the shape changed slightly.[2]

Fig. 5.1 Dang Yard
(Source: the author, 2018)

After the founding of the People's Republic of China, due to the influence of policies such as land policy and urban reform, the Dang Yard has become a multi-family living situation. At present, there are four families in the Dang Yard, living in the first, second, and third courtyards, respectively. Among them, the street-front part of the first courtyard is a shop. There are a barber shop and a flower shop on the east and west sides. The middle room is used as a corridor to connect with the patio courtyard to form a traffic space that connects the living spaces on the left and

1 Laura Anna Pezzetti. Layered Morphologies and Latent Structures: Reading, Decoding and Rewriting to Enhance Historic Rurban Landscape. Tongji University Press, 2019.

2 This information comes from the board in Meng Yard.

right. In the second courtyard, the side rooms are used as kitchen on one side and for living on another side. The location of the west side *Xiafang* was changed to a courtyard. Later, due to the increase in space requirements, the kitchen was built with a cover. On the two sides of the third courtyard, the two sides of the house and the main room are inhabited by two families, mainly using the room on the west side. People's daily activities are in the middle of this traffic space, and debris that can't be placed in the room is also accumulated in this space. The north side of the courtyard is a narrow and long backyard space, surrounded by walls on three sides, and the east side wall is a long-lasting rammed earth wall with historical value. In the backyard, there was still a wall surrounding pigs and poultry, but now it is abandoned.

At present, the protection requirements for the Dang Yard are that the facade along the street should be properly repaired and restored, and no modification is allowed; It is difficult to meet the requirements of modern life and the poor quality parts should be designed and constructed by professionals. It is not allowed to transform without permission, and the transformation process should be coordinated with the original style. *(Fig.5.2)*

a.1st courtyard
b.2nd courtyard
c.Wings in 3rd courtyard
d.Middle room in 3rd courtyard
e. Backyard

Fig. 5.2 Situation images of Dang Yard
(Source: the author, 2018)

(1) The Plan

The original form of the Dang Yard has three courtyards. Due to the renovation and use, left wing of the second part was demolished and connected to the Meng Yard. Later, it became two independent households. Due to the demand for use, half a kitchen was built, forming the current pattern.

The first courtyard has a large depth of about 10.45 meters. It is divided into a frontage shop and two back rooms. The depth of the dwelling house is relatively narrow, about 5.1 meters. At present, only the left room is used for living, and the right room is vacant. The rooms of the first courtyard store, and the third courtyard are relatively high, and are separated by wooden partitions to form an attic, which is mainly used for storage. The second courtyard house is relatively low in height, with only one floor. The walls are made of thicker earth walls with a thickness of about 40 cm. There is a wooden door between each courtyard. *(Fig.5.3)*

(2) The Sections

It can be seen from the longitude section that the door used in the first courtyard room was replaced with a red modern wooden door; the first floor space is partially enclosed, and the traditional wooden lattice windows and wooden skirting boards are still retained. The patio was transformed into a lantern roof to cover the rain. However, the preservation of wood components and walls is poor. The lower part of the walls of the second and third courtyards was damaged by groundwater vapor and rain, and the preservation quality was poor. Doors and windows and wooden components were replaced. Fortunately, the roof and patio are well preserved; the room in the middle of the third courtyard is also used as a corridor and piled with debris, and the rooms on both sides are used for living.

The wings of the Dang Yard are single slopes, and is the civil structure. Except for the wings, a wooden structure is adopted, and the front and rear eaves are raised. There are different types of doors between each entering courtyard to form a sense of enclosure. *(Fig.5.4-5.9)*

(3) The Façade

The facade along the street of the Dang Yard basically maintains the traditional style. But due to the disrepair and actual life needs, residents changed the original wooden wall in the middle to a concrete wall with modern wooden doors.

(4) The Problems

The wooden structure of the Dang Yard is well preserved. There are no obvious cracks in the wood components, but the paint on the surface of the components has obviously fallen off. The structure of the first courtyard in the patio changed into a lantern roof and the connected parts were chaotic. The surface of the earth wall of the envelope structure is seriously detached, and the adobe bricks are exposed. The gap between the bricks is large and the stability is poor. The wall of the third courtyard was severely cracked, and the walls on the left and right of the windows were seriously damaged. The roof is well preserved, but the tiles are partially damaged. The eaves section is severely damaged, and there is rain leakage in the room. The corridor is converted into a concrete floor, which is quite different from the traditional residential style. *(Fig.5.10)*

The physical environment inside the dwellings is poor, and it is difficult to meet the daily needs of today's residents. The Fenghuang ancient town is severely cold in winter, and the rooms in traditional houses are cold and lack heating facilities. Residents use braziers for heating in corridors. The interior of the room is dim and poorly ventilated, and artificial lighting is needed during the day.

The dwellings of the Dang Yard lack the necessary living space, lack of toilets, kitchens and activity space, and can only be carried out in the corridor. The first floor space is idle and lacks vertical traffic connection.

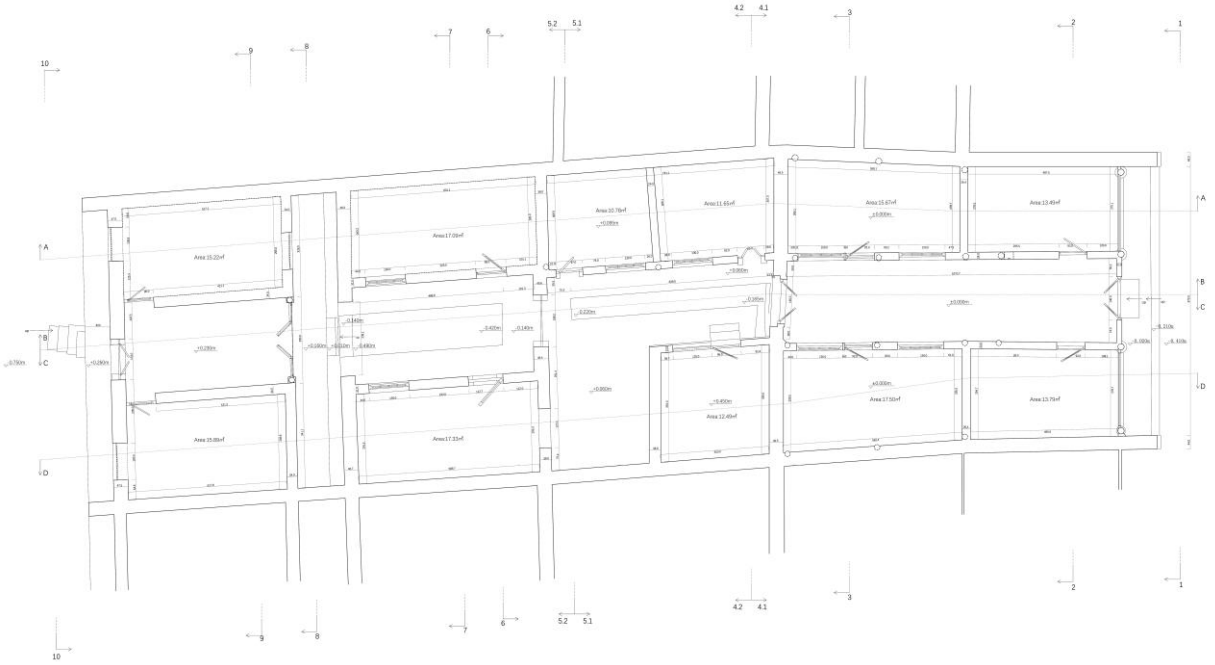


Fig. 5.3 Situation ground floor plan in May 2018
(Elaboration by author)

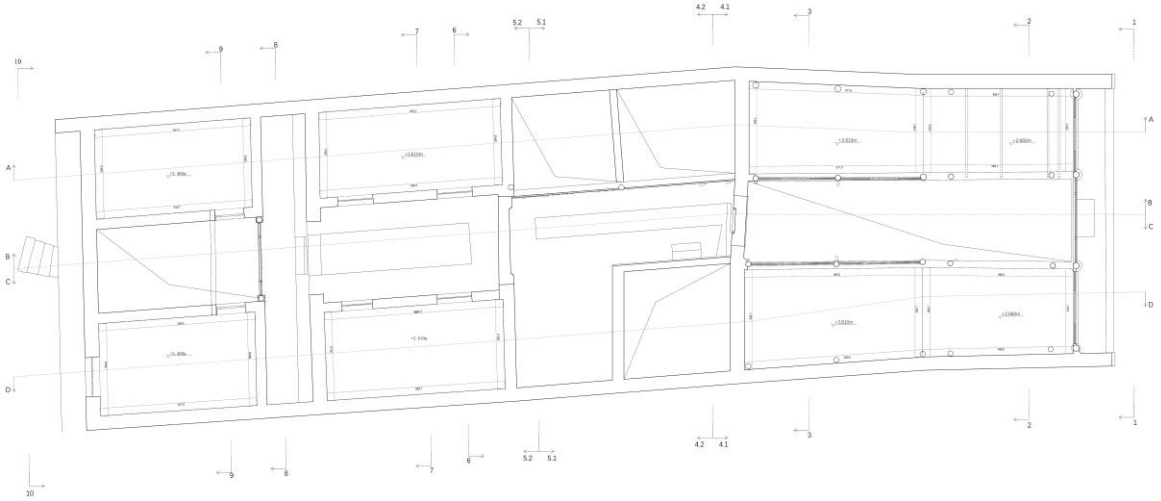


Fig. 5.4 Situation first floor plan in May 2018
(Elaboration by author)

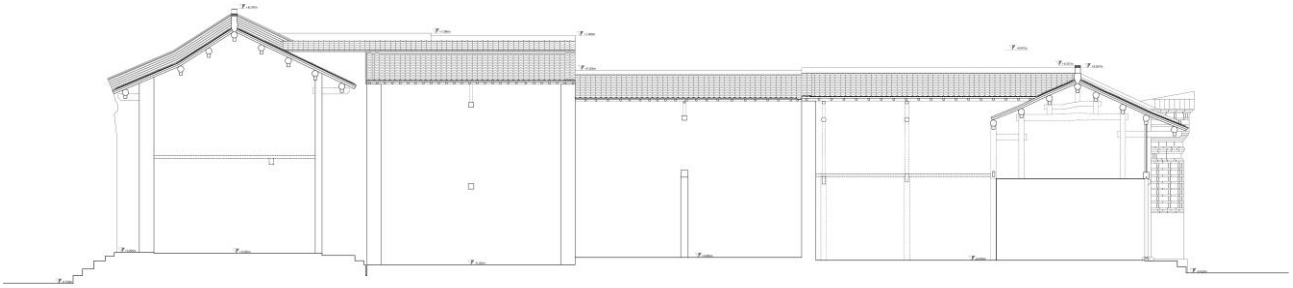


Fig. 5.5 Situation A-A Longitude section in May 2018
(Elaboration by author)

Fig. 5.6 Situation B-B Longitude section in May 2018
(Elaboration by author)

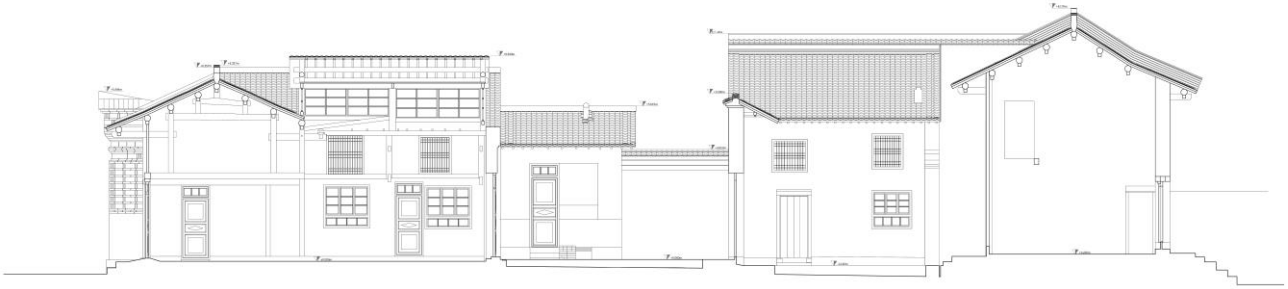


Fig. 5.7 Situation C-C Longitude section in May 2018
(Elaboration by author)

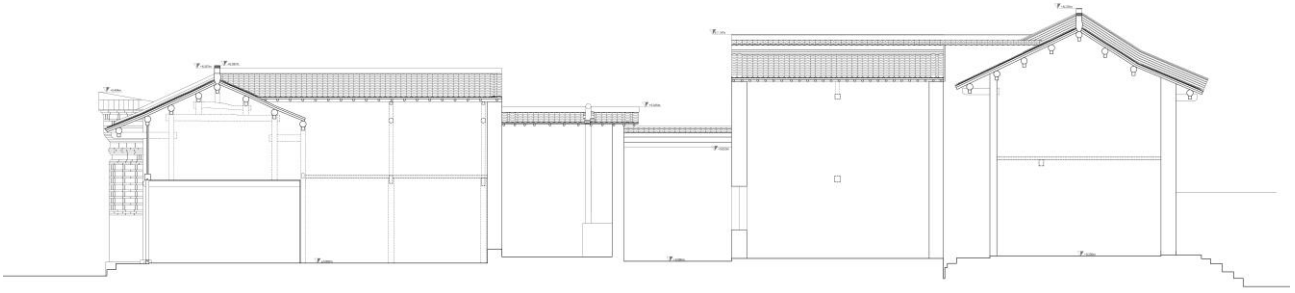


Fig. 5.8 Situation D-D Longitude section in May 2018
(Elaboration by author)

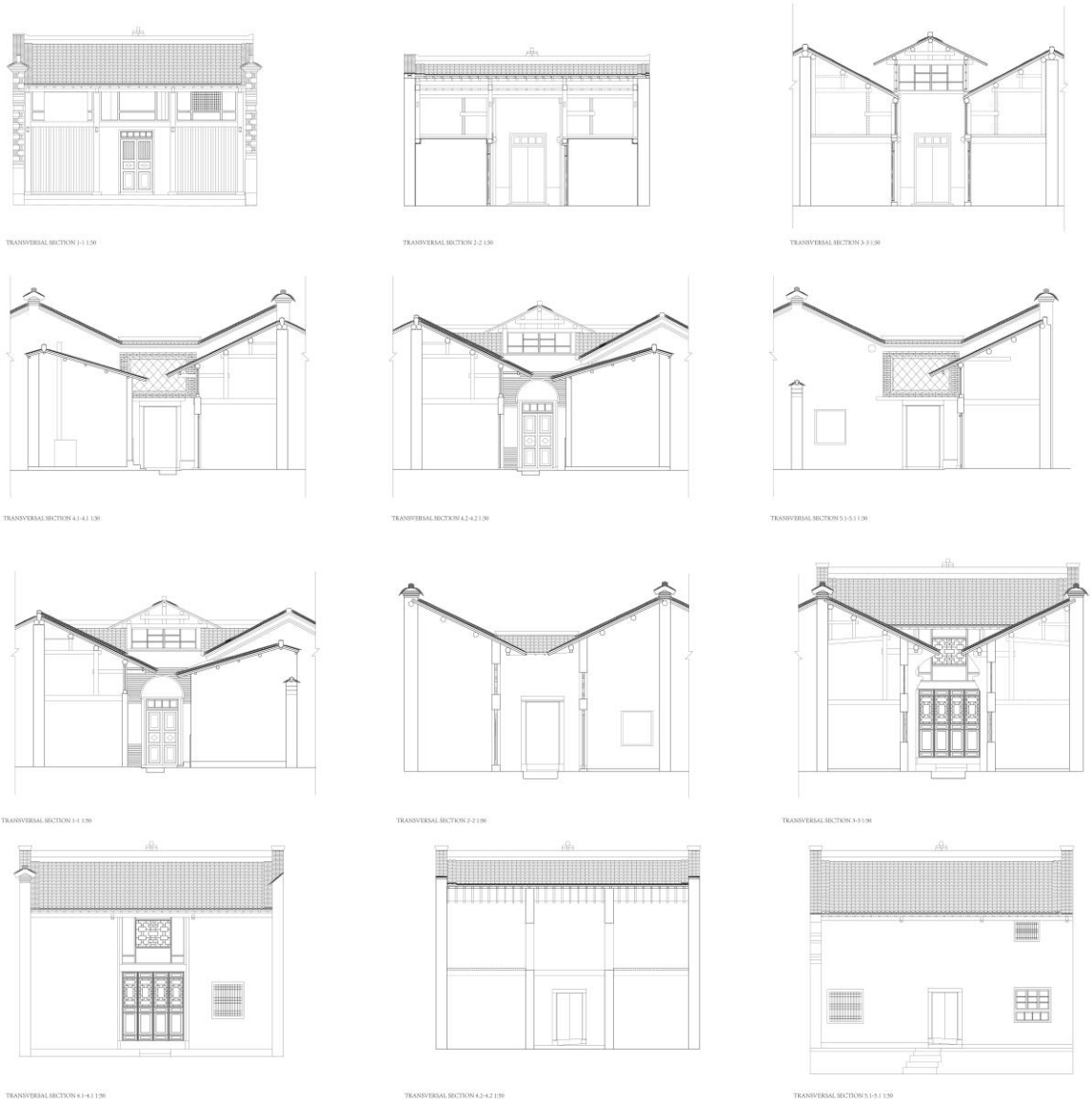


Fig. 5.9 Vertical sections
(Elaboration by author)

Fig. 5.10 Images of Dang Yard
(Resource: the author, 2018)

5.1.2. Conservation of the Dang Yard

Due to the long-term disrepair of the Dang Yard, coupled with the mixed use of modern materials, the Dang Yard is more abundant in decay. *(Fig.5.11, 5.15, 5.16)* It can be seen from the damage diagram of the material that there are many cracks in the rammed earth wall. *(Fig.5.12-5.13)* The white lime-painted rammed earth wall has foaming phenomenon, and some blisters have been broken. Large areas of the wall have stains due to long-term use, and some walls have graffiti for children. There are many problems on the wall near the ground of

the courtyard, green rust and weathering at the feet, and a small part of the moss and green plants grow.

According to the decay presented by the profile of the Dang Yard, the causes can be divided into three categories. The first category is wall bulging, shedding, embroidering, dirt, moss growth, and material disintegration caused by prolonged exposure to moisture due to moisture and rain. Most of these damages occurred on the walls near the ground on both sides of the courtyard. The second category is cracking of rammed earth walls and damage to doors and windows due to lack of repair. The third category is the discoloration, dirt, graffiti, etc. of the wall caused by the long-term use and human factors.

Combining the decay and the cause of damage, the following three aspects of maintenance methods can be proposed for the maintenance and repair of the Dang Yard. *(Fig.5.14)*

First, moisture-proof and waterproof. It can be seen from all the decay of the Dang Yard that waterproofing and moisture resistance are the main points of its repair. The Dang Yard can increase the dripping of eaves, brick feet, and the patio pit to reduce the influence of rain and moisture on the wall structure and materials. The dripping of the eaves reduces the erosion of rain on the rammed earth wall, so that more rain falls into the patio pit. The connection between the wall and the ground is a weak link. The ground rainwater of the patio courtyard often splashes back to the rammed earth wall on both sides. The closer to the ground, the easier the wall to be exposed to rainwater. At the same time, the ground moisture is large, and the moisture in the low part of the wall is larger than that of the wall, so it can be built with masonry to reduce the impact of the rammed earth wall on the ground water and moisture. At the same time, comparing the pavement of the sink pits in the two patio yards, the sink pits of the Meng Family House are made of medium-sized pebbles into "人" shape. The overall gap is large and many, which is easy to seep and is not easy to accumulate water, and greatly reduces the rain splashing and gathering of moisture. The Dang Yard is used for plastering the cement and is simply provided with a drain. Therefore, we can learn from the paving method of the Meng Family House, which not only uses drainage but also has aesthetics.

Second, reinforcement and repair. It can be seen from the decay that the windows of the Dang Yard are seriously damaged. In order to ensure the indoor temperature, humidity and beauty, new glass should be replaced. In order to preserve the historical evolution of the Dang

Yard, it is not necessary to pursue traditional carved doors and windows when replacing the repaired doors and windows. Instead, repair the original doors and windows. At the same time, there are many cracks on the rammed earth wall, which should be filled with optimized rammed earth materials, and the color should be distinguished at the same time to facilitate the identification of materials placed in different periods, and to retain the complete trace of material evolution. The optimized rammed earth material is mixed with a certain proportion of fine sand and gravel in the clay, with a certain proportion of water, that is, to control the proportion of clay particles and sand and gravel, it can improve its strength, water resistance and frost resistance.[3]

Third, refurbish and repaint. The wall surface is mottled due to the discoloration of the wall, graffiti of children, and plastering of the wall surface. To improve the living environment, the wall should be repainted. However, during the painting process, it is necessary to avoid erasing all the historical information carried by traditional houses, and to keep valuable and meaningful wall traces reasonably, such as retaining wall graffiti and cracks, which can add historical interest and thickness to traditional houses.

