Analysis on the Layout of Traditional Residential Courtyards and Building Structures in Guanzhong Area, Shaanxi——Taking Xiaojiapo Village in Lantian County as an example

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Abstract: Traditional houses in Guanzhong area are typical regional sustainable green buildings, which contain ecological wisdom and cultural connotations that are in harmony with the environment. This article takes Xiaojiapo Village in Lantian County as the research object. Based on the integration of traditional residential culture inheritance and green development, this paper conducts a more systematic study on settlement site selection, courtyard layout, and building structure. "Road" Shaanxi section of traditional residential building art and folk culture subject research has added results, and also provides an early stage for the protection and inheritance of traditional residential buildings in the Guanzhong area.

1. Introduction
The starting point of the land "Silk Road" is Chang'an on the Guanzhong Plain, which has been the birthplace and growing place of the Chinese nation since ancient times. It starts from Tongguan in the east and reaches Baoji in the west. It lies between the plateau of northern Shaanxi and the Qinling Mountains. It has a pleasant climate, abundant water resources and fertile soil. The superior natural conditions are known as the "eight hundred miles of Qinchuan"[1]. In the ancient times, the Lantian ape-man, the Yangshao culture of Banpo, and the capital city of Fenghao in the Western Zhou Dynasty had 13 dynasties in history. They are called the earliest "land of abundance" in history. Lantian County is located in the central part of the Guanzhong Plain, surrounded by the Qinling Mountains in the southeast, adjacent to the plateau in the north, and the central Sichuan extending westward, forming a pattern of "seven mountains, two plateaus and one river"[2].

Xiaojiapo Village is located in the south of Lantian County, southeast of the Guanzhong Plain, and is the land of Wofu that runs across the Guanzhong Ring Road. Because of its unique geographical location and rich material foundation, the village gave birth to the unique residential courtyard layout and architectural form of the Guanzhong area. The long history of inheritance shows the unique aesthetic ability and artistic creativity of Guanzhong people. Therefore, this article takes the excavation and sorting of traditional architectural culture as the starting point, combined with the current situation of traditional houses in Xiaojiapo Village, and conducts systematic research from the
aspects of settlement site selection, settlement composition, courtyard layout, and architectural structure characteristics.

2. Overview of traditional houses in Xiaojiapo Village

![Location Map of Xiaojiapo Village, Lantian County, Xi'an City, Shaanxi Province, China](image)

Figure 1 Location Map of Xiaojiapo Village, Lantian County, Xi'an City, Shaanxi Province, China

Picture source: Ministry of Natural Resources of the People's Republic of China, modified by the author

Xiaojiapo Village belongs to Shijiazhai Town, Lantian County, Chang'an City, on the northern foot of the Qinling Mountains and the upper reaches of the Chan River. The central part of the Tang Dynasty imperial "Shanglin Garden" is bordered by Baliyuan, Huanghuagang and Tangyu in the east, Kuyu River and Chang'an District in the west, 30 kilometers away from downtown Xi'an, 16 kilometers away from Lantian County, and Xiaojiapo Village A natural village composed of three administrative villages, Xiaonan, Xiaobei, and Xiaoxi (Figure 1).

2.1. Natural and Humanistic environment

(1) Natural environment

Xiaojiapo Village is located in a temperate semi-humid continental monsoon climate with distinct cold and warm seasons, long in winter and summer, short in spring and autumn, and rain and hot in the same season. The light season is concentrated in summer, accounting for 31.9% of the year, spring in the middle accounted for 25.8% of the year, winter and autumn accounted for 20.7% and 21.6% of the year. Precipitation has obvious seasonality, with an average annual rainfall of 720.4mm [2]. Within the scope of the village and even the entire Lantian County, there is sufficient sunlight and abundant rain, which provides the most basic natural resources for the selection of the location of the village.

(2) Humanistic environment

Since ancient times, Lantian apes have lived in this area, and the superiority of natural conditions is vital to the survival and reproduction of the settlement. Therefore, when selecting a settlement site for
Xiaojiapo Village, both natural and cultural and historical conditions are more favorable than other areas in Guanzhong.