3 Shi Chencan. 'Study on the Construction Wisdom and Renewal Strategy of Tibetan Dwellings in the Baima River Basin'. Master Diss, XAUAT. 2018. （史琛灿. 白马河流域藏族民居的营建智慧与更新策略研究. 硕士论文，西安建筑科技大学. 2018.）

Fig. 5.11 Photo collage of section B-B in May 2018
(Elaboration by author according to ICOMOS-ISCS)

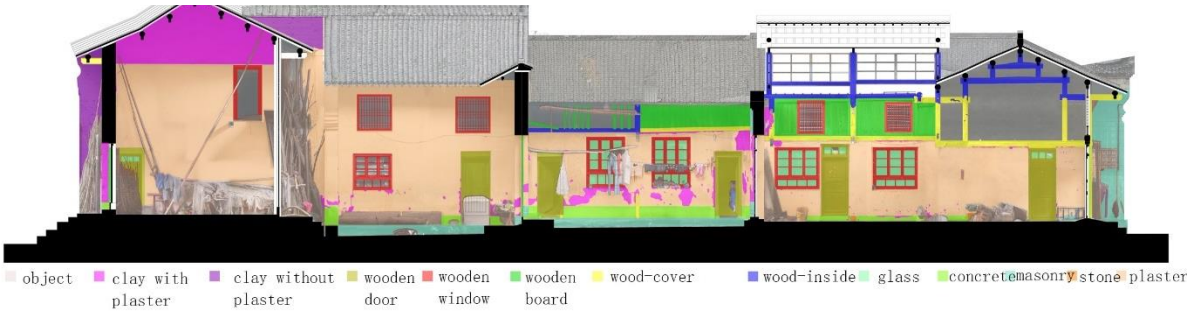


Fig. 5.4 Material of section B-B in May 2018
(Elaboration by author according to ICOMOS-ISCS)

Fig. 5.5 Decay of section B-B in May 2018
(Elaboration by author according to ICOMOS-ISCS)

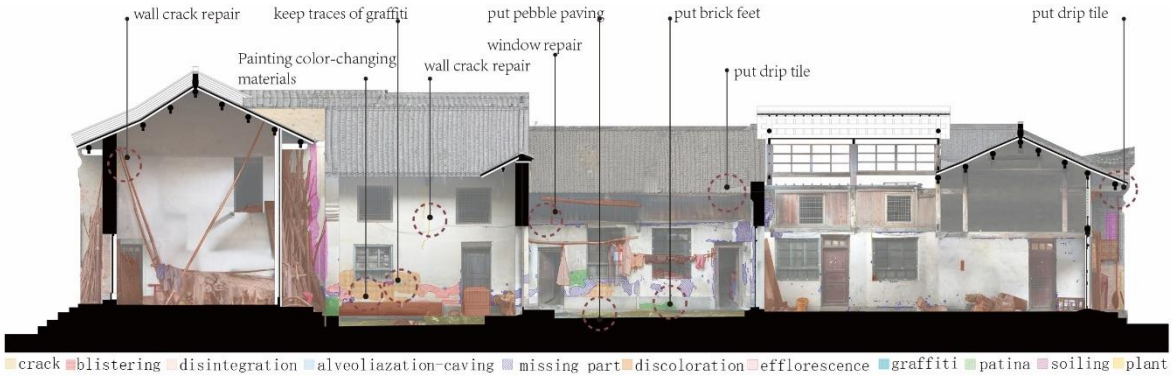


Fig. 5.6 Conservation solution of section B-B in May 2018
(Elaboration by author)

Fig. 5.15 Decay of vertical section A-A, B-B, C-C in June 2020
(Elaboration by author according to ICOMOS-ISCS)

Fig. 5.16 Decay of roof in June 2020
(Elaboration by author according to ICOMOS-ISCS)

Fig. 5.17 Strategies of elements
(Elaboration by author)

5.2. Continuity of Use under Conservation

5.2.1. Restore the Zhaiyuan Type of Dang Yard

The zhai yuan type of Dang Yard is one of the highest level of traditional dwellings in Fenghuang ancient town with five parts and three courtyards and well-preserved. The Dang Yard is the twin of the Meng Yard which is another traditional *Zhaiyuan* and restored in 2018. Therefore, the forms of these two traditional dwellings should be the same. However, according to the survey, compared with the Meng Yard, the second courtyard of the Dang Yard has a small house on the west and middle sides. Although this building uses local construction materials and construction methods, it is known from the interview that the house was built late, so this room does not belong to the original form, and it should be demolished to restore the original form. However, the additional houses are also part of history, so the pedestal of the additional building is preserved, thereby keeping traces of the historical development of the Dang Yard.

After demolishing the small house, the courtyard space in the second courtyard becomes larger, which can expand the outdoor space in the building, thus providing residents with more possibilities for outdoor activities. In particular, this courtyard shares a wall with the second entrance courtyard of Meng Family House. From the perspective of development, Meng Family House as a physical museum may be merged with Dang Yard again. This wall will become an important element to link between the two.

5.2.2. Continuity the Form of 'Front Store, Back House

The distinguishing feature of traditional dwellings in Fenghuang Ancient Town from other dwellings is the layout of the 'front store, back house'. This way also determines the unique lifestyle of the residents of Fenghuang Ancient Town-commercial activities along the street, daily living activities on the back street. *(Fig.5.18)* It is also the traditional lifestyle of the ancient town inherited to this day, and has certain value. Therefore, the reuse design process should not only retain the form of 'front store, back house', but also retain the traditional lifestyle.

Based on the survey, it can be seen that the tourism business of the Fenghuang ancient town

is very depressed. According to the survey results of tourists, it is because the tourism business of the ancient town is relatively backward, unable to meet the needs of modern tourists, and lacks attractiveness. Therefore, it is necessary to introduce a new type of tourism business to enhance the attractiveness of traditional houses. At the same time, considering the continuation of the traditional space layout and lifestyle, the part along the street can be transformed into an external commercial space, and the rear of building can be changed to homestay. The commercial reuse of traditional houses is a trend, and in order to avoid the traditional life memory being completely engulfed by tourism businesses, choosing the commercial form of homestay can not only retain the traditional lifestyle and architectural space layout, but also bring certain income to local residents.

Use and rent a room to form a homestay, providing tourists with the opportunity to stay on both sides of the ancient street at night (there is no hotel on the ancient street). Homestay has a certain introversion, so it is placed in the back of the Dang Yard, not only away from the noisy Old Street, but also has a good living environment in the backyard. *(Fig.5.20)*

The covered halls formed by the first and second parts are highly open to the outside. The internal walls of the ground floor are removed, and the exposed columns and cornerstones are retained to obtain a complete large space for use as a tea room and restaurant. It not only serves tourists on Old Street, but also serves guests staying in the Dang Yard. The second courtyard has naturally become a transitional space. As a public living room, it can be used as both a guest check-in hall and an event space for ordinary tourists to ensure that homestay is not disturbed.

5.2.3. Preserve the Featured Elements: Lantern Roof, Removable Door Panel, and Fire Wall

Covered by a lantern roof above the first courtyard of the Dang Yard, this roof did not appear in the Meng Yard, to avoid rain and also provide the light and indoor insulation. This unique roof comes from Hubei and is the spontaneous and adaptive solution in the town. Therefore, keep it in the form of restoration. [4]It can not only make the first courtyard into a complete indoor space, but also independently adjust the indoor microclimate environment and light.

4 Prof. Laura Anna Pezzetti emphasized the particularity of the lantern roof and kept it in the design during the guidance.

Especially in the second courtyard, you can see the facade formed by the lantern roof and the wall, which is a facade with southern architectural characteristics. Thanks to the restoration of the second entry courtyard, this unique facade can be fully displayed to residents and tourists.

The removable door panel along the street of the traditional houses of Fenghuang Ancient Town is also a major characteristic element of the ancient town. Its detachability allows commercial spaces to gain more lighting and display during the day. But now in the improper renovation of the residents of the ancient town, this characteristic element is removed and replaced by ordinary swing doors. Therefore, in the reuse of the Dang Yard, in order to ensure the indoor thermal comfort of the first courtyard, a foldable glass door can be added after the original removable door. In summer, the folding glass door can be fully opened without affecting indoor ventilation. In winter, when the removable door panel is removed, the folding glass door can be closed, so that the indoor heat can be maintained without affecting the traditional facade. The foldable glass door is just like the invisible door behind the removable door, which can be opened and closed according to actual needs.

The fire wall is also one of the main elements of the Dang Yard. The continuation design based on protection is mainly reflected in the backyard, which has been explained above.

5.3. Adaptive Reuse Design for the Second Floor and Modern Life

5.3.1. Give New Use to Upper Floor by Light Stairs[5]

The upper floor in most traditional houses in ancient town can only be reached by climbing labbers, and because of the inconvenience, it is gradually abandoned. *(Fig.5.19)* In the survey of the reuse of traditional houses in ancient towns in 2018, no case was found of a household's reconstruction of the second floor space, which means that the second floor space may be abandoned by residents. However, The upper floor is an important part of the folk houses in the Fenghuang ancient town, so it is necessary to promote the reuse of the upper floor by adding new stairs.

Since the internal space of traditional houses is relatively cramped, light and compact stairs

5 In the guidance process, prof. Laura Anna Pezzetti emphasized the importance of reuse of the upper floor, and she thought if ignoring the reuse of the upper floor, it would be disappear soon,

should be selected to reduce the proportion of traffic space in the limited space. At the same time, the materials of the newly added stairs and the reinforced structure should be distinguishable, and they should not be confused with the original building materials to ensure their authenticity.

The Dang Yard has added four staircases to the reuse design. The existence of the Lantern roof of the Dang Yard made the first and second parts merge to form a covered hall. A staircase is placed in the first entrance, providing a high-height space for the hall and bringing a vertical visual change to the indoor space experience, which is very attractive to tourists. Due to the needs of safe evacuation, the second staircase is set up by using the open space in the second courtyard where the house is demolished. It makes the second courtyard more aggregated and public, which is a better communication space. The remaining two stairs are installed in the gap between the fourth and fifth entrances. This reuse of debris space does not waste the effective area while ensuring the full utilization of the upper floor. The reuse of the fifth entrance into the upper floor provides a new perspective of the landscape, which is very interesting for the first floor open space of the courtyard.

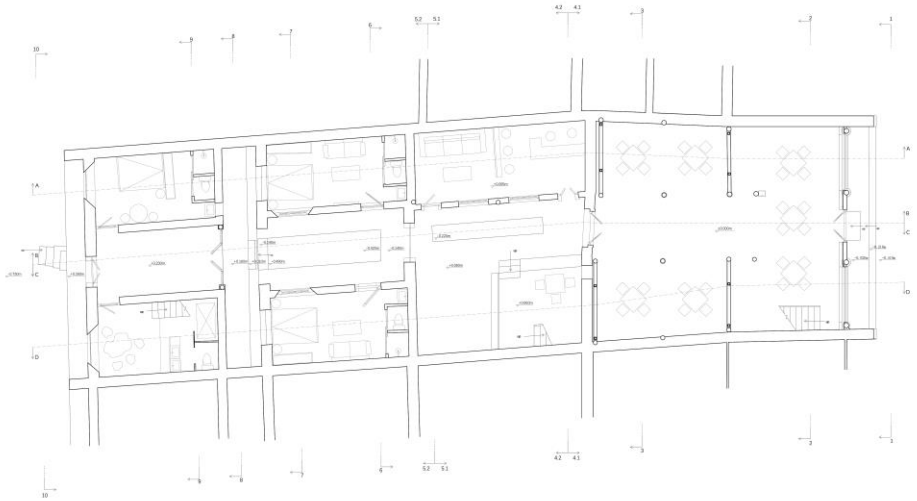
5.3.2. Design for the Modern Life

The traditional dwellings of Fenghuang Ancient Town can no longer meet the needs of modern life, which brings inconvenience to residents and tourists. For example, lack of light in the room, cold and humid indoors in winter, partial height of the attic (because of the roof structure), and lack of indoor toilets, which is the main issue.

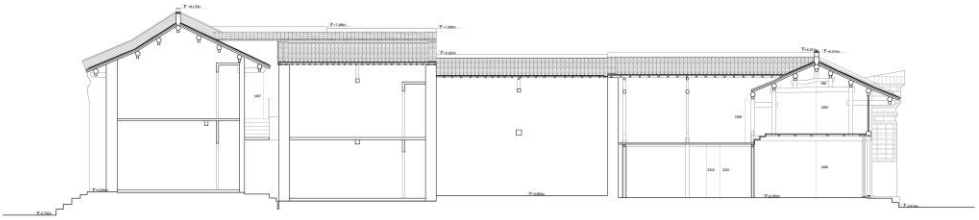
Since the main materials of the traditional houses in the ancient town are wood and rammed earth, their waterproof and moisture-proof performance is poor. Therefore, in order to extend the life of the building, residents do not generally install indoor toilets. However, in order to adapt to the lifestyle of modern people and provide tourists with perfect infrastructure, it is necessary to design indoor toilets. Modern materials and technologies can be used, such as the placement of an integral bathroom to form a box-in-box model, to avoid contact between the bathroom and the original wall, which can solve the problem of poor water and moisture resistance of the original building. The indoor toilet not only facilitates life, but also reduces the un-safeness of going to the toilet at night and in bad weather.

Another big issue is about the physical comfort of the room. This part will be explained in detail in the physical environment design below. Through the design of door and window openings and the design of wall insulation, the Dang Yard can obtain an indoor thermal and comfortable environment that meets the needs of contemporary people.

The reuse of the Dang Yard not only activates the building, but also provides visitors with an opportunity to experience and experience traditional residential buildings in depth. *(Fig.5.21-5.22)* Not only provides a new perspective and perfect facilities, the most important thing is an opportunity to observe and touch traditional houses at close range.



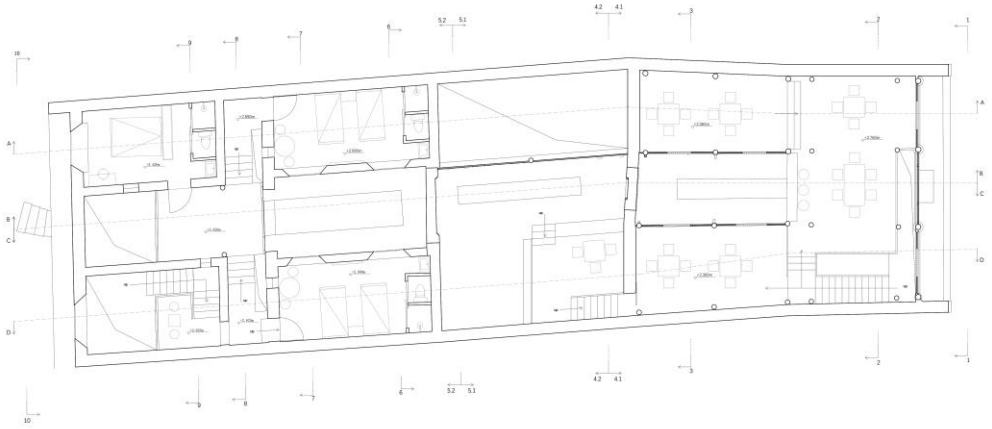
GROUND FLOOR PLAN 1:100



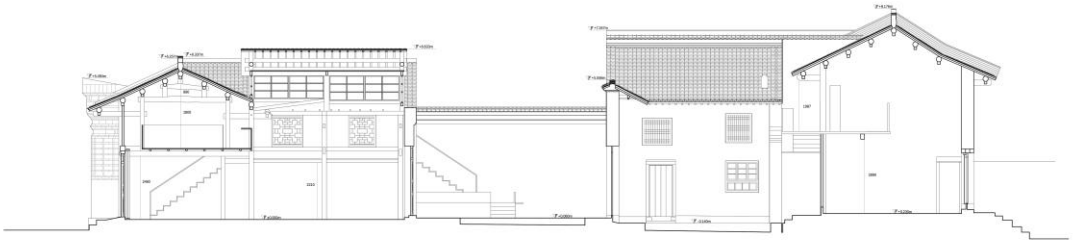
LONGITUDE SECTION A-A 1:100

LONGITUDE SECTION B-B 1:100

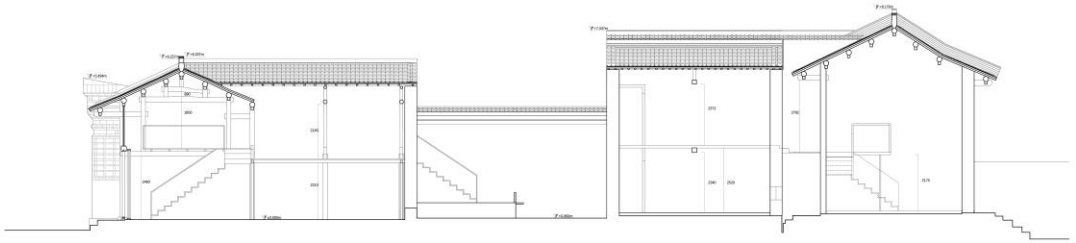
Fig. 5.18 Design of Dang Yard
(Elaboration by author)



1ST FLOOR SECTION 1:100



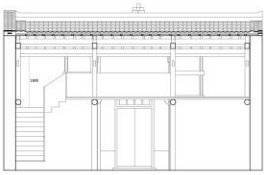
LONGITUDE SECTION C-C 1:100



LONGITUDE SECTION D-D 1:100

Fig. 5.17 Design of Dang Yard
(Elaboration by author)

TRANSVERSAL SECTION 1-1 1:100



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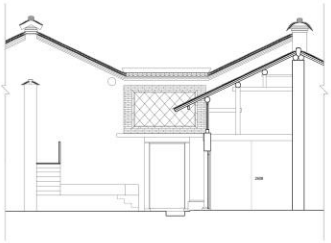

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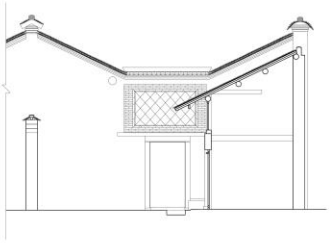

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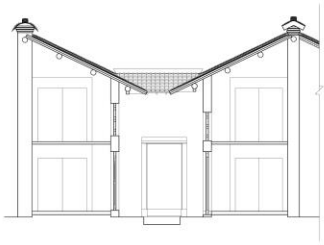

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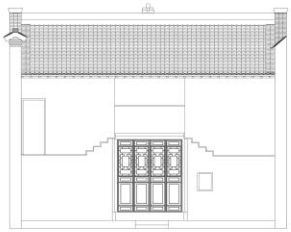

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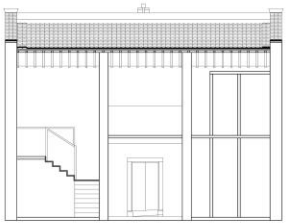

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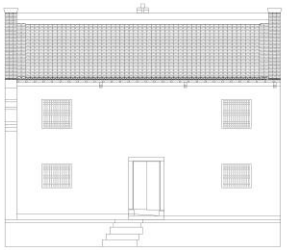


TRANSVERSAL SECTION 10-10 1:100

Fig. 5.20 Design of Dang Yard
(Elaboration by author)

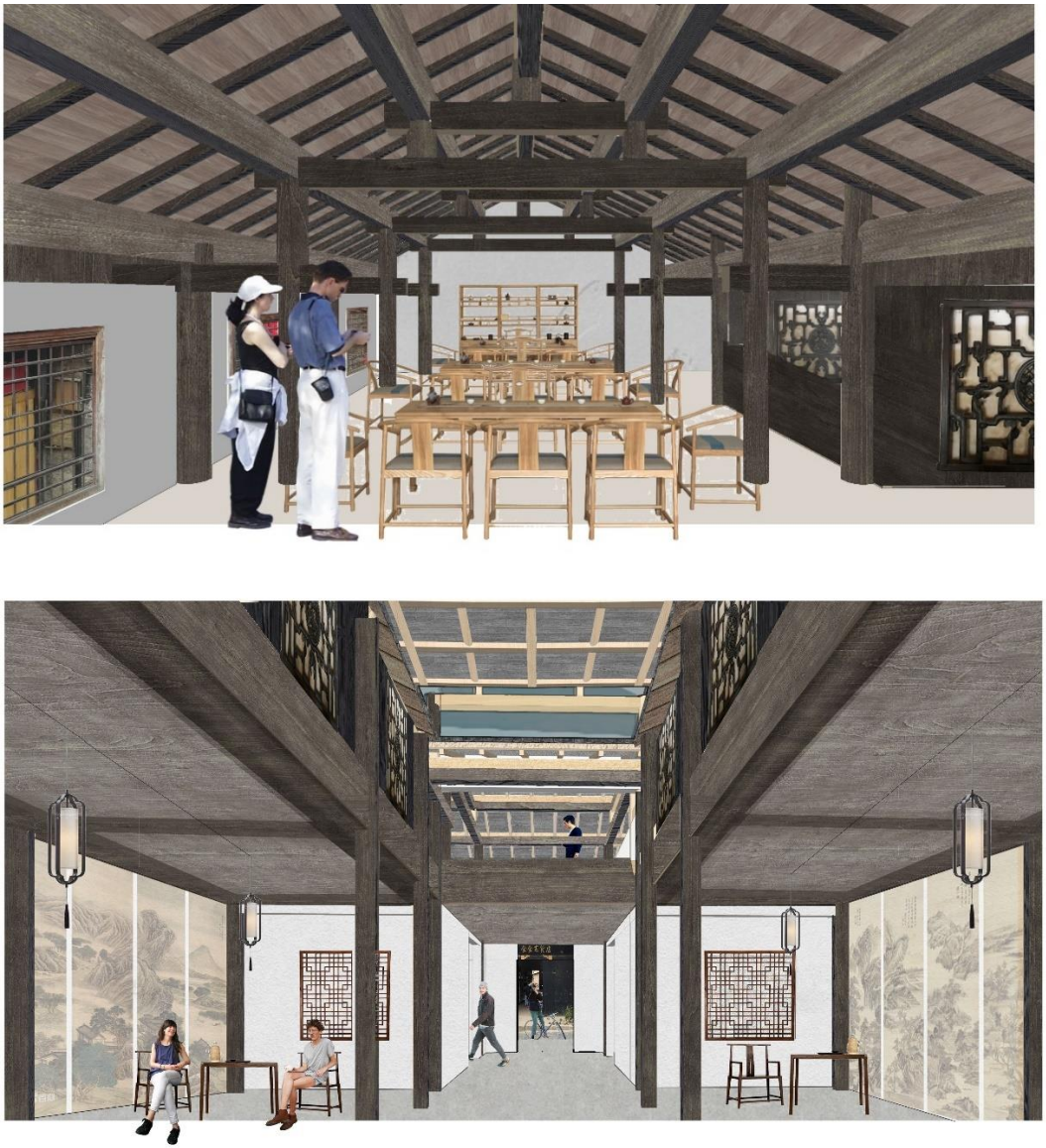


Fig. 5.8 View of Dang Yard-1
(Elaboration by author)

Fig. 5.22 View of Dang Yard-2
(Elaboration by author)

5.4. Energy Performance of the Historical Building

5.4.1. Current Situation

After detailed surveying and mapping of the dwellings of the Dang Yard, the advanced energy design tools were used to simulate the internal environment performance of the dwellings to obtain imaged and data-based information for updating and transformation.

Global Thermal Transmittance

The thermal transmittance (U-value) of the wall refers to the heat transfer through the unit area of the wall per unit time when the temperature difference between the two sides of the whole wall is one unit, ie 1K (1 ℃) under the premise of stable heat transfer. The physical unit is W/㎡·K. The overall wall surface refers to all levels included in the wall structure, reflecting the strength of the wall's heat transfer. In other words, it shows the heat resistance performance of the wall. The smaller the thermal transmittance (U-value), the weaker the degree of heat transfer, the better the insulation performance, and the lower the energy consumption for building heating.[6] The larger the thermal transmittance, the more the heat loss from the wall or roof, and the worse the thermal environment performance of the building. Through the measurement of the wall and roof of the residential buildings, the total thermal transmittance of each part of the surrounding structure can be calculated.

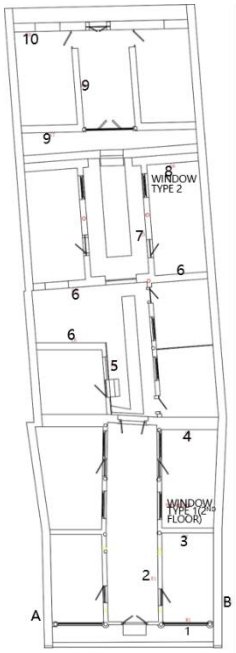


Fig. 5.23 Wall number of Dang Yard (Elaboration by author)

① Wall Structure

The stratigraphy of walls with different materials and thicknesses in the Dang Yard are

6 Shen Zufeng. 'Research on Thermal transmittance (U-value) Detection of Wall based on Ansys based on Heat Flow Meter Method.' Master Diss,. Zhejiang University, 2011. (沈祖锋. 基于 Ansys 的热流计法墙体传热系数检测的研究[D].浙江大学,2011.)

identified, and the results are shown in the figure. Within a certain range, the thickness of the rammed earth wall is inversely proportional to the thermal transmittance and directly proportional to the thermal insulation capacity. *(Fig.5.23-5.24)*

	description	thinkness(mm)	thermal conductivity[w/mk]	U-value(W/m2k)	
extenal surface					0.06
Wall	A	440	0.75	1.3	
	B	460	0.75	1.26	
	1	30	0.15	2.63	
	2	240	0.75	2	
	3	264	0.75	1.88	
	4	465	0.75	1.25	
	5	220	0.75	2.11	
	6	380	0.75	1.46	
	7	310	0.75	1.69	
	8	460	0.75	1.26	
	9	340	0.75	1.58	
	10	475	0.75	1.23	
internal surface					0.12

Fig. 5.24 Wall U-value
(Elaboration by author)

② Roof Structure

The roof structure of the Dang Yard is relatively simple. *(Fig.5.25)* The components include tiles, wooden boards and rafters. Based on the thickness and the thermal conductivity of the constituent materials, the total thermal transmittance of the roof structure is 1.67 W/㎡·K, not Conducive to thermal insulation.

roof	description	thinkness(mm)	thermal conductivity[w/mk]	U-value(W/m2k)
layer	tile ceramic	34mm	1	1.67
	wood board	50mm	0.15	
	wood beam	9.87mm	0.15	

Fig. 5.25 Roof U-value
(Elaboration by author)

③ Ground and Floor

There is a floor made of wooden partitions in the Dang Yard to divide and isolate the space. *(Fig.5.26)* It is mainly used for storage and load-bearing, but residents are not active on it. The ground composition is relatively simple, and it is currently paved with cement.

description	thinkness(mm)	thermal conductivity[w/mk]	U-value(W/m2k)	area A（m2）	exposed perimeter P(m)
ground floor	20mm水泥砂浆	0.93	1.47	20.9	19.265
floor	wood broad80mm	0.15	1.2		
	9mm wood beam	0.15			
	8.7mm wood liang	0.15			

Fig. 5.9 Floor U-value
(Elaboration by author)

④ Window

There are two types of windows in the Dang Yard. The first type is the traditional wooden lattice window. But the window paper has been damaged, which is a state of empty air leakage. Type two is modern glass windows that have been replaced. The windows of the rooms in use are relatively complete, and the glass and wooden frames are well preserved; the windows of the idle houses are damaged. After calculating this window, the following results are obtained.

By calculating the total thermal transmittances of the envelopes of the Dang Yard, it can be known that the larger thermal transmittance (U-value) of each component means that its thermal insulation performance is poor and the thermal environment performance inside the building is poor. *(Fig.5.27)*

window

type 1	area	conductivity	U value
wood frame	0.554	0.15	25.4
air	0.866	0.0267	
type 2	area	conductivity	U value
wood frame	1.117	0.15	4.05
glass	1.067	0.76	

Fig. 5.10 Window U-value
(Elaboration by author)

(1) Building Energy Consumption Simulation

Through the simulation of building energy consumption, it can be obtained how much energy the building needs to consume when the indoor temperature demand is met. The more energy consumed, the worse the indoor thermal insulation ability under the current conditions and the worse the thermal environment performance; The less energy consumed, the stronger the indoor thermal insulation capability under current conditions, and the less external energy is required. Through energy consumption simulation, the thermal environment performance can be digitized, and the specific value of the energy consumption required to reach the given

temperature environment is clearly known, so as to prepare for the next step to improve the internal environment performance.

This simulation uses BESTEnergy software, which is an advanced building energy calculation software based on the EnergyPlus platform. Computable items include building heating, cooling, electricity consumption, the impact of shading equipment on the building, thermal comfort level, ground source heat pump energy supply system, etc.

Using BESTEnergy software to simulate the building energy consumption, it is divided into 5 thermal zones according to the space configuration and thermal zone requirements. *(Fig.5.28)* Input the relevant data of the envelope structure, local climate data and building use efficiency and other related control parameters, and get the following data from the operation.

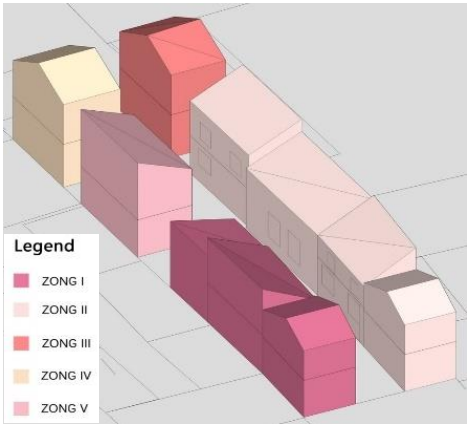
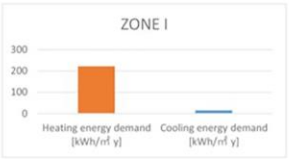


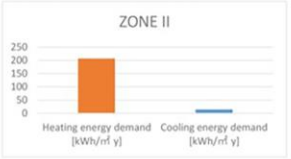
Fig. 5.28 Thermal zone of original Dang Yard (Elaboration by author)

It can be seen from the data that in order to achieve 20 ℃ in winter and 26 ℃ in summer thermal environment in the building, the energy required for heating is about 215 kWh/$m^2 \cdot$y, and the energy required for cooling is 13 kWh/m^2·y. *(Fig.5.29)* It can be seen that the thermal insulation performance of the envelope structure of the Dang Yard is poor, and consequently, the energy performance is poor. In the transformation process, attention should be paid to the improvement of the insulation performance of the envelope structure, and if necessary, the design and selection of the heating system also required to be carried out.

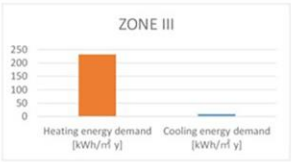
ZONE I	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone1	2875930	26347.4	15.9		
Thermal Zone3	2848190	0	21		
Thermal Zone5	5249760	731057	15.9		
Thermal Zone9	4256710	514972	21		
Thermal Zone11	4645980	28279	15.7	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	19876570	1300655.4	89.5	222.084581	14.53246257



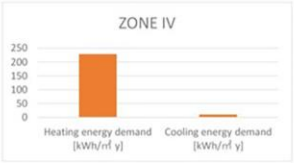
ZONE II	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone2	2314950	8849.81	15.8		
Thermal Zone4	3798410	669308	15.8		
Thermal Zone6	2676250	0	19		
Thermal Zone7	7878250	86936.2	26.8		
Thermal Zone8	3973610	517597	19		
Thermal Zone12	2778750	0	20.6		
Thermal Zone13	5033650	698020	20.6	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	28453870	1980711.01	137.6	206.7868459	14.39470211



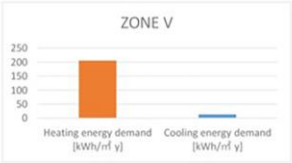
ZONE III	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone17	3457890	0	18.6		
Thermal Zone10	5175980	338805	18.6	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	8633870	338805	37.2	232.0932796	9.10766129



ZONE IV	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone15	3532650	0	19.4		
Thermal Zone18	5327610	387590	19.4	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	8860260	387590	38.8	228.3572165	9.98943299



ZONE V	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone14	3121500	0	20.9		
Thermal Zone16	5448510	552447	20.9	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	8570010	552447	41.8	205.0241627	13.21643541



	W	KW			
max heating pea	31208.69	31.20869			
max cooling peal	12096.17	12.09617			
	74394580	4560208.41	344.9	215.6989852	13.22182781

	W	KW
max heating peak load [W]	31636.16	31.63616
max cooling peak load [W]	12169.66	12.16966

Fig. 5.29 Energy demand of original Dang Yard
(Elaboration by author)

5.4.2. Application of Construction Technology Update Strategy

Through the simulation of the internal environmental performance before the transformation, it can be seen that the environmental performance of the building of the Dang Yard is poor. In this transformation process, the thermal environment, light environment and wind environment need to be improved. The improvement of building thermal environment is simulated by calculation of building energy consumption. In addition, the improvement of construction techniques such as the envelope structure, doors and windows openings, and ground laying has a crucial role in improving the internal environment of the building. The following is a detailed description from several aspects.

(1) Insulation Optimization

① Wall Insulation Strategy

In order to improve the insulation performance of the wall of the Dang Yard, sandwich insulation is used, and the insulation layer EPS is used between the two rammed earth walls. *(Fig.5.30)* The wall structure is rammed earth wall-bonded material-EPS insulation board-bonded material-rammed earth wall from inside to outside.

② Roof Insulation Strategy

Roof insulation is also in the form of adding insulation. Insulation layer selection SIPs are formed by pre-pressing OSB board cushion and insulation board XPS. *(Fig.5.31)* The insulation material is sandwiched directly between the inner and outer board cushions, and the integrated insulation and load-bearing function can be used on the roof instead of the wooden board. The specific structure is as follows.

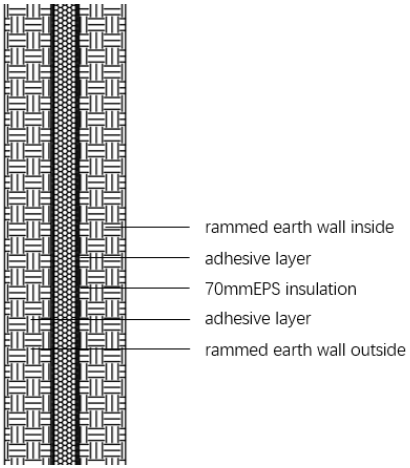


Fig. 5.30 Wall insulation strategy
(Elaboration by author)

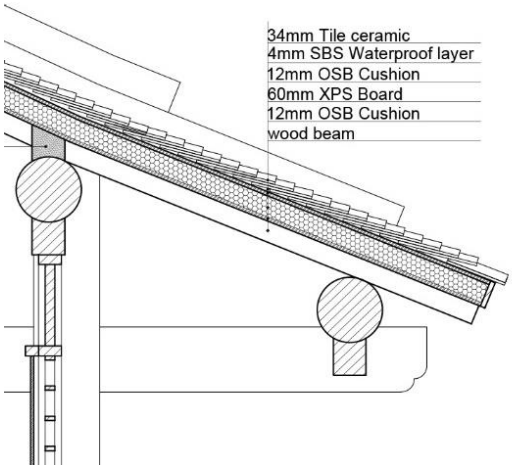


Fig. 5.11 Roof insulation strategy
(Elaboration by author)

③ Door and Window Insulation Strategy

In the process of transformation, modernized doors and windows in the Dang Yard were replaced. Combined with other preserved traditional doors and windows in the ancient town, and designing and making antique decorative windows. At the same time, modern double-layer windows are added for insulation. Repair the existing wooden lattice windows and use double-layer thermal insulation windows behind it to improve the thermal insulation performance of residential houses. The specific structure is shown in the figure. *(Fig.5.32)*

④ Floor Insulation Strategy

In order to make the Dang Yard more comfortable during winter, consider setting up a floor heating layer on the ground floor. *(Fig.5.33)*The backyard of the Dang Yard and the near water source provide sufficient facilities for the ground source heat pump equipment and the running water source. The practice of laying floor heating on the ground is shown in the figure.

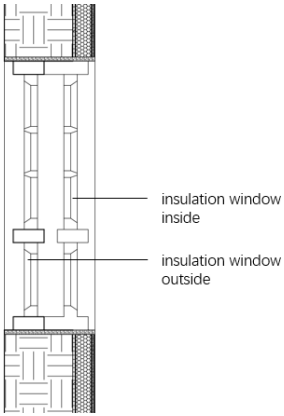


Fig. 5.12 Window insulation strategy
(Elaboration by author)

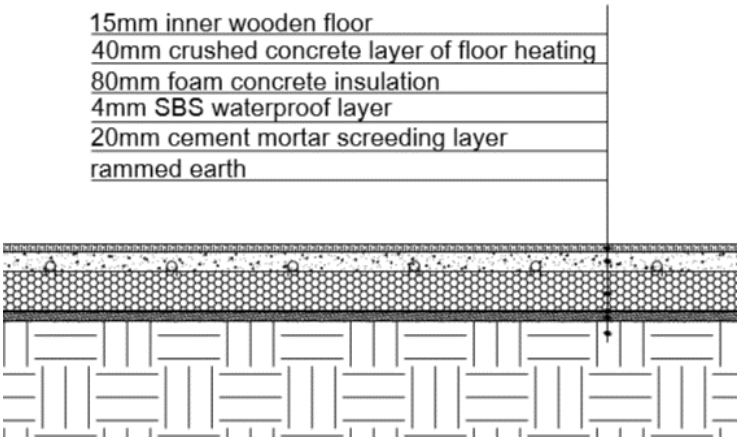


Fig. 5.13 Floor insulation strategy
(Elaboration by author)

(2) Lighting Strategy

In the use of the first courtyard, a railing is formed on the first floor, so that the light on both sides of the lantern roof can enter the room. The lighting of the living space is enhanced by the provision of reflective panels on the inner side of the window, and the opening of the side wall is enhanced. *(Fig.5.34)*

(3) Ventilation Strategy

The shape of the indoor space has a great influence on the direction, size and speed of the indoor wind. Different spaces will induce different forms of wind flow. *(Table 5.1)*

The first courtyard of the Dang Yard is a public space. The removal of the wall will open up the interior and with the lantern roof, the ventilation effect is good. *(Fig.5.35)* The third courtyard room has poor lighting, so choose to set the window on the side wall of the wings, and use the indoor space to guide the wind to accelerate the indoor air flow.

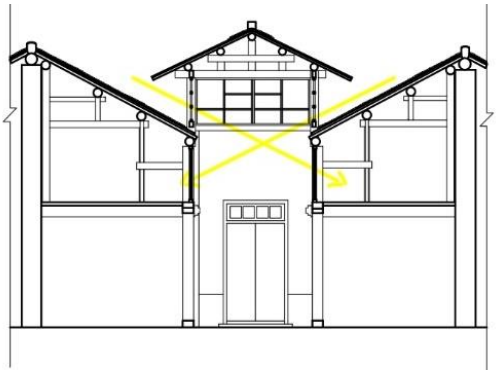


Fig. 5.34 Light in 'Tiandou'
(Elaboration by author)

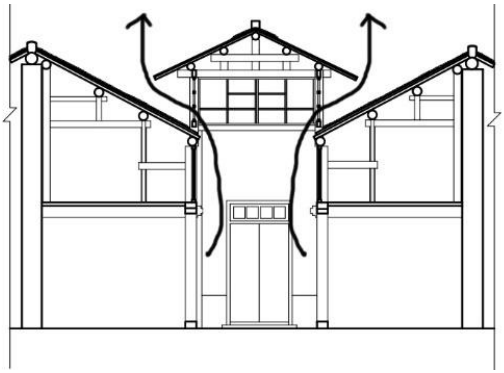
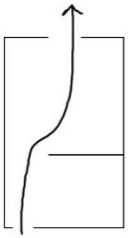
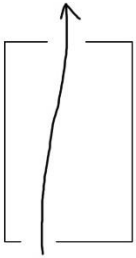


Fig. 5.35 Ventilation in 'Tiandou'
(Elaboration by author)

Table 5.1 Influnce of indoor space segmentation on wind speed
(Elaboration by author based on *Liu Hui. 'Research on the Application of New Technology in the Comprehensive Renovation of the Indoor Environmental Quality of the Traditional Village Houses'. (Master diss., Chongqing University, 2017): 54*)

Methods	Plan Layout	Indoor and Outdoor Wind Speed Ratio	Ventilation
Method 1		V1/V0=40%	The air outlet is diagonally opposed, and there is a blockage that greatly reduces the indoor wind speed
Method 2		V1/V0=42.2%	The air outlet is diagonally opposed, without obstruction, and the wind speed drops slightly

5.4.3. Simulation of Environmental Performance in Buildings after Update

(1) Thermal Transmittance

To improve the thermal insulation performance of walls, roofs, floors, and windows, it is possible to enhance the thermal insulation performance of the residential building envelope structure by reducing its total thermal transmittance (U-value) and improving the thermal performance of the building.

① Wall Structure

The addition of EPS insulation layer greatly reduces the total thermal transmittance (U-value) of the wall. After the design, in order to ensure that the thickness of the wall is similar to the original wall thickness, adjust the thickness of the rammed earth part and the inner insulation layer part. After the calculation experiment, the rammed earth can be used in the main enclosure wall of the Dang Yard. The thickness of 150mm inside and outside, and the inner EPS insulation layer of 70mm can meet the requirements of the wall thermal transmittance (U-value) in the climate area. *(Fig.5.36)*

wall	description	thickness(mm)	thermal conductivity(w/mk)	U-value(W/m^2k)
	internal earth wall	150	0.75	0.4
adhesive layer	dry powder construction adhesive	10		
	overturned glass fiber mesh cloth			
	EPS insulation	70	0.036	
adhesive layer	dry powder construction adhesive	10		
	overturned glass fiber mesh cloth			
	external earth wall	150	0.75	

Fig. 5.36 Wall U-value after design
(Elaboration by author)

② Roof Structure

SIPs prefabricated panels are used in the roof structure, and the thermal insulation performance and the envelope bearing are combined in a structural layer. Compared with the traditional inverted roof, the thickness is greatly reduced, and the thermal insulation performance is also improved. *(Fig.5.37)*

roof	description	thickness(mm)	thermal conductivity(w/mk)	U-value(W/m^{2}k)
	tile ceramic	34	1	0.4
SIPs	SBS waterproof layer	4	0.23	
	OSB cushion	12	0.13	
	XPS extruded benzene board insulation	60	0.03	
	OSB cushion	12	0.13	
	wood beam	9.87	0.15	

Fig. 5.37 Roof U-value after design
(Elaboration by author)

③ Ground and Floor

In order to improve the environmental performance of the Dang Yard, an underfloor heating layer is provided on the ground floor to provide moisture and heat insulation while heating. The total thermal transmittance (U-value) of the updated ground floor is shown in the figure. *(Fig.5.38)*

	description	thickness(mm)	thermal conductivity(w/mk)	U-value(W/m^{2}k)
ground	earth			0.48
	cement mortar	20	0.87	
	SBS waterproof layer	4	0.23	
	foam concrete insulation	80	0.07	
	floor heating(crushed concrete)	40	1.58	
	indoor wooden floor	15	0.15	

Fig. 5.38 Floor U-value after design
(Elaboration by author)

④ Window

For windows, the calculation is more complicated. According to the proportion of the physical area of the window, there are different total thermal transmittance (U-value) values. The total thermal transmittance (U-value) of windows is 2.03, whose frame (physical part) is about 30%. The total thermal transmittance (U-value) of windows is 2.1, whose frame (physical part) is 45%.

(2) Building Energy Simulation

For the Dang Yard after the renovation, the BSETEnergy software is also used to establish the model, and the energy consumption is simulated. *(Fig.5.39)*

It can be seen from the data that after the transformation, the energy required for heating needs of the Dang Yard is 76 kWh/m^2·y, and the energy required for cooling needs is 11 kWh/m^2·y. Compared with before the update, the energy required for heating was reduced by

139 kWh/m^2·y. *(Fig.5.40)*

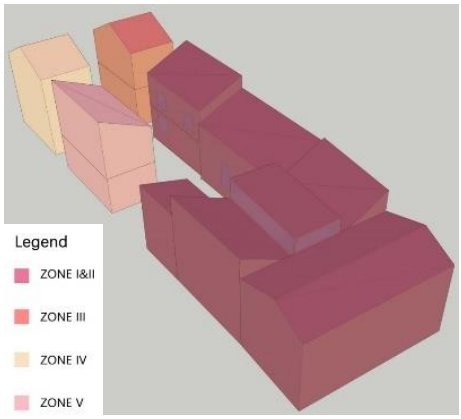
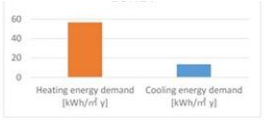


Fig. 5.39 Thermal zone after design
(Elaboration by author)

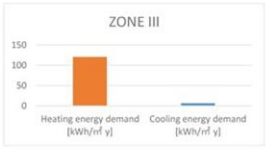
Through the comparison of the simulation of the environment inside the Dang Yard, it can be seen that the insulation performance of the building has been significantly improved, and the heating energy consumption of the building has been greatly reduced. In the design, it can be combined with ground source heat pump technology and solar photovoltaic panels to supply energy to it, so that the thermal environment performance of the Dang Yard can meet the needs of modern life. At the same time, spontaneous heating behaviors such as braziers are reduced to prevent from damaging wooden structures. The lighting environment of the building has been improved significantly in public areas. The interior of the room has improved the lighting inside the building due to the reflective panels at the opening of the sash. Skylights or bright tiles can be used in further designs to improve daylighting from the roof structure. Through the opening of windows and the increase of door panels in the room, the improvement of the wind environment in the living room has been strengthened. In a further design, it can be combined with the sash of the roof for ventilation.

It can be seen that through the improvement and optimization of materials and structures in construction techniques, it has a very positive effect on the improvement of environmental performance in buildings. Through the integration of modern technology and traditional technology, the performance of the building can be improved and the use of traditional houses can be continued while preserving the integrity of the architectural style. By optimizing the construction skills of traditional houses, on the other hand, the protection and development of traditional construction skills are protected, so that residents recognize traditional crafts, traditional culture, and traditional houses, and then continue the traditional features in the construction of new houses.