XiaoJiaPo village of distance Chang'an capital and is strongly influenced by emperor city construction and has a long history, and the other on the cornerstone of XiaoJiaPo village center old theatrical stage there carved, "qing daoguang six years (1826) August 3 and fix" the words that XiaoJiaPo village life of at least two hundred years history, XiaoJiaPo villagers house and yard morphological characteristics as a standard of "the guanzhong quadrangle courtyard".

2.2. Features of settlement site selection
   (1) Xiaojiapo Village is located in the half-ridge area of the loess hilly area, with an altitude of about 400-600 meters. The south is backed by the Qinling Mountains, and the north is surrounded by water. It is sunny and leeward. It is also in the half-ridge area of the loess hilly area. The superior terrain and natural environmental factors make the agricultural harvest abundant every year, and the leading role of agriculture can be better developed in the countryside.

   (2) In addition to the superior geographical conditions, water resources and agriculture are also inseparable and play a decisive role. In terms of water resources, Xiaojiapo Village closes to the Chan River in the east and Chan River tributary in the southwest, which has ample water retention throughout the year. The soil is thick and fertile. It is one of the main grain producing areas in Lantian County.

   (3) Xiaojiapo Village’s topography is relatively flat and vast. The Qinling Mountains serve as a barrier to the southeast. It is not easy to generate wind and dust, the air is fresh, the streets and lanes are less dusty, and the geographical location is unique and beautiful.

2.3. Characteristics of settlement structure
   (1) Village area and scale

Xiaojiapo Village is a purely residential natural village. In addition to residential land, in order to meet the production and daily necessities, it is usually equipped with public activity areas, such as mills, ancestral halls, theaters, small shops, and central squares. Due to the moderate geographical location of Xiaojiapo Village, relatively close to Xi'an City and Lantian County, and relatively convenient transportation, the scale of agricultural trade and commerce has gradually expanded, forming a supporting system of production, living, and commerce.

   (2) Village skeleton composition

In addition to the living and residential areas of the above-mentioned villages, the traffic road system that determines the layout of the Xiaojiapo village, as well as the terrain, water system, mountains, and fields around the village, together constitute the skeleton of the village.

   (3) Village street space

The traffic road system of Xiaojiapo Village is composed of different road grades of big and small streets and alleys. Because the north and south are narrow and long, the main street runs from north to south and runs through the central axis. With the passage of time, the village space continues to expand, and the north-south spindle street extends out of the lanes in the east and west directions, and the street and lane space organization is roughly in an I-shape pattern. The main street is wide and narrow, with different curves and straight; the lanes are rich in twists and turns, usually with a "T". The courtyard gate does not conflict with the street, and the lane openings on the east and west sides are not opposite. The heights and lows of the residential mountain walls on both sides of the lane, combined with the dense and dense green space, break the depression of the overall lane.

3. Characteristics of the layout of traditional residential courtyards in Xiaojiapo Village

At present, there are still many traditional residential buildings from the Ming and Qing dynasties in Xiaojiapo South Village and Xiaojiapo north Village (Figure 2).
Figure 2 Comparison of the current situation of Xiaojiapo Village and the location of ancient courtyards
Picture source: Self-photographing, self-drawing

Whether it is land selection and utilization, or architectural layout, architectural space processing, architectural structure, and detailed decoration, they all have the characteristics of traditional residences in the Guanzhong area [3]. For example, the courtyard is compact in plan layout, mostly arranged along the longitudinal axis, layered in and out of the narrow courtyard space, residential land is economical and economical, and the buildings are mostly civil or brick-wood structures, and the detailed decoration has a high artistic standard and value. Although traditional dwellings have regional characteristics and styles, the architectural layout and architectural space processing still belong to the architectural model of traditional dwellings in the Guanzhong area, that is, the traditional dwellings with strong local characteristics-"narrow courtyard dwellings". Share a gable wall between them to form a large space for traditional residential settlements.