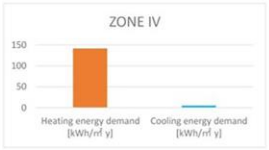
Thermal Zone7	4797090	440407	53.6		
Thermal Zone12	1188980	112029	20.6		
Thermal Zone13	1686440	441727	20.6	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	17176690	4104233	302.8	56.7261889	13.55427015



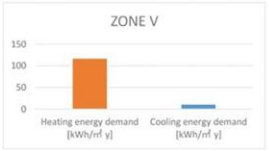
ZONE III	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone17	2040120	54379.7	18.6		
Thermal Zone10	2447040	196534	18.6	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	4487160	250913.7	37.2	120.6225806	6.744991935



ZONE IV	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone15	5486850	188350	38.8		
				Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	5486850	188350	38.8	141.4136598	4.854381443



ZONE V	Sum(Heating/Wh)	Sum(Cooling/Wh)	Area/㎡		
Thermal Zone14	2021740	109587	20.9		
Thermal Zone16	2842980	322974	20.9	Heating energy demand [kWh/㎡ y]	Cooling energy demand [kWh/㎡ y]
Total	4864720	432561	41.8	116.3808612	10.34834928
TOTAL	32015420	4976057.7	420.6	76.11844983	11.83085521



	W	KW
max heating peak load [W]	15135.31	15.13531
max cooling peak load [W]	9728.572	9.728572

Fig. 5.40 Energy consumption of Dang Yard after design
(Elaboration by author)

5.4.4. Consumption of Total Energy

(1) Energy Demand Estimation

①Heating and Cooling Load Calculation---Ground-Source Heat Pump Project

Through the calculation in the previous step, it can be seen that it is also necessary to provide heating and cooling to the traditional dwelling. In this design, the ground source heat pump(GSHP) is used to solve the above problems.

First of all, because the backyard area is limited, so horizontal loops was selected, and after mainly compared the efficiency parameter, TRILOGY&TRANQUILITY packaged system comparison 20（TS）was selected, the detailed parameters are shown below.*(Fig.5.41)*

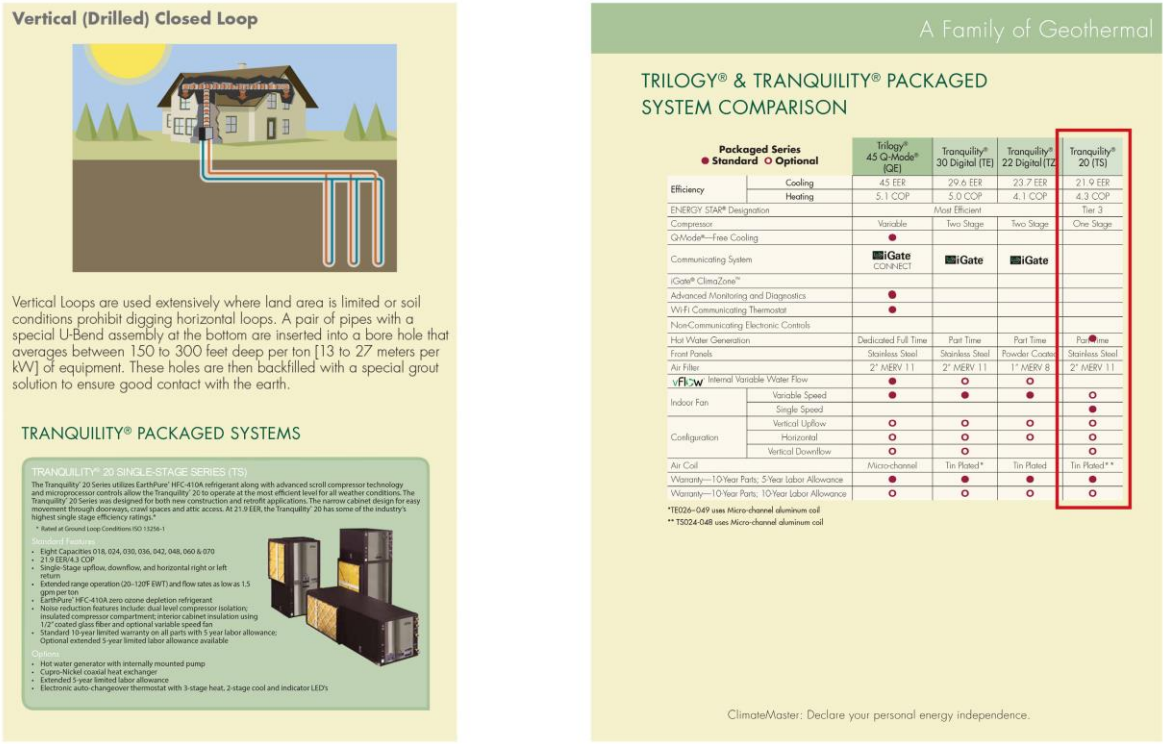
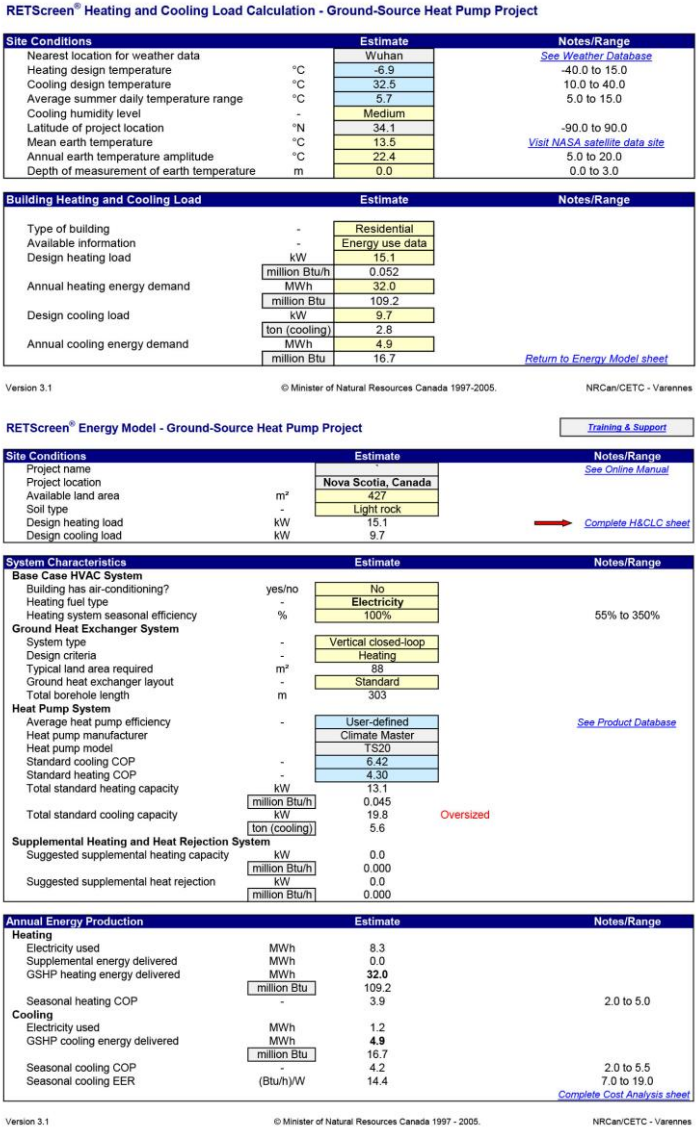


Fig.5.41 The selected GSHP
(Source: www.Climate Master.com)

Based on the parameters and the energy demands shown in Fig.5.40, the electricity used for heating is 8.3 MWh and the electricity used for cooling is 1.2 MWh by using the RETScreen Energy Model. *(Fig.5.42)*



RETScreen® Heating and Cooling Load Calculation - Ground-Source Heat Pump Project

Site Conditions		Estimate	Notes/Range
Nearest location for weather data		Wuhan	See Weather Database
Heating design temperature	°C	-6.9	-40.0 to 15.0
Cooling design temperature	°C	32.5	10.0 to 40.0
Average summer daily temperature range	°C	5.7	5.0 to 15.0
Cooling humidity level	-	Medium	
Latitude of project location	°N	34.1	-90.0 to 90.0
Mean earth temperature	°C	13.5	Visit NASA satellite data site
Annual earth temperature amplitude	°C	22.4	5.0 to 20.0
Depth of measurement of earth temperature	m	0.0	0.0 to 3.0

Building Heating and Cooling Load		Estimate	Notes/Range
Type of building	-	Residential	
Available information	-	Energy use data	
Design heating load	kW	15.1	
	million Btu/h	0.052	
Annual heating energy demand	MWh	32.0	
	million Btu	109.2	
Design cooling load	kW	9.7	
	ton (cooling)	2.8	
Annual cooling energy demand	MWh	4.9	
	million Btu	16.7	Return to Energy Model sheet

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RETScreen® Energy Model - Ground-Source Heat Pump Project Training & Support

Site Conditions		Estimate		Notes/Range
Project name				See Online Manual
Project location		Nova Scotia, Canada		
Available land area	m²	427		
Soil type	-	Light rock		
Design heating load	kW	15.1		Complete H&CLC sheet
Design cooling load	kW	9.7		
System Characteristics		**Estimate**		**Notes/Range**
Base Case HVAC System				
Building has air-conditioning?	yes/no	No		
Heating fuel type	-	Electricity		
Heating system seasonal efficiency	%	100%		55% to 350%
Ground Heat Exchanger System				
System type	-	Vertical closed-loop		
Design criteria	-	Heating		
Typical land area required	m²	88		
Ground heat exchanger layout	-	Standard		
Total borehole length	m	303		
Heat Pump System				
Average heat pump efficiency	-	User-defined		See Product Database
Heat pump manufacturer		Climate Master		
Heat pump model		TS20		
Standard cooling COP	-	6.42		
Standard heating COP	-	4.30		
Total standard heating capacity	kW	13.1		
	million Btu/h	0.045		
Total standard cooling capacity	kW	19.8	Oversized	
	ton (cooling)	5.6		
Supplemental Heating and Heat Rejection System				
Suggested supplemental heating capacity	kW	0.0		
	million Btu/h	0.000		
Suggested supplemental heat rejection	kW	0.0		
	million Btu/h	0.000		

Annual Energy Production		Estimate	Notes/Range
Heating			
Electricity used	MWh	8.3	
Supplemental energy delivered	MWh	0.0	
GSHP heating energy delivered	MWh	**32.0**	
	million Btu	109.2	
Seasonal heating COP	-	3.9	2.0 to 5.0
Cooling			
Electricity used	MWh	1.2	
GSHP cooling energy delivered	MWh	**4.9**	
	million Btu	16.7	
Seasonal cooling COP	-	4.2	2.0 to 5.5
Seasonal cooling EER	(Btu/h)/W	14.4	7.0 to 19.0
			Complete Cost Analysis sheet

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Fig.5.42 Annual energy production of GSHP
(Elaboration the author)

②Artificial Lighting and Equipment

The first three parts of the building is used for commercial, the rest two parts are used for residential, the total commercial area is 217.64 m^2, the total residential area is 159.18 m^2. *(Fig.5.43)*

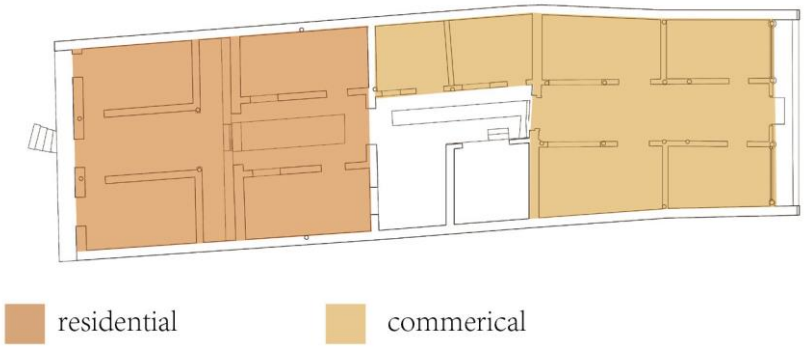


Fig.5.43 Building Usage
(Elaboration by author)

Best Practices (European Standards)		
	kWh/m²year	kWh/m²year
Building type	Lighting	Equip./appliances
Residential	3	15
Commercial	15	20

Fig.5.44 Standards for the electricity demand
(Source: lecture from Rajendra. S. Adhikari, 2018)

According to the standards *(Fig.5.44)*, it can be calculated that the total electricity demand for artificial lighting and equipment is 10482 kWh/y, i.e. 10.482MWh/y. *(Fig.5.45)*

ELECTRICITY CONSUMPTION		
	kWh /year	kWh /year
Building type	Lighting	Equip./appliances
Residential	477.54	2387.7
Commercial	3264.6	4352.8

Fig.5.45 Electricity demand for artificial lighting and equipment
(Elaboration by author)

③DHW & SHW

According to the formula, we could know that the daily energy demand for 14 person(there were three families of 14 person living in) is 112839650J, i.e.0.031 MWh which means it needs 0.031 MWh electricity to meet the need of the hot water. *(Fig.5.46)*

For residential buildings, (T_w = 45 °C), The demand for domestic hot water ranging from 35 l/person (low comfort) to 50 l/person (average comfort) to 75 l / person (high comfort)

The energy requirements are estimated based on the number of users and the per capita water consumption.

The data required for this assessment are:

number of persons (P);
daily consumption per person (Cg = 50 l /person);
water inlet temperature (T_m: 10 °C);
temperature of the water use (T_w: 45 °C).

The daily energy demand = [J]

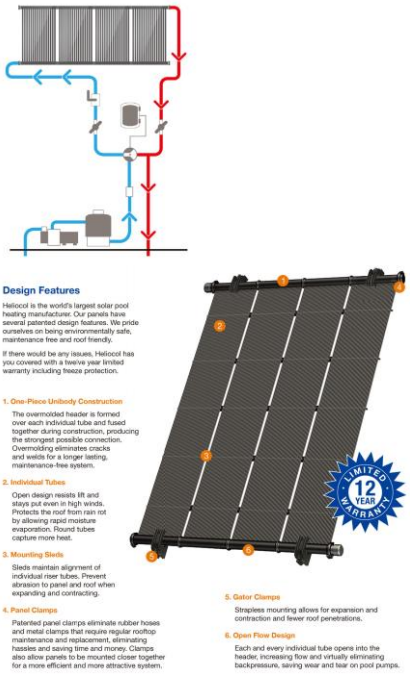
$$L = (T_w - T_m) \times P \times Cg \times \rho \times C_p * 1.1$$

Where ρ is the density of water 1 kg/l
C_p is the specific heat of water 4187 J/kg °C

Fig.5.46 Electricity demand for hot water in residential building
(Source: lecture from Rajendra. S. Adhikari, 2018)

In order to provide hot water for the building, several equipment are compared, finally, we selected the HC-30 solar pool heating collector from Heliocol, the world's largest solar pool heating manufacturer. *(Fig.5.47)*

By using the RETScreen Energy Model, we could conclude that one collector could meet the need of hot water. *(Fig.5.48)*



Design Features

Heliocol is the world's largest solar pool heating manufacturer. Our panels have several patented design features. We pride ourselves on being environmentally safe, maintenance free and roof friendly.

If there would be any issues, Heliocol has you covered with a twelve year limited warranty including freeze protection.

1. One-Piece Unibody Construction

The overmolded header is formed over each individual tube and fused together during construction, producing the strongest possible connection. Overmolding eliminates cracks and welds for a longer lasting, maintenance-free system.

2. Individual Tubes

Open design resists lift and stays put even in high winds. Protects the roof from rain rot by allowing rapid moisture evaporation. Round tubes capture more heat.

3. Mounting Sleds

Sleds maintain alignment of individual riser tubes. Prevent abrasion to panel and roof when expanding and contracting.

4. Panel Clamps

Patented panel clamps eliminate rubber hoses and metal clamps that require regular rooftop maintenance and replacement, eliminating hassles and saving time and money. Clamps also allow panels to be mounted closer together for a more efficient and more attractive system.

5. Gator Clamps

Strapless mounting allows for expansion and contraction and fewer roof penetrations.

6. Open Flow Design

Each and every individual tube opens into the header, increasing flow and virtually eliminating backpressure, saving wear and tear on pool pumps.

Collector Data

Collector Model	HC-50	HC-40	HC-38	HC-30
Size, Nominal	4' x 12.5'	4' x 10.5'	4' x 9.5'	4' x 8'
Width	46.56"	46.56"	46.56"	46.56"
Length	151.44"	127.00"	114.84"	91.00"
Aperture Area	48.32 sq ft	40.68 sq ft	36.68 sq ft	29.15 sq ft
Manifold Diameter	2"	2"	2"	2"
Dry Weight	22 lbs	19 lbs	18 lbs	15 lbs
Volume Capacity	3.7 gal	3.1 gal	2.8 gal	2.4 gal
Working Pressure	90 psi	90 psi	90 psi	90 psi
Burst Pressure	270 psi	270 psi	270 psi	270 psi
Typical Flow	5 - 7 gpm	4 - 6 gpm	3 - 5 gpm	3 - 4.4 gpm

HC-30 **Solar Insolation**

Category T(°F)		2,000 BTU/ft²	1,500 BTU/ft²	1,000 BTU/ft²
Water Temp. Minus Air Temp.	A (-9)	61.22	46.64	34.98
	B (+9)	29.15	17.49	5.83
	C (+36)	2.92	0	0
	D (+90)	0	0	0

Thousands of BTU's per day per panel

Fig.5.47 HC-30 solar pool heating collector
(Source: www. Heliocol.com)

RETScreen® Energy Model - Solar Water Heating Project | Training & Support

Site Conditions		Estimate	Notes/Range
Project name		bath	See Online Manual
Project location		wuhan	
Nearest location for weather data		Wuhan	Complete SR&HL sheet
Annual solar radiation (tilted surface)	MWh/m²	1.18	
Annual average temperature	°C	16.3	-20.0 to 30.0
Annual average wind speed	m/s	1.9	
Desired load temperature	°C	27	
Number of months analysed	month	3.50	
Energy demand for months analysed	MWh	0.73	

System Characteristics		Estimate	Notes/Range
Application type		Swimming pool (outdoor)	
Base Case Water Heating System			
Heating fuel type	-	Electricity	
Water heating system seasonal efficiency	%	250%	50% to 190%
Solar Collector			
Collector type	-	Evacuated	See Technical Note 1
Solar water heating collector manufacturer		Heliocol	See Product Database
Solar water heating collector model		HC-30	
Gross area of one collector	m²	2.73	1.00 to 5.00
Aperture area of one collector	m²	2.70	1.00 to 5.00
Fr (tau alpha) coefficient	-	0.85	0.40 to 0.80
Fr UL coefficient	(W/m²)/°C	11.56	0.30 to 3.00
Temperature coefficient for Fr UL	(W/(m·°C)²)	0.00	0.000 to 0.010
Suggested number of collectors		2	
Number of collectors		1	
Total gross collector area	m²	2.7	
Balance of System			
Heat exchanger/antifreeze protection	yes/no	Yes	
Heat exchanger effectiveness	%	85%	50% to 85%
Suggested pipe diameter	mm	31	8 to 25 or PVC 35 to 50
Pipe diameter	mm	50	8 to 25 or PVC 35 to 50
Pumping power per collector area	W/m²	0	3 to 22, or 0
Piping and solar tank losses	%	1%	1% to 10%
Losses due to snow and/or dirt	%	3%	2% to 10%
Horz. dist. from mech. room to collector	m	5	5 to 20
# of floors from mech. room to collector	-	2	0 to 20

Annual Energy Production (3.50 months analysed)		Estimate	Notes/Range
SWH system capacity	kW_{th}	2	
	MWth	0.002	
Pumping energy (electricity)	MWh	**0.00**	
Specific yield	kWh/m²	37	
System efficiency	%	8%	
Solar fraction	%	14%	
Renewable energy delivered	MWh	**0.10**	
	kWh	101	
			Complete Cost Analysis sheet

Fig. 5.48 Electricity demand for hot water in residential building
(Elaboration by author)

(2) Final Energy Consumption

Total energy consumption is the sum of electricity demand of heating and cooling, lighting and equipments, DHW. *(Fig.5.49)*

Total energy consumption=D(heating&cooling)+D(DHW)+
D(lighting &equipments)
=8.3+1.2+0.031+10.482MWh
=20.013MWh

Fig.5.49 Total energy consumption
(Elaboration by author based on lecture from Rajendra. S. Adhikari, 2018)

(3) Renewable Energy Plants-Solar PV

The plan area is 193.07m2, the roof area is larger than 193.07m2. To meet the total demand for total electricity, it needs 154.9m2, PV array area. Almost all the roofs are be used. *(Fig.5.50-5.51)*

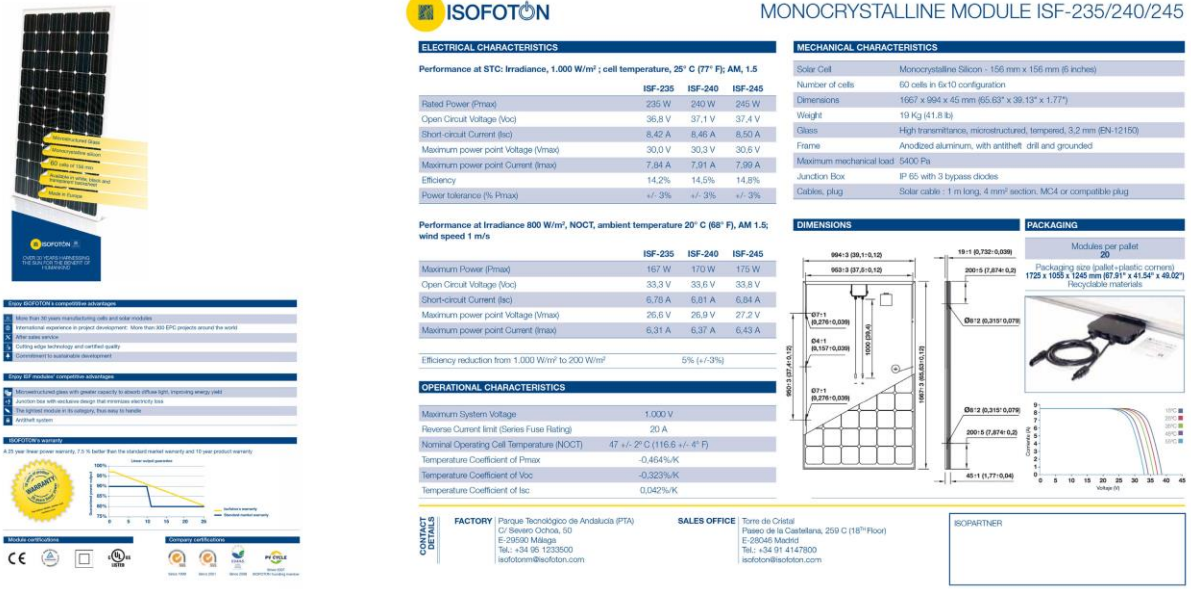
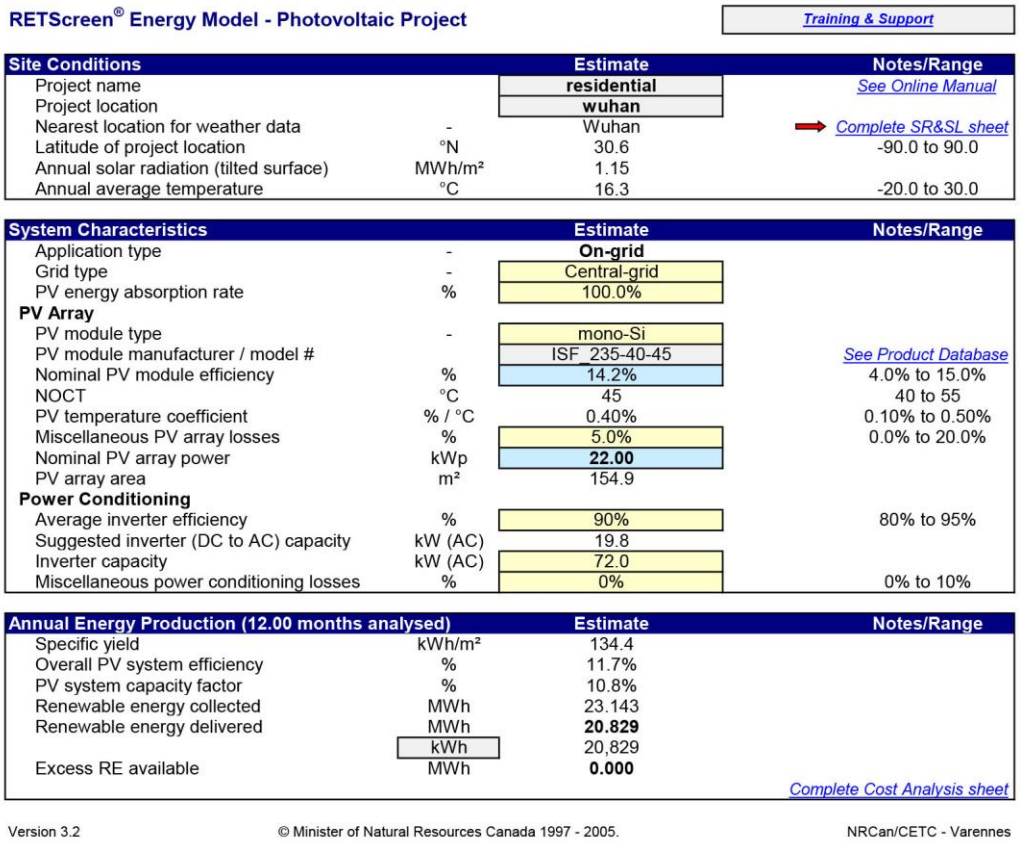


Fig.5.50 Parameters of Solar PV
(Source: www.isopotion.com)



RETScreen® Energy Model - Photovoltaic Project

Training & Support

Site Conditions		Estimate	Notes/Range
Project name		residential	See Online Manual
Project location		wuhan	
Nearest location for weather data	-	Wuhan	Complete SR&SL sheet
Latitude of project location	°N	30.6	-90.0 to 90.0
Annual solar radiation (tilted surface)	MWh/m²	1.15	
Annual average temperature	°C	16.3	-20.0 to 30.0

System Characteristics		Estimate	Notes/Range
Application type	-	On-grid	
Grid type	-	Central-grid	
PV energy absorption rate	%	100.0%	
PV Array			
PV module type	-	mono-Si	
PV module manufacturer / model #		ISF_235-40-45	See Product Database
Nominal PV module efficiency	%	14.2%	4.0% to 15.0%
NOCT	°C	45	40 to 55
PV temperature coefficient	% / °C	0.40%	0.10% to 0.50%
Miscellaneous PV array losses	%	5.0%	0.0% to 20.0%
Nominal PV array power	kWp	22.00	
PV array area	m²	154.9	
Power Conditioning			
Average inverter efficiency	%	90%	80% to 95%
Suggested inverter (DC to AC) capacity	kW (AC)	19.8	
Inverter capacity	kW (AC)	72.0	
Miscellaneous power conditioning losses	%	0%	0% to 10%

Annual Energy Production (12.00 months analysed)		Estimate	Notes/Range
Specific yield	kWh/m²	134.4	
Overall PV system efficiency	%	11.7%	
PV system capacity factor	%	10.8%	
Renewable energy collected	MWh	23.143	
Renewable energy delivered	MWh	20.829	
	kWh	20,829	
Excess RE available	MWh	0.000	
			Complete Cost Analysis sheet

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Fig.5.51 Photovoltaic project
(Elaboration by author)

But from architecture point of view, for now, products we could find on the market is not suitable, for the appearances and color is really different from the original roof which is a conflicting to restoration.

(4) Net Building Energy Consumption

Net building energy consumption is the difference change of Total energy consumption and renewable energy. The net building energy consumption is 0.916MWh as shown. *(Fig. 5.52)*

Total energy consumption=D(heating&cooling)+D(DHW)+
D(lighting &equipments)
=8.3+1.2+0.031+10.482MWh
=20.013MWh

renewable energy=De (SHW)+De(PV)
=0.10+20.829MWh
=20.929MWh

Net building energy consumption=20.013-20.929=-0.916MWh

Fig.5.52 Net building energy consumption
(Elaboration by author based on lecture from Rajendra. S. Adhikari, 2018)

(4) Total Greenhouse Gases

By using the RETScreen Energy Model, the greenhouse gases emission could be calculated.
The greenhouse gases emission reduction for SWH is 0.03 t_{co2}/yr. *(Fig. 5.54)*
The greenhouse gases emission reduction for PV is 15.45 t_{co2}/yr. *(Fig. 5.55)*
The greenhouse gases emission reduction for GSHP is 17.45 t_{co2}/yr. *(Fig. 5.56)*
The total greenhouse gases emission reduction is the sum of the above three which is 32.93 t_{co2}/yr. *(Fig. 5.53)*

Total greenhouses gases emission reduction=
R(SWH) + R(PV) +R(GSHP)
=0.03+15.45+17.45
=32.93 tCO2/yr

Fig.5.53 Total greenhouse gases emission reduction
(Elaboration by author based on lecture from Rajendra. S. Adhikari, 2018)

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Solar Water Heating Project

Use GHG analysis sheet? Yes Type of analysis: Standard

Background Information

Project Information

Project name	bath
Project location	wuhan

Global Warming Potential of GHG

1 tonne CH_4 =	21	tonnes CO_2	(IPCC 1996)
1 tonne N_2O =	310	tonnes CO_2	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Natural gas	5.5%	56.1	0.0030	0.0010	45.0%	8.0%	0.491
Coal	68.6%	94.6	0.0020	0.0030	35.0%		0.983
#6 oil	7.6%	77.4	0.0030	0.0020	30.0%		0.937
Large hydro	18.3%	0.0	0.0000	0.0000	100.0%		0.000
Electricity mix	100%	212.5	0.0051	0.0065		0.4%	0.773

Base Case Heating System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Electricity	100.0%	212.5	0.0051	0.0065	250.0%	0.309

Proposed Case Heating System (Solar Water Heating Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Electricity	0.0%	212.5	0.0051	0.0065	100.0%	0.000
Solar	100.0%	0.0	0.0000	0.0000	100.0%	0.000
Heating energy mix	100.0%	0.0	0.0000	0.0000		0.000

GHG Emission Reduction Summary

	Base case GHG emission factor (t_{CO2}/MWh)	Proposed case GHG emission factor (t_{CO2}/MWh)	End-use annual energy delivered (MWh)	Annual GHG emission reduction (t_{CO2})
Heating system	0.309	0.000	0.10	0.03
			Net GHG emission reduction t_{CO2}/yr	**0.03**

Complete Financial Summary sheet

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Fig.5.54 Greenhouse gases emission reduction analysis-solar water heating project (Elaboration by author)

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Photovoltaic Project

Use GHG analysis sheet? Yes Type of analysis: Standard

Background Information

Project Information

Project name	residential
Project location	wuhan

Global Warming Potential of GHG

1 tonne CH_4 =	21	tonnes CO_2	(IPCC 1996)
1 tonne N_2O =	310	tonnes CO_2	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Natural gas	5.5%	56.1	0.0030	0.0010	45.0%	8.0%	0.491
Coal	68.6%	94.6	0.0020	0.0030	35.0%		0.983
#6 oil	7.6%	77.4	0.0030	0.0020	30.0%		0.937
Large hydro	18.3%	0.0	0.0000	0.0000	100.0%		0.000
Electricity mix	100.0%	212.5	0.0051	0.0065		0.4%	0.773

Proposed Case Electricity System (Photovoltaic Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Electricity system							
Solar	100.0%	0.0	0.0000	0.0000	100.0%	4.0%	0.000

GHG Emission Reduction Summary

	Base case GHG emission factor (t_{CO2}/MWh)	Proposed case GHG emission factor (t_{CO2}/MWh)	End-use annual energy delivered (MWh)		Annual GHG emission reduction (t_{CO2})
Electricity system	0.773	0.000	19.996		15.45
			Net GHG emission reduction	t_{CO2}/yr	**15.45**

Complete Financial Summary sheet

Version 3.2 UNEP/DTIE and NRCan/CETC - Varennes

Fig.5.55 Greenhouse gases emission reduction analysis-photovoltaic project
(Elaboration by author)

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Ground-Source Heat Pump Project

Use GHG analysis sheet? Yes Type of analysis: Standard

Background Information

Project Information		Global Warming Potential of GHG		
Project name		1 tonne CH_4 =	21 tonnes CO_2	(IPCC 1996)
Project location	Nova Scotia, Canada	1 tonne N_2O =	310 tonnes CO_2	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Natural gas	5.5%	56.1	0.0030	0.0010	45.0%	8.0%	0.491
Coal	68.6%	94.6	0.0020	0.0030	35.0%		0.983
#6 oil	7.6%	77.4	0.0030	0.0020	30.0%		0.937
Large hydro	18.3%	0.0	0.0000	0.0000	100.0%		0.000
Electricity mix	100%	212.5	0.0051	0.0065		0.4%	0.773

Base Case Heating and Cooling System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Electricity	100.0%	212.5	0.0051	0.0065	100.0%	0.773

Proposed Case Heating and Cooling System (Ground-Source Heat Pump Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Electricity	100.0%	212.5	0.0051	0.0065	387.7%	0.199
Cooling system						
Electricity	100.0%	212.5	0.0051	0.0065	421.0%	0.183

GHG Emission Reduction Summary

	Base case GHG emission factor (t_{CO2}/MWh)	Proposed case GHG emission factor (t_{CO2}/MWh)	End-use annual energy delivered (MWh)		Annual GHG emission reduction (t_{CO2})
Heating system	0.773	0.199	32.0		18.35
Cooling system	0.000	0.183	4.9		-0.90
			Net GHG emission reduction	t_{CO2}/yr	**17.45**

Complete Financial Summary sheet

Version 3.1 © United Nations Environment Programme & Minister of Natural Resources Canada 2000 - 2005. UNEP/DTIE and NRCan/CETC - Varennes

Fig.5.56 Greenhouse gases emission reduction analysis-ground-source heat pump project (Elaboration by author)

06

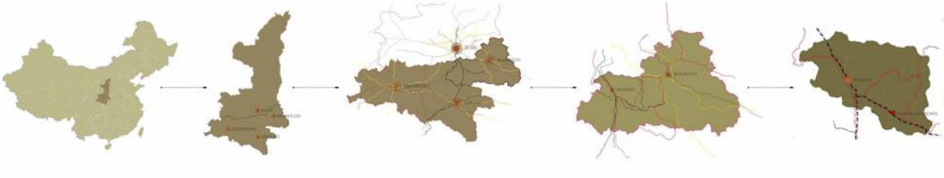
Attachment

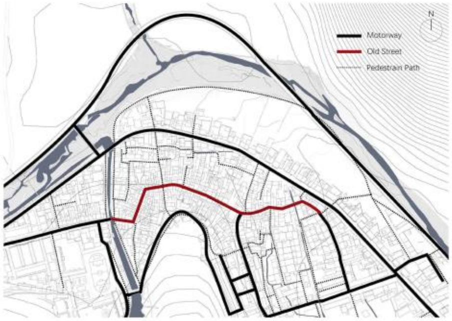
6.1 Plates

6.2 Model Photos

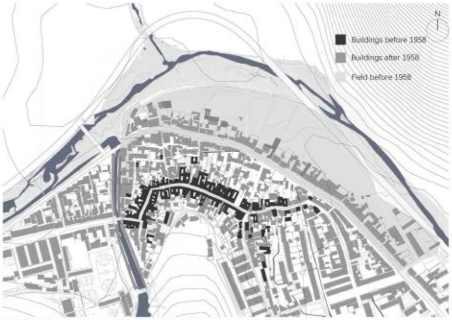
6 Attachment

6.1 Plates

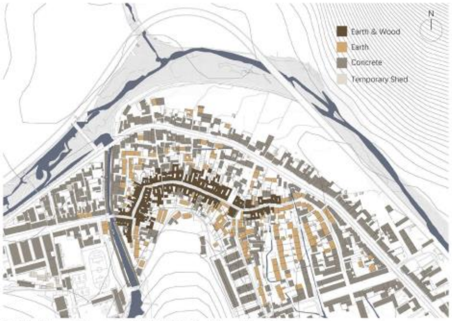




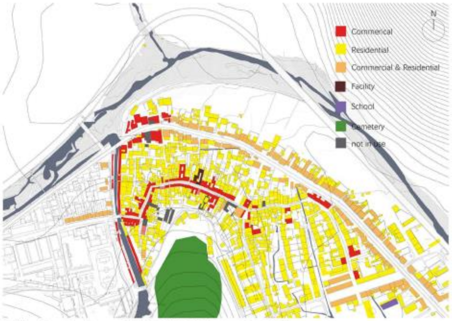
Network (Source: POLIMI-XAUAT Workshop, May 2018)



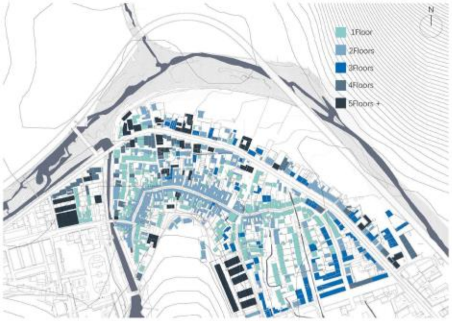
Building History (Source: POLIMI-XAUAT Workshop, May 2018)



Building Material (Source: POLIMI-XAUAT Workshop, May 2018)



Building Function (Source: POLIMI-XAUAT Workshop, May 2018)



Building Floor (Source: POLIMI-XAUAT Workshop, May 2018)

Greenery (Source: POLIMI-XAUAT Workshop, May 2018)

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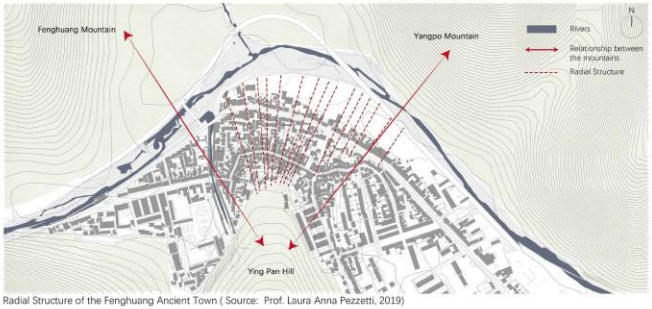
THE CASE OF DANG YARD
Overall Understanding of Fenghuang Ancient Town

Final Delivery: 06/07/2020

01



Radial Structure of the Fenghuang Ancient Town (Source: Prof. Laura Anna Pezzetti, 2019)

Element of the Radial Structure--Traditional Dwellings (Source: Prof. Laura Anna Pezzetti, 2019)

Element of the Radial Structure--The Old Wall (Source: Prof. Laura Anna Pezzetti, 2019)

Element of the Radial Structure--The Yard (Source: Prof. Laura Anna Pezzetti, 2019)

1957-drawing (source: Gao Lin, 2008)

1958-photo (source: Fenghuang Old Town Tourism Development and Construction Management Committee)

1958-photo (source: Fenghuang Old Town Tourism Development and Construction Management Committee)

2019-photo (source: POLIMI-XAUAT Workshop, May 2018)

Development of Fenghuang Ancient Town

View A

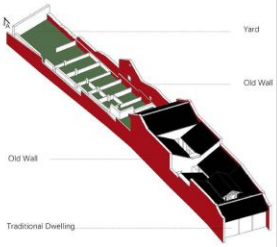


Diagram of the Three Elements
(Source: Prof. Laura Anna Pezzetti, 2019)

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THE CASE OF DANG YARD

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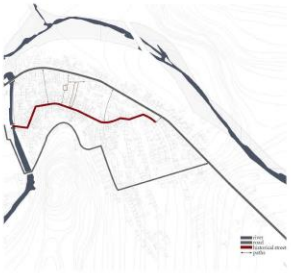
Radial Structure and Main Elements

02

SITUATION

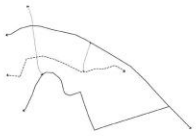
Behavior :
---a pattern of "business infront and live behind"
---few residents live in the ancient dwellings
---the backyard is abandoned



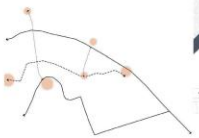
Accessibility:
---two main streets, one is new and one is ancient
---the ancient one is mostly visited
---the accessibility between the two streets is weak
---some "paths" have potential to guide

Greenery:
---the backyard and open spaces have an impact on each other
---influence the surrondings in a horizontal direction
---connect the two streets in a vertical direction

STRATEGY



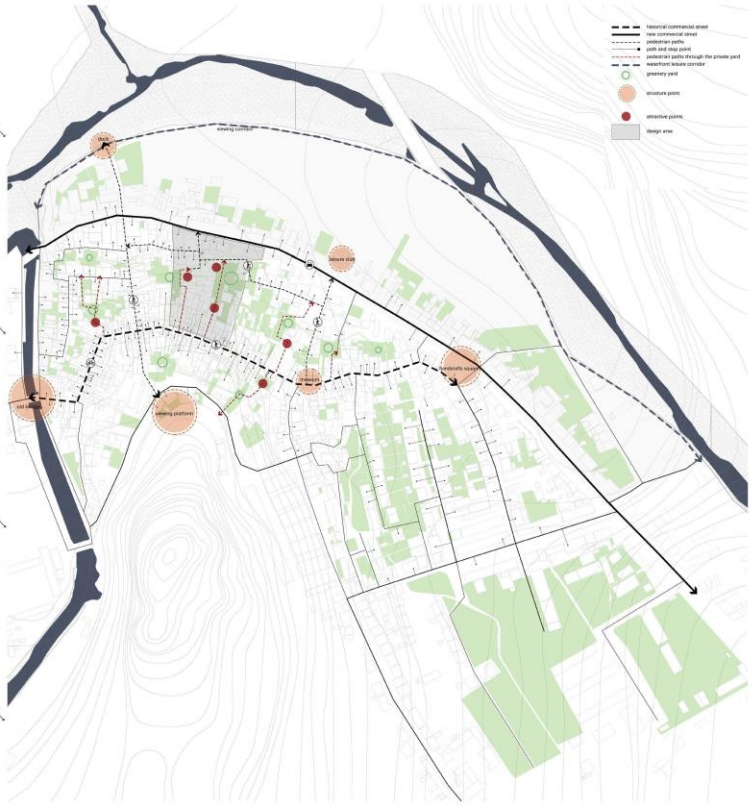
IMPROVE CONNECTION
---break the unachievable of two streets
---guide people to the new street to active the whole town



ENHANCE MAIN POINTS
---the yards are the value for the ancient town
---make use of the wasted yards
---active in order to let people to find the hinden value

DEVELOPE THE SECONDARY SYSTEM
---connect two streets by the new paths
---through the yards.
---yards can be used well

TRANSFORM HISTORICAL DWELLINGS TO ATTRACTIVE POINTS
---Find the potential traditional dwellings
---transform into some attractive points
---effective the secondary road system




SITUATION
pedestrain network
building use
open space
event/activity
STRATEGY
pedestrain network
building use
open space
event/activity
dock
leisure club
museum
viewing platform
historical commercial street
new commercial street
existing pedestrian paths
area boundary
2nd pedestrian
3th pedestrain
supporting buildings
homestay hotel
heritage building
added buildings
greenery in area
swimming pool
greenary
activity points
greenery yard
structure point
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AEROPHOTO

INFRASTRUCTURE NETWORK

NORTH STREET FACADE

ROOF BOUNDARY

MAT

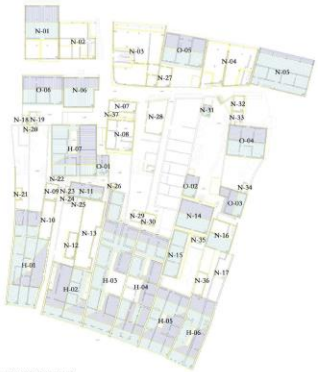
FLOOR

BUILDING AGE

SOUTH STREET FACADE

FUNCTION

GREENARY



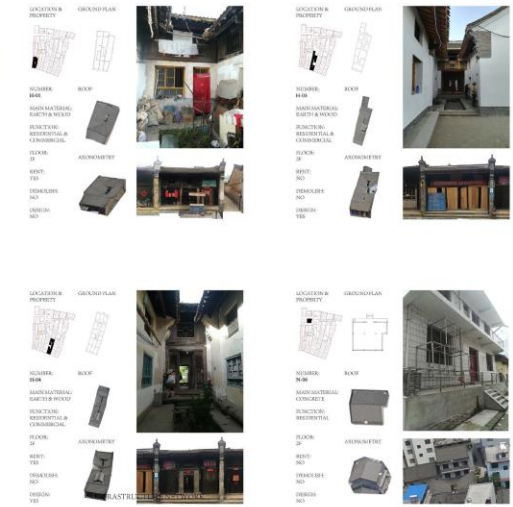
CLASSIFICATION NUMBER

H-buildings which were built during Ming&Qing Dynasty with traditional material

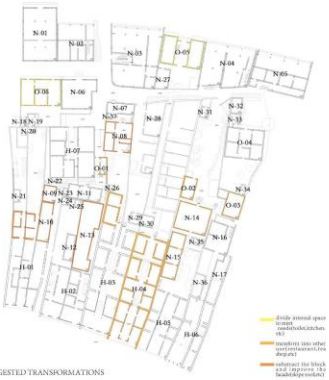
O-buildings which were built after Ming&Qing Dynasty with traditional material

N-buildings which were built with new materials and structure

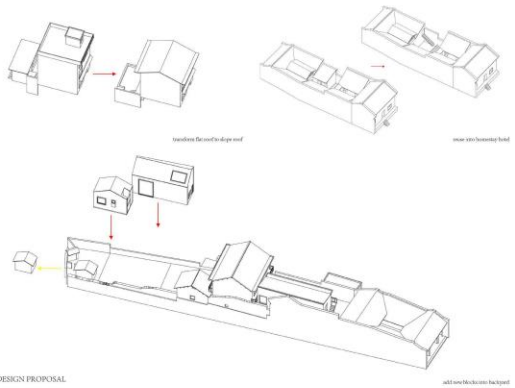
EVELUATION CONCLUSION



BUILDING INFORMATION



SUGGESTED TRANSFORMATIONS



REDESIGN PROPOSAL

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THE CASE OF DANG YARD

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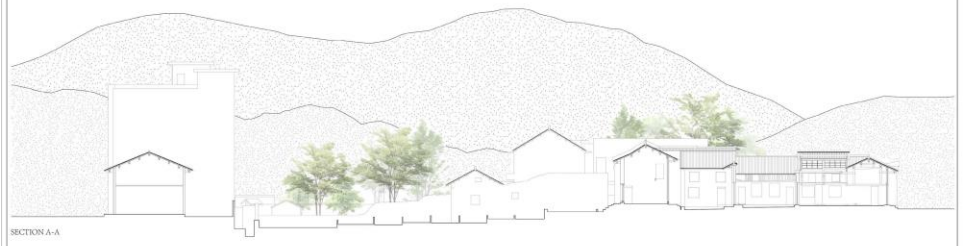
Scale 1:400
Typology Study on Buildings

07



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THE CASE OF DANG YARD

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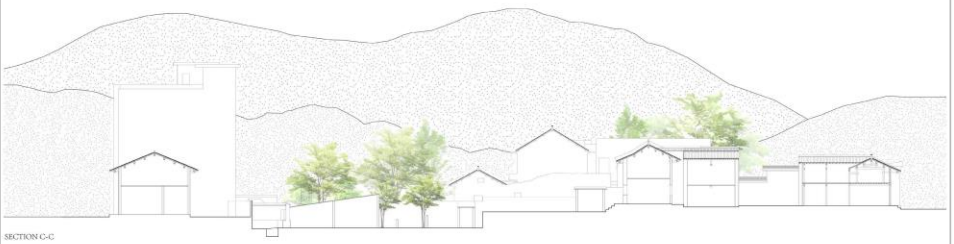
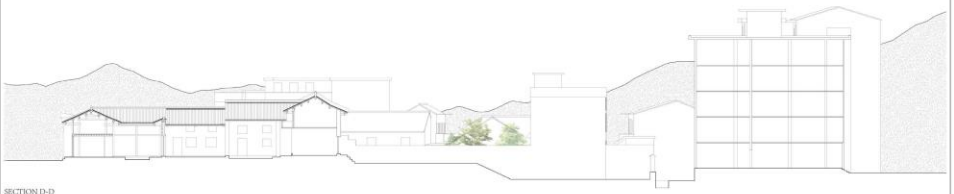
Scale 1:200
Fundamental Features of the Area

08

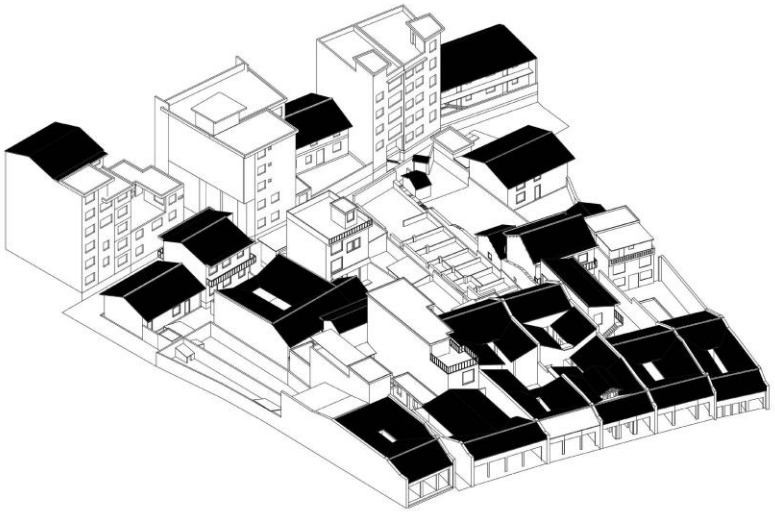
SECTION B-B



SECTION C-C



SECTION D-D



AXONOMETRY

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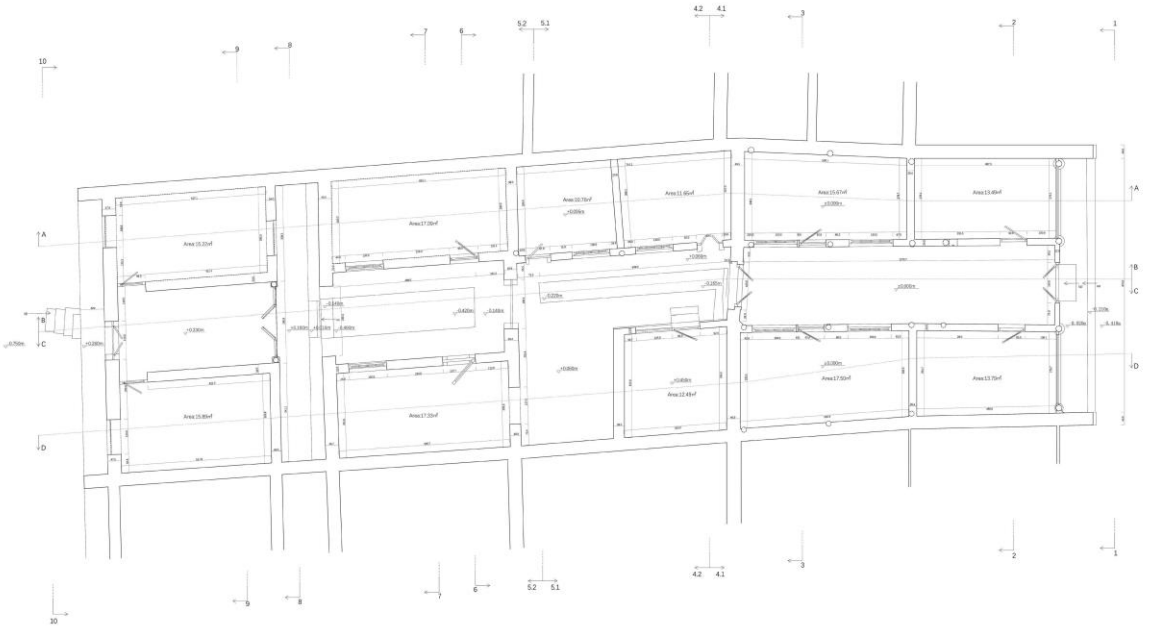
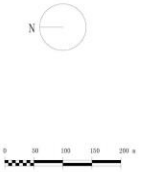
09



GROUND FLOOR PLAN 1:50

LOCATION

CUTTING HEIGHT



LEGEND

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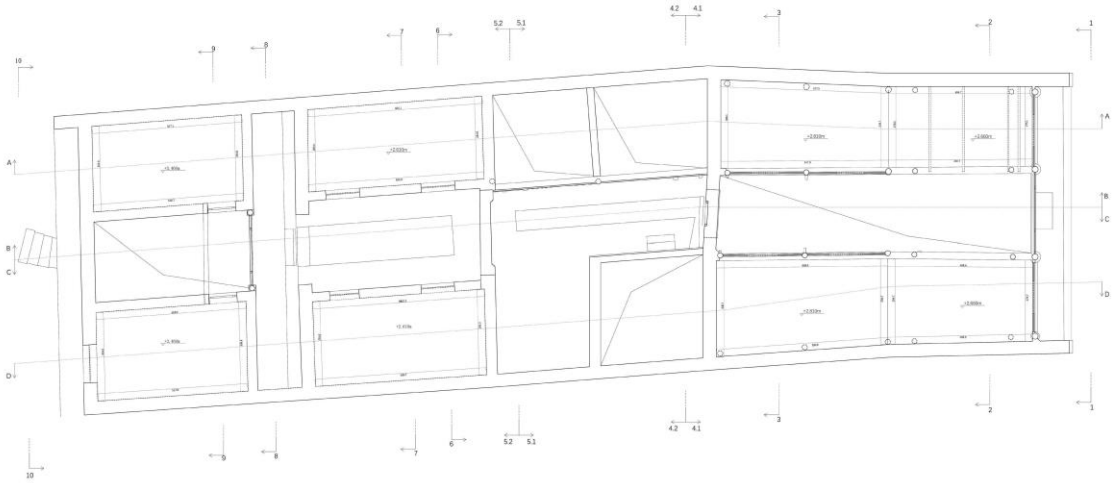
NOT MEASURED



1ST FLOOR PLAN 1:50

LOCATION

CUTTING HEIGHT

LEGEND

NOT MEASURED

NOT MEASURED

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THE CASE OF DANG YARD

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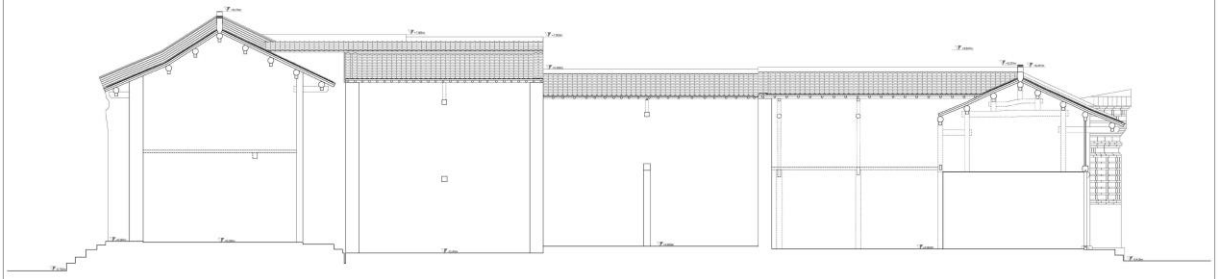
Scale 1:50
Conservation of Dang Yard Building

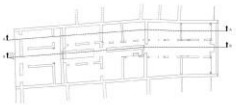
11



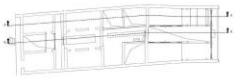
LONGITUDE SECTION A-A 1:50

LONGITUDE SECTION B-B 1:50

GROUND FLOOR SECTION LINE



1ST FLOOR SECTION LINE



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NOT MEASURED

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THE CASE OF DANG YARD

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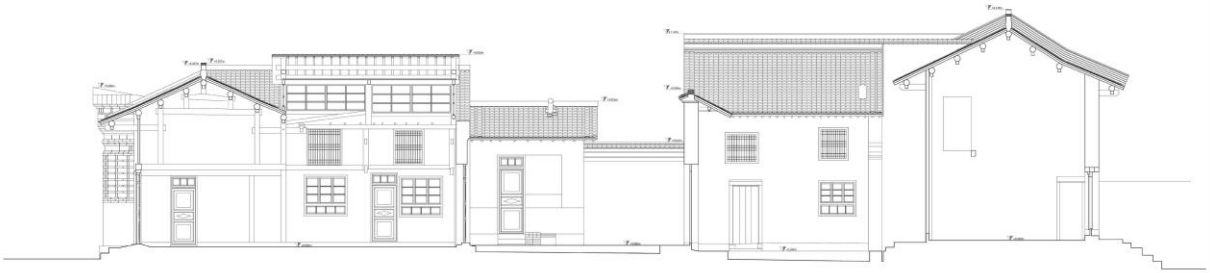
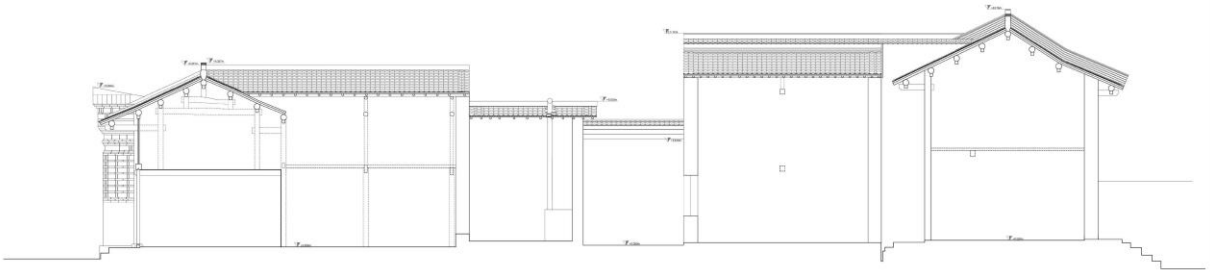
Scale 1:50
Conservation of Dang Yard Building

12

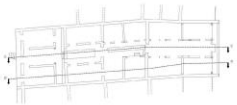


LONGITUDE SECTION C-C 1:50

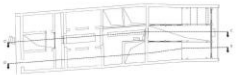


LONGITUDE SECTION D-D 1:50

GROUND FLOOR SECTION LINE



1ST FLOOR SECTION LINE



LEGEND

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NOT MEASURED

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THE CASE OF DANG YARD

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Scale 1:50
Conservation of Dang Yard Building

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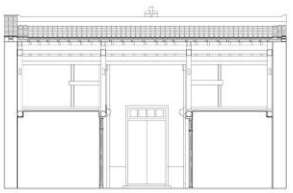
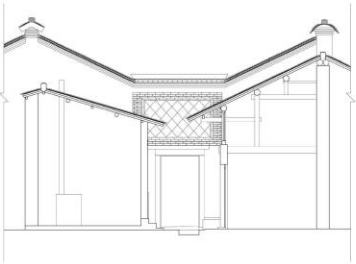
TRANSVERSAL SECTION 1-1 1:50



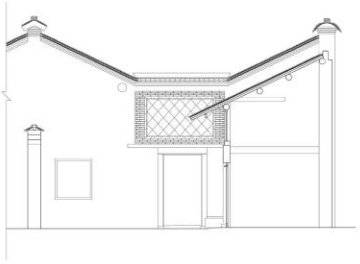
TRANSVERSAL SECTION 2-2 1:50

TRANSVERSAL SECTION 3-3 1:50



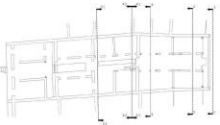
TRANSVERSAL SECTION 4.1-4.1 1:50

TRANSVERSAL SECTION 4.2-4.2 1:50



TRANSVERSAL SECTION 5.1-5.1 1:50

GROUND FLOOR SECTION LINE



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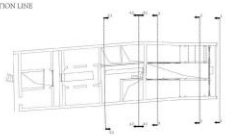

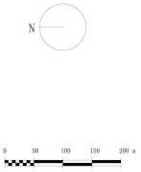

LEGEND

NOT MEASURED

NOT MEASURED

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Conservation of Dang Yard Building

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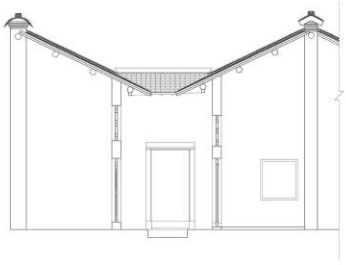
TRANSVERSAL SECTION 5-5 1:50



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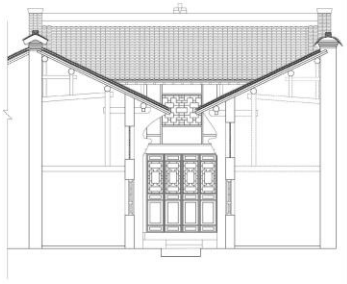

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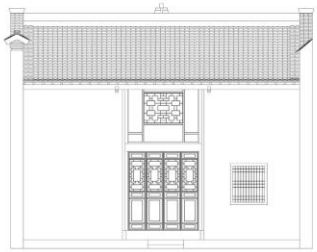

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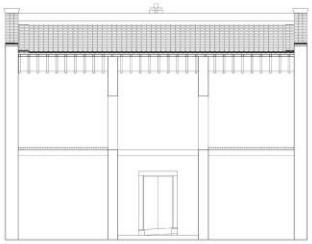

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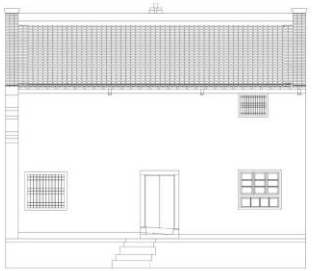
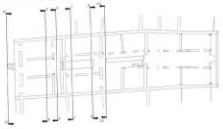
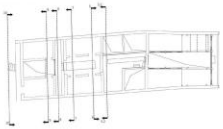


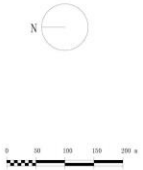
TRANSVERSAL SECTION 10-10 1:50

GROUND FLOOR SECTION LINE



1ST FLOOR SECTION LINE





LEGEND

NOT MEASURED

NOT MEASURED

POLITECNICO MILANO 1863

ARCHITECTURE DESIGN STUDIO
D.A.A 2018/19

GROUP
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CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:50
Conservation of Dang Yard Building

15

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THE CASE OF DANG YARD

Demolish and Design of the Ground Floor

Final Delivery: 06/07/2020
Scale 1:200

16

MASTERPLAN

SECTION

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THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:200
Integration of the Area

17

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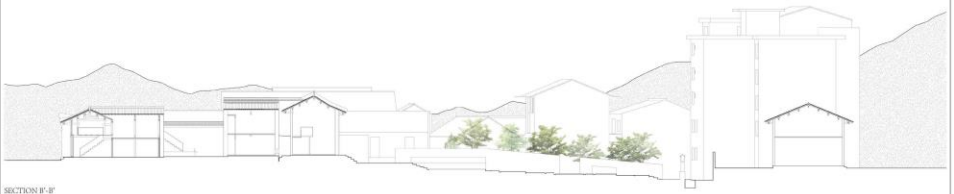
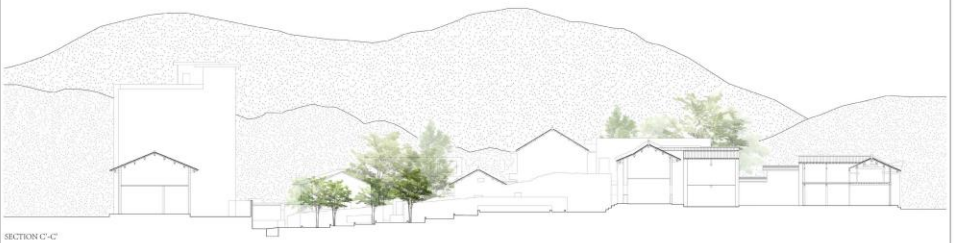
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:200
Overwriting the Area

18

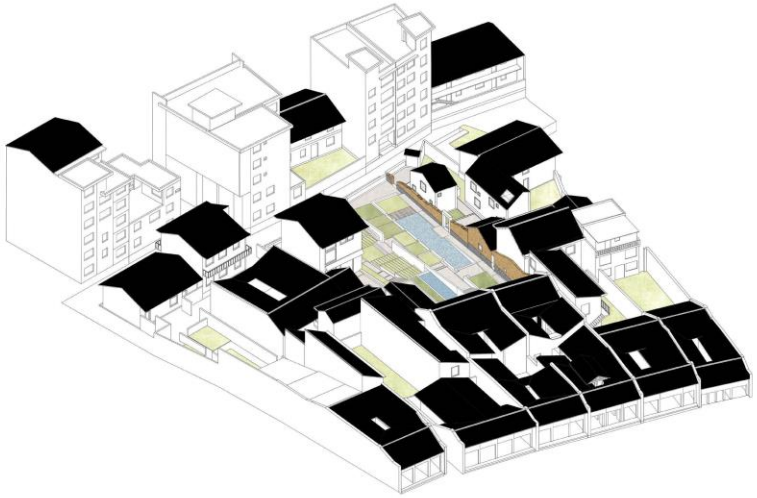


SECTION B'-B'



SECTION C'-C'

SECTION D'-D'



AXONOMETRY

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THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:200
Overwriting the Area

19

PHOTO 1:50

MATERIAL 1:50

Object | Clay1 (deep layer of clay,usually covered by a plaster, used for wall inside the house) | Clay2 (used to build the main wall of the house, it was not covered by plaster) | Wood-Door | Wood-Window | Wood-board | Wood-Cover of pillar&beam | Wood-Inside pillar&beam | Glass | Concrete | Masonry | Stone | Plaster

DECAY 1:50

Object

Crack
Individual fissure, clearly visible by the naked eye, resulting from separation of one part from another.

Blistering
Separated, air-filled, raised hemispherical elevations on the face of stone resulting from the detachment of an outer stone layer. This detachment is not related to the stone structure.

Disintegration
Detachment of single grains or aggregates of grains.

Alveoliazation-Caving
Formation, on the stone surface, of cavities (alveoles) which may be interconnected and may have variable shapes and sizes (generally centimetric, sometimes metric).
Sub-type:
Coving : erosion feature consisting in a single alveole developing from the edge of the stone block.

Missing Part
Empty space, obviously located in the place of some formerly existing stone part. Protruding and particularly exposed parts of sculptures (nose, fingers...) are typical locations for material loss resulting in missing parts.

Discoloration
Change of the stone colour in one to three of the colour parameters : hue, value and chroma

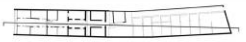
Efflorescence
Generally whitish, powdery or whisker-like crystals on the surface. Efflorescences are generally poorly cohesive and commonly made of soluble salt crystals.

Graffiti
Engraving, scratching, cutting or application of paint, ink or similar matter on the stone surface.

Patina
Chromatic modification of the material, generally resulting from natural or artificial ageing and not involving in most cases visible surface deterioration.

Soiling
Deposit of a very thin layer of exogenous particles (eg. soot) giving a dirty appearance to the stone sur- face.

Plant
Vegetal living being, having, when complete, root, stem, and leaves, though consisting sometimes only of a single leafy expansion (e.g. Tree, fern, herb).



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CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:50
Decay of Dang Yard Building

21

PHOTO 1:50

SECTION A-A

SECTION B-B

SECTION C-C

MATERIAL 1:50

SECTION A-A

SECTION B-B

SECTION C-C

Object | Clay1 (deep layer of clay,usually covered by a plaster, used for wall inside the house) | Clay2 (used to build the main wall of the house, it was not covered by plaster) | Wood-Door | Wood-Window | Wood-board | Wood-Cover of pillar&beam | Wood-Inside pillar&beam | Glass | Concrete | Masonry | Stone | Plaster

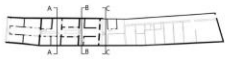
DECAY 1:50

SECTION A-A

SECTION B-B

SECTION C-C

Crack | Blistering | Disintegration | Alveolization-Caving | Missing Part | Discoloration | Efflorescence | Graffiti | Patina | Soiling | Plant



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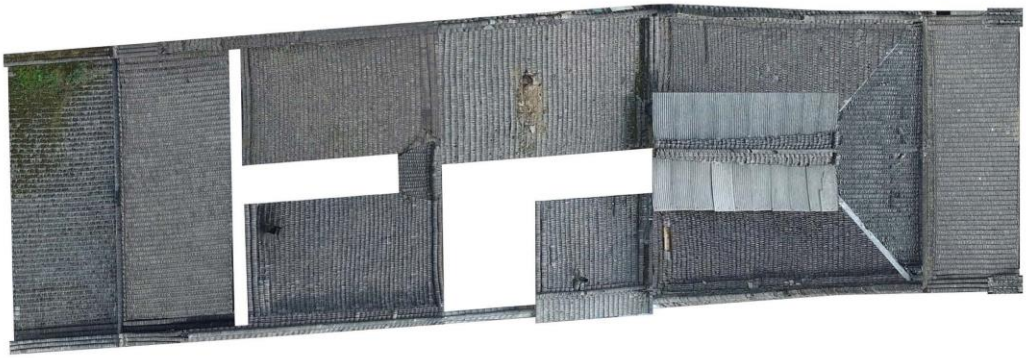
CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:50
Decay of Dang Yard Building

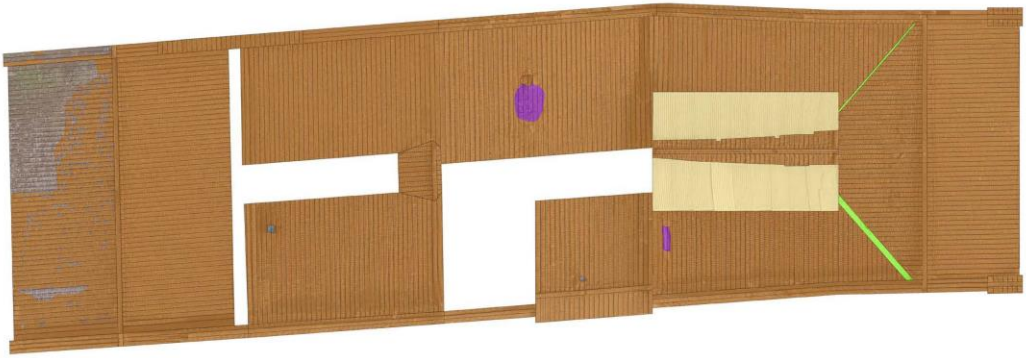
22

PHOTO 1:50



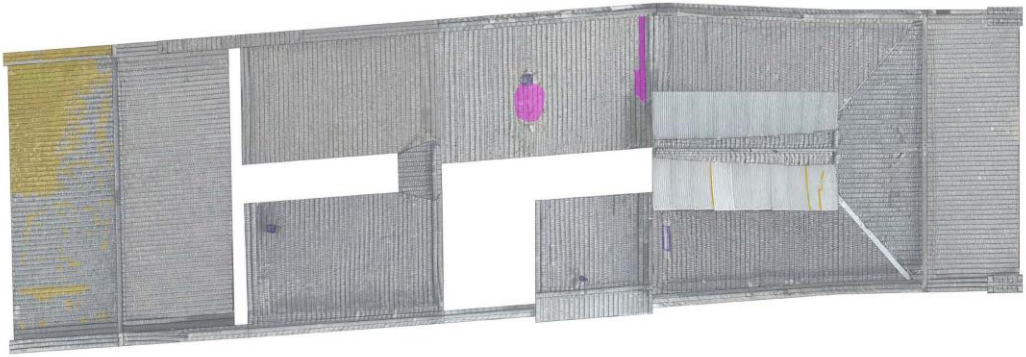
MATERIAL 1:50

- Object
- Fired Clay
- Steel Plate
- Clay2



DECAY 1:50

- Soiling
- Crack
- Plant/Moss

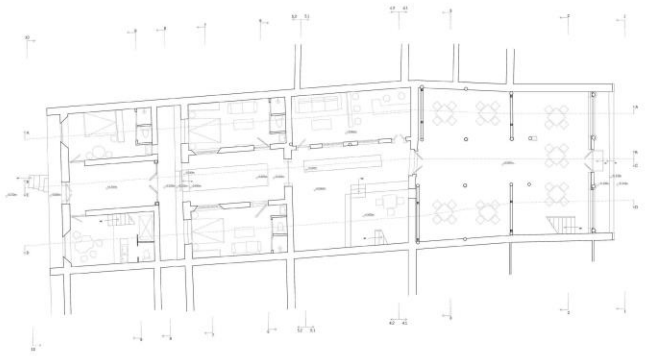


POLITECNICO MILANO 1863 | ARCHITECTURE DESIGN STUDIO D.A.A.2018/19 | GROUP WU XUI ZHAO JIAYING

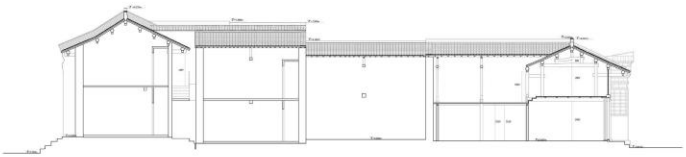
CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:50
Decay of Dang Yard Building

23

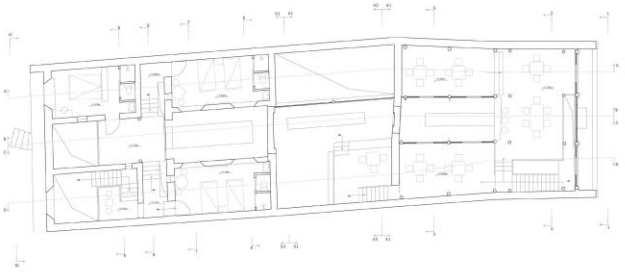


GROUND FLOOR PLAN 1:100

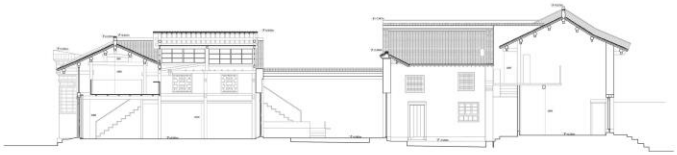


LONGITUDE SECTION A-A 1:100

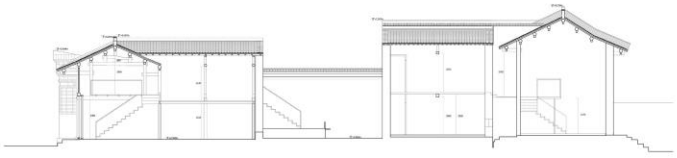
LONGITUDE SECTION B-B 1:100



1ST FLOOR SECTION 1:100

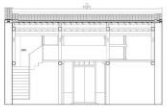


LONGITUDE SECTION C-C 1:100



LONGITUDE SECTION D-D 1:100

TRANSVERSAL SECTION 1-1 1:100

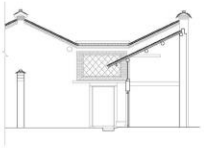


TRANSVERSAL SECTION 2-2 1:100

TRANSVERSAL SECTION 3-3 1:100

TRANSVERSAL SECTION 4.1-4.1 1:100

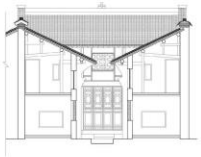
TRANSVERSAL SECTION 4.2-4.2 1:100



TRANSVERSAL SECTION 5.1-5.1 1:100

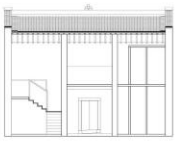
TRANSVERSAL SECTION 5.2-5.2 1:100

TRANSVERSAL SECTION 6-6 1:100

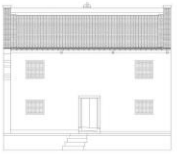


TRANSVERSAL SECTION 7-7 1:100

TRANSVERSAL SECTION 8-8 1:100



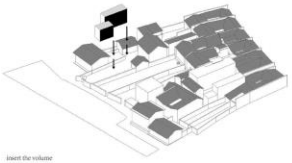
TRANSVERSAL SECTION 9-9 1:100



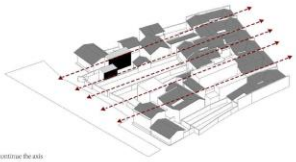
TRANSVERSAL SECTION 10-10 1:100

MASTERPLAN 1:100

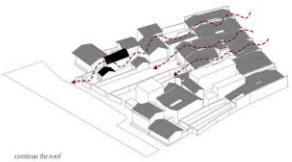
active the backyard



insert the volume



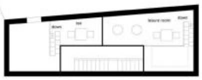
continue the axis



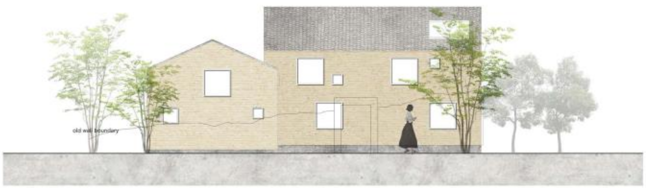
continue the roof

GROUND PLAN 1:100

1ST FLOOR PLAN 1:100



2ND FLOOR PLAN 1:100



FACADE 1:100

ARCHITECTURE DESIGN STUDIO
D-A.A 2018/19

POLITECNICO MILANO 1863

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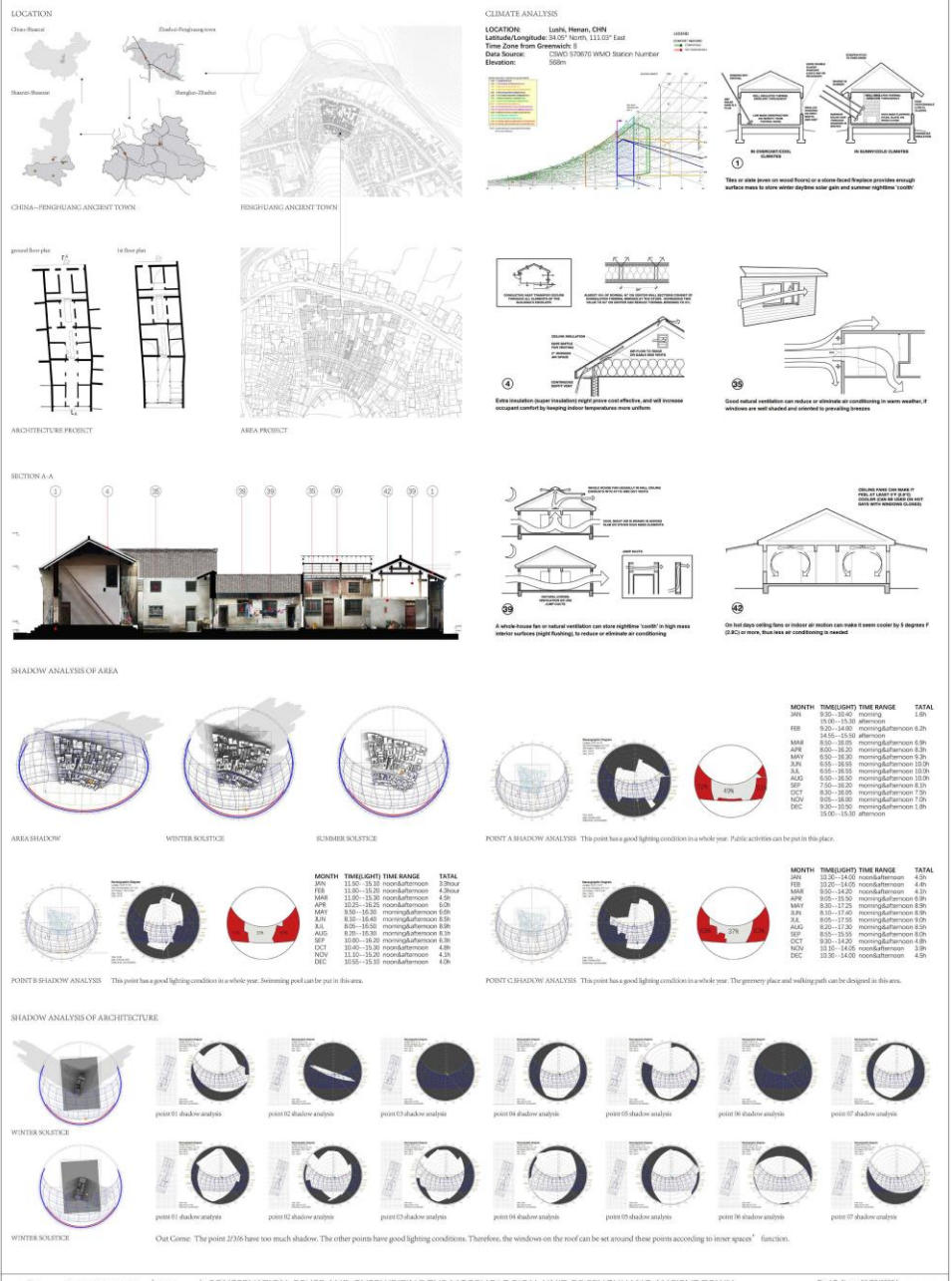
CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:100
Insertion of New Volunm

29


LOCATION
CHINA--FENGHUANG ANCIENT TOWN
FENGHUANG ANCIENT TOWN
ARCHITECTURE PROJECT
AREA PROJECT
CLIMATE ANALYSIS
LOCATION: Lushi, Henan, CHN
Latitude/Longitude: 34.05° North, 111.03° East
Time Zone from Greenwich: 8
Data Source: CSWD 578670 WMO Station Number
Elevation: 568m
Tiles or slate (even on wood floors) or a stone-faced fireplace provides enough surface mass to store winter daytime solar gain and summer nighttime 'coolth'
Extra insulation (super insulation) might prove cost effective, and will increase occupant comfort by keeping indoor temperatures more uniform
Good natural ventilation can reduce or eliminate air conditioning in warm weather, if windows are well shaded and oriented to prevailing breezes
SECTION A-A
A whole-house fan or natural ventilation can store nighttime 'coolth' in high mass interior surfaces (night flushing), to reduce or eliminate air conditioning
On hot days ceiling fans or indoor air motion can make it seem cooler by 6 degrees F (3.3C) or more, thus less air conditioning is needed
SHADOW ANALYSIS OF AREA
AREA SHADOW
WINTER SOLSTICE
SUMMER SOLSTICE
POINT A SHADOW ANALYSIS This point has a good lighting condition in a whole year. Public activities can be put in this place.
MONTH TIME(LIGHT) TIME RANGE TATAL
JAN 9.30--10.40 morning 1.6h
15.00--15.30 afternoon
FEB 9.20--14.00 morning&afternoon 6.2h
14.55--15.50 afternoon
MAR 8.50--16.05 morning&afternoon 6.9h
APR 8.00--16.20 morning&afternoon 8.3h
MAY 6.50--16.30 morning&afternoon 9.3h
JUN 6.55--16.55 morning&afternoon 10.0h
JUL 6.55--16.55 morning&afternoon 10.0h
AUG 6.50--16.50 morning&afternoon 10.0h
SEP 7.50--16.20 morning&afternoon 8.1h
OCT 8.30--16.05 morning&afternoon 7.5h
NOV 9.05--16.00 morning&afternoon 7.0h
DEC 9.30--15.50 morning&afternoon 1.8h
15.00--15.30 afternoon
POINT B SHADOW ANALYSIS This point has a good lighting condition in a whole year. Swimming pool can be put in this area.
MONTH TIME(LIGHT) TIME RANGE TATAL
JAN 11.50--15.10 noon&afternoon 3.3hour
FEB 11.00--15.20 noon&afternoon 4.3hour
MAR 11.00--15.30 noon&afternoon 4.5h
APR 10.25--16.25 noon&afternoon 6.0h
MAY 9.50--16.30 morning&afternoon 6.6h
JUN 8.10--16.40 morning&afternoon 8.5h
JUL 8.05--16.50 morning&afternoon 8.9h
AUG 8.20--16.30 morning&afternoon 8.1h
SEP 10.00--16.20 morning&afternoon 6.3h
OCT 10.40--15.30 noon&afternoon 4.8h
NOV 11.10--15.20 noon&afternoon 4.2h
DEC 10.55--15.10 noon&afternoon 4.0h
POINT C SHADOW ANALYSIS This point has a good lighting condition in a whole year. The greenery place and walking path can be designed in this area.
MONTH TIME(LIGHT) TIME RANGE TATAL
JAN 10.30--14.00 noon&afternoon 4.5h
FEB 10.20--14.05 noon&afternoon 4.4h
MAR 9.50--14.20 noon&afternoon 4.1h
APR 9.05--15.50 morning&afternoon 6.9h
MAY 8.30--17.25 morning&afternoon 8.9h
JUN 8.10--17.40 morning&afternoon 8.9h
JUL 8.05--17.55 morning&afternoon 9.0h
AUG 8.20--17.30 morning&afternoon 8.5h
SEP 8.55--15.55 morning&afternoon 6.0h
OCT 9.30--14.20 morning&afternoon 4.8h
NOV 10.10--14.05 noon&afternoon 3.9h
DEC 10.30--14.00 noon&afternoon 4.5h
SHADOW ANALYSIS OF ARCHITECTURE
WINTER SOLSTICE
point 01 shadow analysis
point 02 shadow analysis
point 03 shadow analysis
point 04 shadow analysis
point 05 shadow analysis
point 06 shadow analysis
point 07 shadow analysis
WINTER SOLSTICE
Out Come: The point 2/3/6 have too much shadow. The other points have good lighting conditions. Therefore, the windows on the roof can be set around these points according to inner spaces' function.
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D-A.A 2019/19
GROUP
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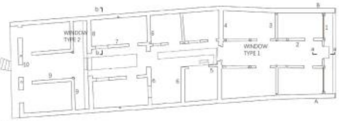
CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD
Final Delivery: 06/07/2020
Climate and Shadow Analysis
30

U-VALUE OF EXISTING BUILDING



THE WALL

	description	thickness(mm)	thermal conductivity(w/mk)	U-value(W/m2k)	
external surface					0.06
Wall	A	440	0.75	1.3	
	B	460	0.75	1.26	
	1	30	0.15	2.63	
	2	240	0.75	2	
	3	264	0.75	1.88	
	4	465	0.75	1.25	
	5	220	0.75	2.11	
	6	380	0.75	1.45	
	7	310	0.75	1.69	
	8	460	0.75	1.26	
	9	340	0.75	1.58	
	10	475	0.75	1.23	
internal surface					0.12

THE ROOF

	description	thickness(mm)	thermal conductivity(w/mk)	U-value(W/m2k)	
layer	tile ceramic	34mm	1	1.67	
	wood board	50mm	0.15		
	wood beam	3.57mm	0.15		

THE FLOOR

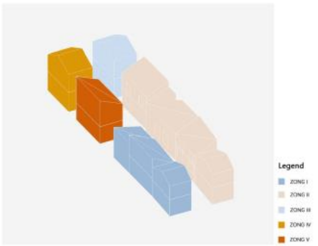
description	thickness(mm)	thermal conductivity(w/mk)	U-value(W/m2k)	area A (m2)	exposed perimeter P(m)
ground floor	20mm水泥砂浆	0.93	1.47	20.9	19.265
floor	wood broad80mm	0.15	1.2		
	5mm wood beam	0.15			
	8.7mm wood long	0.15			

THE WINDOW

type 1	area	conductivity	U value	Af/Aw	
wood frame	0.554	0.15	25.4	38%	
air	0.890	0.0267			

type 2	area	conductivity	U value	Af/Aw	
wood frame	1.117	0.15	4.05	53%	
glass	1.087	0.76			

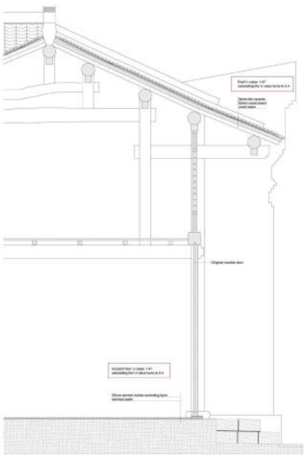
ENERGY DEMAND OF EXISTING BUILDING



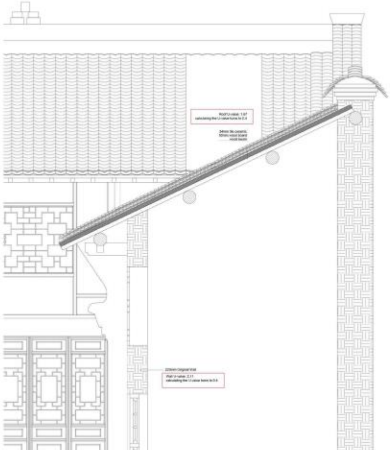
[illegible]

EXISTING ENVELOPT DESIGN DETAILS

SECTION a-a



SECTION b-b



U-VALUE OF BUILDING AFTER TRANSFORMATION

The Wall

原墙面original wall		夯土墙体	
[illegible]Construction adhes	10mm		
[illegible]Fiberglass mesh			
EPS	70mm	0.036	
[illegible]Anchor			
[illegible]Varnishing glue			
[illegible]Fiberglass mesh			
[illegible]Smoothing m	5mm	0.87	
[illegible]Finish paint			

注：计算220earth墙，U值为0.41，目标值小于0.40
P.S. calucalating the 220mm wall, the Uvalue truns to 0.41

description		thickness(mm)	thermal conductivity[w/mk]	U-value[W/m2K]	
external surface					0.00
Wall	A	440 + 80	0.75	0.37	
	B	460+80	0.75	0.36	
	1	30	0.15	2.63	
	6	380+80	0.75	0.38	
	7	310+80	0.75	0.39	
	8	460+80	0.75	0.38	
	9	340+80	0.75	0.39	
	10	475+80	0.75	0.36	
internal surface					0.13

The Ground Floor

description	thickness (mm)	thermal conductivity [w/mk]	U-Value[w/m²k]
素土夯土earth			0.48
水泥砂浆找平Cement mortar	20mm	0.87	
SBS防水层SBS Waterproof layer	4mm	0.23	
[illegible]Insulation	80mm	0.07[illegible]Foam concrete	
[illegible]Floor heating	40mm	1.58[illegible]Crushed concrete	
室内木地板Indoor wooden floor	15mm	0.15	

注：计算得到U值为0.48，目标值小于0.4
P.S. calusulating the Uvalue truns to 0.74

The Floor

description	thickness (mm)	thermal conductivity [w/mk]	U-Value[w/m²k]
[illegible]Stringer	8.7mm	0.15	1.62
横梁beam	9mm	0.15	
OSB板[illegible]OSB Cushion	12mm	0.13	
[illegible]Floor heating	40mm	1.58[illegible]Crushed concrete	
室内木地板Indoor wooden floor	15mm	0.15	

注：计算得到U值1.62，目标值小于0.4
P.S. calusulating the Uvalue truns to 0.86

The Roof

description		thickness (mm)	thermal conductivity [w/mk]	U-Value[w/m²k]
[illegible]	青瓦tile ceramic	34mm	1	0.4
	SBS防水层SBS Waterproof layer	4mm	0.23	
SIPs	OSB板[illegible]OSB Cushion	12mm	0.13	
	XPS[illegible]	60mm	0.03	
	OSB板[illegible]OSB Cushion	12mm	0.13	
	[illegible]wood beam	9.87mm	0.15	
	（[illegible]）(Ceiling interior)			

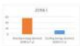
注：计算得到U值为0.4，目标值小于0.4
P.S. calucalating the new roof, the Uvalue truns to 0.4

The Window

new window type 1	U-value	Af/Aw	SHGC	透射率
	2.69	30%	0.84	0.7
new window type 2	U-value	Af/Aw		
	2.9	45%	0.84	0.7

ENERGY DEMAND OF BUILDING AFTER TRANSFORMATION

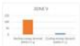
ZONE I	Sum(Heating)[Wh]	Sum(Cooling)[Wh]	Area[m²]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]	Heating energy demand [kWh/m² y]	Cooling energy demand [kWh/m² y]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



ZONE III	Sum(Heating)[Wh]	Sum(Cooling)[Wh]	Area[m²]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]	Heating energy demand [kWh/m² y]	Cooling energy demand [kWh/m² y]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ZONE IV	Sum(Heating)[Wh]	Sum(Cooling)[Wh]	Area[m²]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]		
				Heating energy demand [kWh/m² y]	Cooling energy demand [kWh/m² y]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ZONE V	Sum(Heating)[Wh]	Sum(Cooling)[Wh]	Area[m²]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]		
Thermal Zone[illegible]	[illegible]	[illegible]	[illegible]	Heating energy demand [kWh/m² y]	Cooling energy demand [kWh/m² y]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

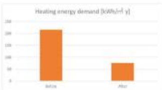


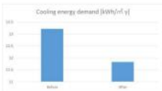
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

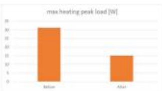
	W	kW
max heating peak load [W]	[illegible]	[illegible]
max cooling peak load [W]	[illegible]	[illegible]

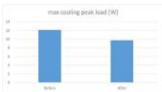
ENERGY DEMAND COMPARISION

	Before	After
Heating energy demand [kWh/m² y]	[illegible]	[illegible]
Cooling energy demand [kWh/m² y]	[illegible]	[illegible]
max heating peak load [W]	[illegible]	[illegible]
max cooling peak load [W]	[illegible]	[illegible]



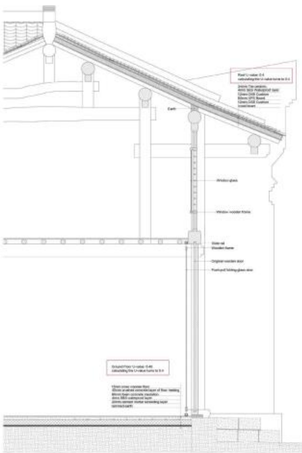




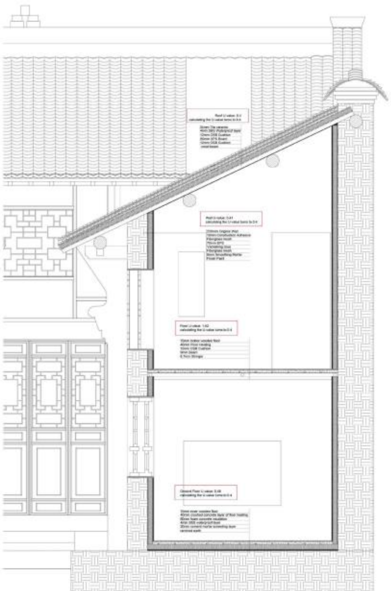


ENVELOPE DESIGN DETAILS AFTER TRANSFORMATION

SECTION a-a

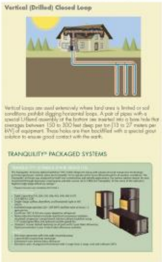


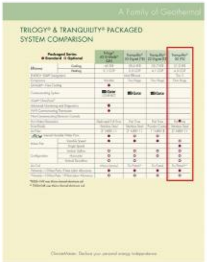
SECTION b-b

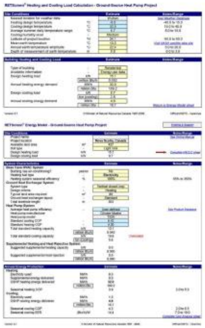


ENERGY DEMAND ESTIMATION

1. HEATING AND COOLING(PUMP)







For building heating and cooling , GHSP is choosen, using the underground of the back yard. the detail data are in former slide. Using the pump , it needs 8.3 MWh electricity for heating and 1.2 MWh electricity for cooling, which can be provided by Solar PV .

2. ARTIFICIAL LIGHTING AND EQUIPMENTS

Best Practices (European Standards)		
	kWh/m²year	kWh/m²year
Building type	Lighting	Equip./appliances
Residential	3	15
Commercial	15	20

The total residential area is 159.18 ㎡

The total commercial area is 217.64 ㎡

ELECTRICITY CONSUMPTION		
	kWh /year	kWh /year
Building type	Lighting	Equip./appliances
Residential	477.54	2387.7
Commercial	3264.6	4352.8

The total electricity demand for artificial lighting and equipement is 10482Kwh,i.e. 10.482MWh.

3.DHW AND SHW

Energy Demand for Hot water in Residential Building

For residential buildings, (T_w = 45 °C). The demand for domestic hot water ranging from 35 l/person (low comfort) to 50 l/person (average comfort) to 75 l / person (high comfort)

The energy requirements are estimated based on the number of users and the per capita water consumption.

The data required for this assessment are:

number of persons (P);
daily consumption per person (Cg = 50 l /person);
water inlet temperature (T_{in}: 10 °C);
temperature of the water use (T_w: 45 °C).

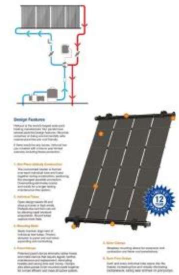
The daily energy demand = [J]

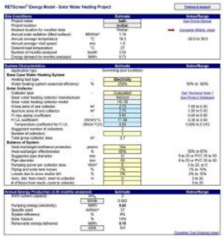
$$L = (T_w - T_{in}) \times P \times Cg \times \rho \times C_p * 1.1$$

Where ρ is the density of water 1 kg/l
C_p is the specific heat of water 4187 J/kg °C

According to the formula, the daily energy demand is 112839650J,i.e. 0.031Mwh.

It means that it needs 0.031Mwh electricity to meet the need of the hot water.

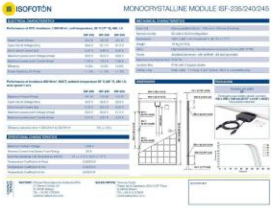


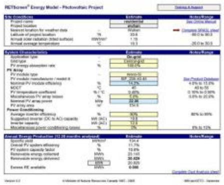


One collector could meet the need of hot water.
But the appearance of the collector is much too different from the original roof which would have a negative influence from the architecture point of view.

FINAL ENERGY CONSUMPTION

Total energy consumption=D(heating&cooling)+D(DHW)+D(lighting &equipments)
=8.3+1.2+0.031+10.482MWh
=20.013MWh





RENEWABLE ENERGY PLANTS-SOLAR PV

The plan area is 193.07 ㎡ ,the roof area is larger than 193.07 ㎡ . To meet the total demand for electricity(heating and cooling, lighting and equipment) ,it needs 154.9 ㎡ PV array area. Almost all the roofs are be used.
But from architecture point of view , for now ,products we could find on the market is not suitable . For the appearances and color is really different from the original roof which is a conflicting to restoration.

NET BUILDING ENERGY CONSUMPTION

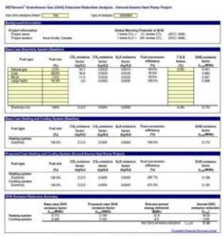
Total energy consumption=D(heating&cooling)+D(DHW)+D(lighting &equipments)
=8.3+1.2+0.031+10.482MWh
=20.013MWh

renewable energy=De (SHW)+De(PV)
=0.10+20.829MWh
=20.929MWh

Net building energy consumption=20.013-20.929=-0.916MWh

The Greenhouses gases emission reduction for SWH is 0.03

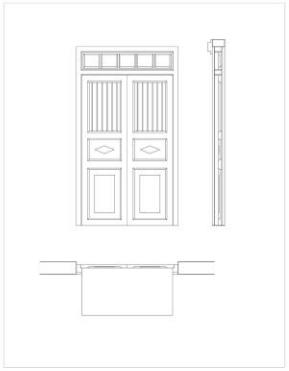
The Greenhouses gases emission reduction for PV is 15.45



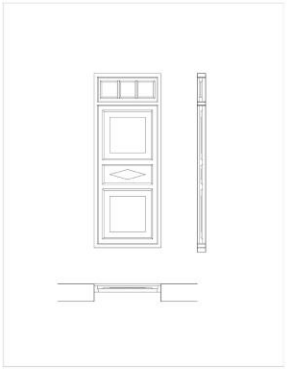
The Greenhouses gases emission reduction for GSHP is 17.45

TOTAL GREENHOUSES GASES EMISSION REDUCTION

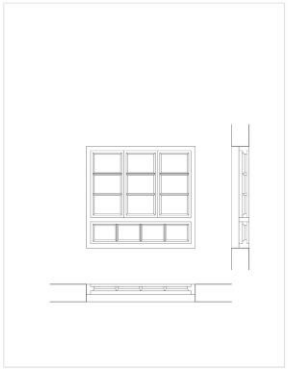
Total greenhouses gases emission reduction=
R(SWH) + R(PV) +R(GSHP)
=0.03+15.45+17.45
=32.93 tCO2/yr



ELEMENT 1-1 1:20



ELEMENT 1-1-R1/L1 2-1-R2/L2 1:20



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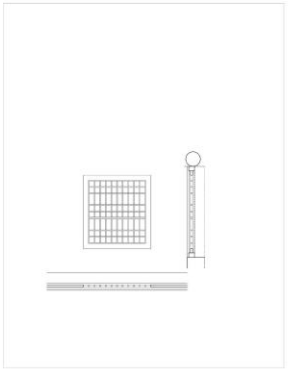

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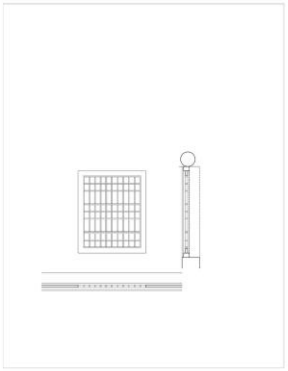
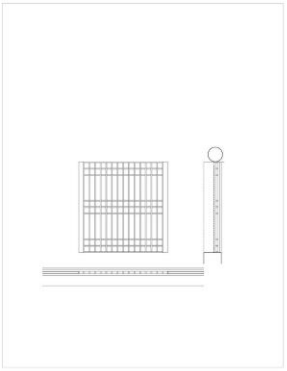
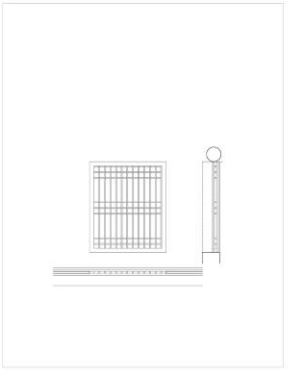


ELEMENT 2-2-R2 1:20

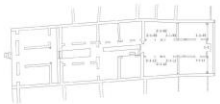


ELEMENT 2-2-L1 1:20



ELEMENT 2-2-L2 1:20

GROUND FLOOR ELEMENTS LOCATION



1ST FLOOR ELEMENTS LOCATION

SECTION B-B CUTTING HEIGHT

SECTION C-C CUTTING HEIGHT

LEGEND

NOT MEASURED

NOT MEASURED

POLITECNICO MILANO 1863

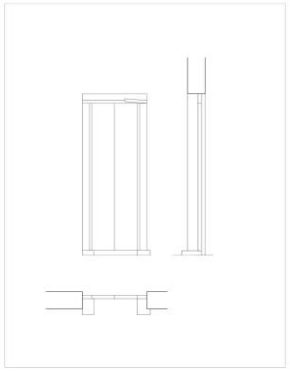
ARCHITECTURE DESIGN STUDIO
D.A.A 2018/19

GROUP
WU RUI
ZHAO JIAWING

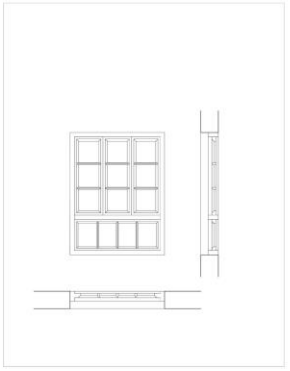
CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:50
Conservation of Dang Yard Building

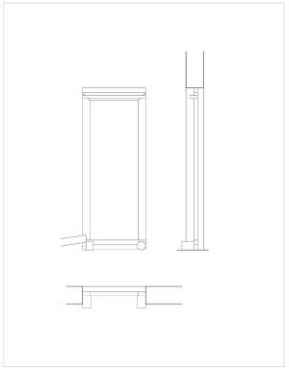
34



ELEMENT 3-1-R1 1:20



ELEMENT 3-1-R2/R3 1:20



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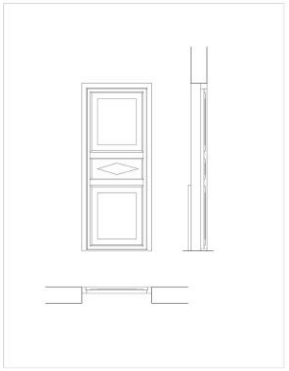
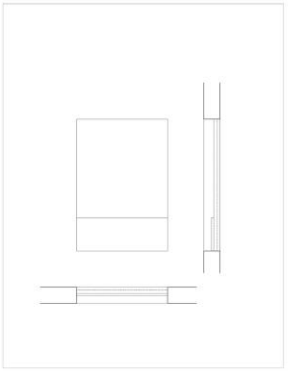


ELEMENT 3-1-L1 1:20



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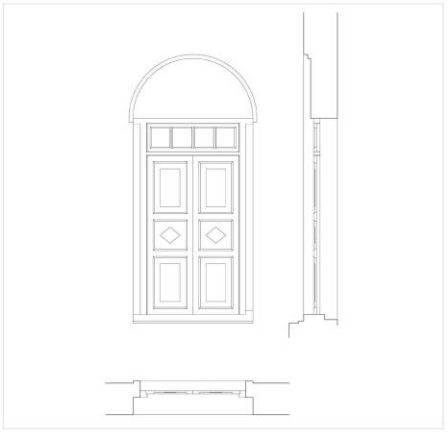
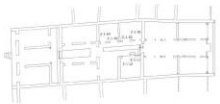
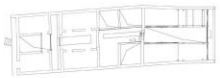


ELEMENT 3-1 1:20

GROUND FLOOR ELEMENTS LOCATION

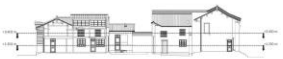


1ST FLOOR ELEMENTS LOCATION



SECTION B-B CUTTING HEIGHT

SECTION C-C CUTTING HEIGHT



LEGEND

NOT MEASURED

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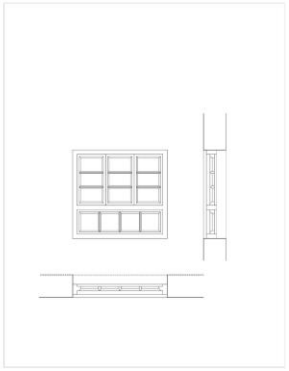
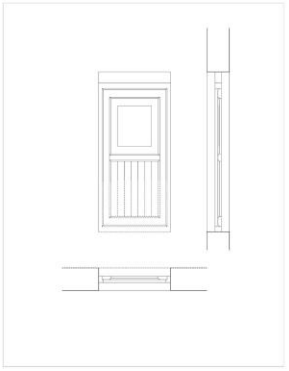


ELEMENT 4-1-R2/L2 1:20



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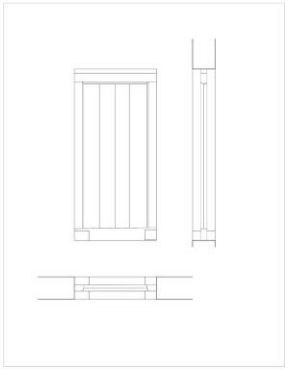

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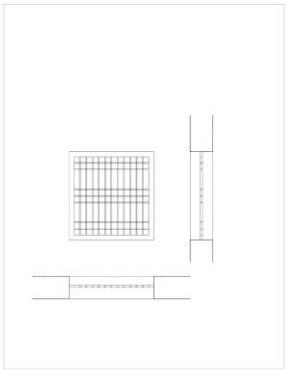

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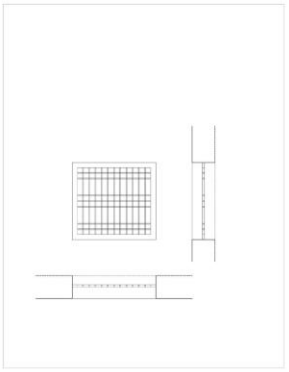

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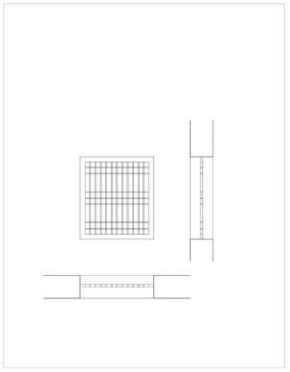
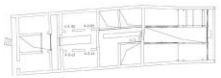


ELEMENT 4-2-L2 1:20

GROUND FLOOR ELEMENTS LOCATION

1ST FLOOR ELEMENTS LOCATION



SECTION B-B CUTTING HEIGHT

SECTION C-C CUTTING HEIGHT

LEGEND

NOT MEASURED

NOT MEASURED

POLITECNICO MILANO 1863

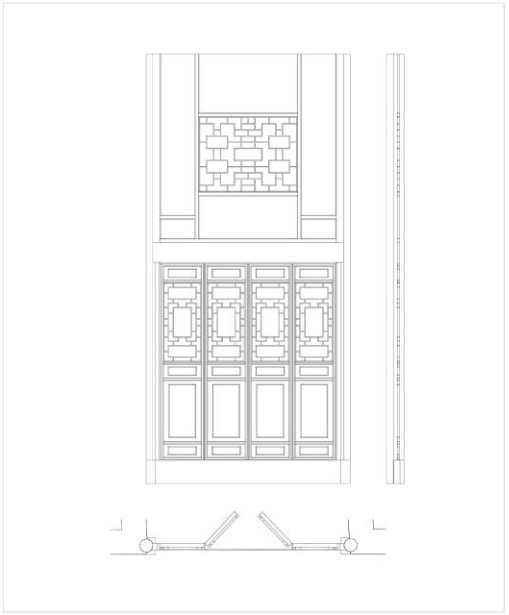
ARCHITECTURE DESIGN STUDIO
D.A.A 2018/19

GROUP
WU RUI
ZHAO JIAWING

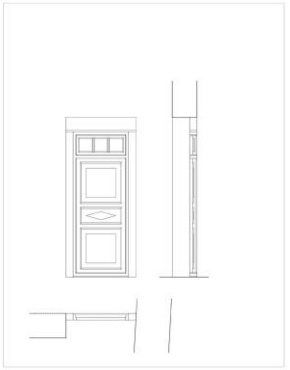
CONSERVATION, REUSE AND OVERWRITING THE MORPHOLOGICAL UNIT OF FENGHUANG ANCIENT TOWN
THE CASE OF DANG YARD

Final Delivery: 06/07/2020
Scale 1:50
Conservation of Dang Yard Building

36



ELEMENT 5-1 1:20



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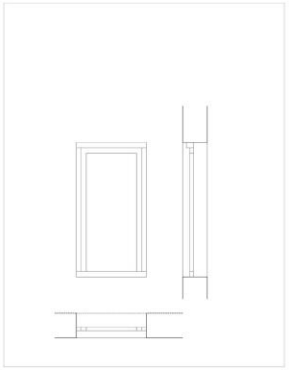
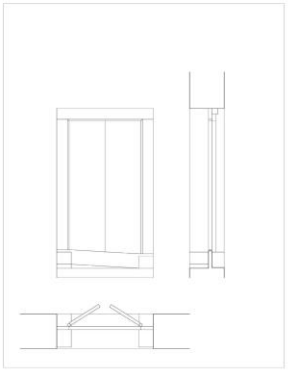
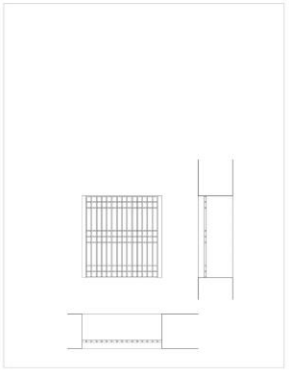


ELEMENT 5-1-L1 1:20

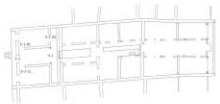


ELEMENT 5-2 1:20

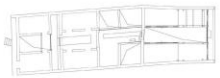


ELEMENT 5-1-R2 1:20

GROUND FLOOR ELEMENTS LOCATION

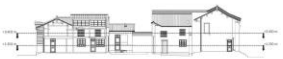


1ST FLOOR ELEMENTS LOCATION



SECTION B-B CUTTING HEIGHT

SECTION C-C CUTTING HEIGHT



LEGEND

NOT MEASURED

NOT MEASURED

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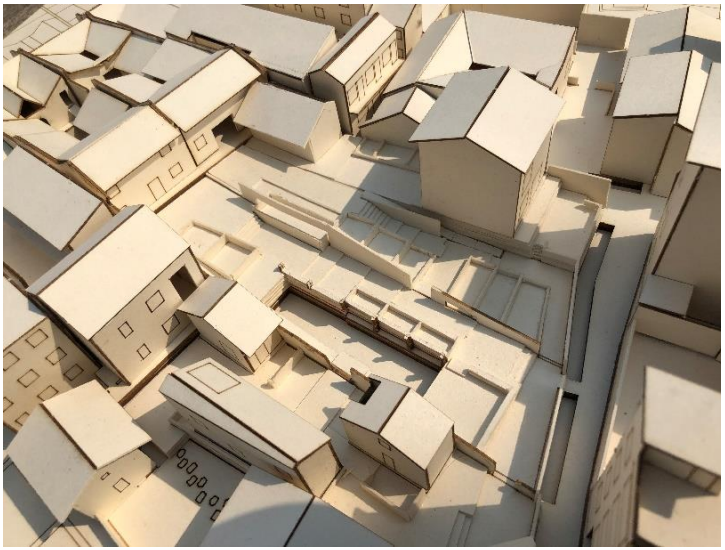
6.2 Model Photos



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