3.1. Current status and layout of the courtyard
The layout patterns of traditional residential houses in Guanzhong area include: courtyard style, vertical multi-entry style, horizontal joint courtyard style, and crisscross large houses [4]. Based on on-site field investigation, the layout mode of traditional houses in Xiaojiapo Village is mainly courtyard-style relatively simple traditional rural houses (Figure 3).

Figure 3 The current layout of the courtyards in Xiaojiapo Village
(Quadrangle courtyards, triple courtyards, and Two-in-one courtyards)
Picture source: Self-photo

(1) Quadrangle and triple courtyard layout
Xiaojiapo Village is mostly dominated by a courtyard-style layout (Figure 4). Its most distinctive feature is that the rooms are arranged along the longitudinal axis of the homestead, with the above houses as the core, and from front to back. The gate house (inverted seat, street house, front house, head house), mansion house, courtyard, upper house (main house) and backyard, which are combined into a traditional Chinese courtyard layout pattern. According to the family's economic conditions and the scale of land use, in addition to the quadrangle courtyard, there are also the triad courtyard.
Due to the influence of rain, climatic environment, wood use factors and wider use of courtyard space, wing room (locally known as Shazi building) with "low inside and high outside" are usually arranged on both sides of the courtyard, which is one of the eight strange things in Guanzhong, be called "The house half of the cover". The Shazi building is arranged vertically between the upper room and the gatehouse at both ends of the central axis of the courtyard. Due to the economy of land, the layout of the courtyard is relatively compact. The number of bays in the building is mostly three bays, each bay is about 3 meters, and the depth is about 4 meters. The different number of openings results in the enclosure of different lengths of mansions, thus enriching the courtyard space. There are also eaves, corridors and lofts in part of the building, which make the overall building more magnificent and visually impactful. At the same time, the increase in building space can provide more space for storage. The Shazi building is generally used for the living, kitchen and food storage of the younger generation. Although it is not as rigorous as the upper room and the concierge, the emphasis is on practicality and functionality.

The gate house is built facing the street. The number of bays is generally three bays. One side has a gatehouse and passageway, and the other side is used as a storage room. The Ming room is usually used for receptions and other purposes. Generally, the floor height is mostly one floor. A small number of relatively wealthy families have two levels. In order to make full use of the floor space, shelves are often added to the concierge to turn it into a two-story loft with storage functions.

The upper room is the core main building in the entire courtyard space, and it controls the overall layout of the courtyard. Therefore, in terms of conceptual hierarchy, the gap between the platform base and the height of the house and the detailed decorations show the traditional etiquette culture and order of the upper, middle, and lower areas of the entire courtyard. Usually the number of bays is three bays, and each bay is about 3 meters. In order to increase the use space of the bright room, individual courtyards often increase the number of rooms and depth to obtain it. The common five bays and the rare seven bays have a depth of about 5-7. Rice is a spatial layout pattern of "one light and two dark". The "light room" is used for the whole family gathering, entertaining guests, worshiping or celebrating. The "dark rooms" (secondary rooms) on both sides are for the elders to live, or one side is set as a study room and a living room. There is usually a distance of 1.5 meters to 2 meters between the eaves of the upper house and the gable wall of the Shazi building, which not only ensures the normal ventilation and lighting of the "dark room", but also ensures the normal drainage of the upper house roof to avoid direct intrusion during the rainy season. The gable of the Shazi building. Some of the doors leading to the backyard are opened in the "Ming Room" of the upper room, and some have paths leading to the backyard by about 1 meter beside the upper room. However, the overall structure and architectural space of the upper room still belong to the three-bay room.

The single-yard-style traditional houses have a floor width of about 7-10 meters and a depth of about 12-23 meters. The layout of the courtyard is long and narrow. The layout is economical, and the small space can be fully utilized. Ventilation and daylighting can effectively solve the problem. Although the sunlight effect of the building is relatively insufficient, the inclined roof can also get a certain amount of light. Single-court-style traditional dwellings are courtyard-style buildings surrounded by a courtyard with only one entrance. It is not only a common layout pattern in Xiaojiapo.
Village, but also the most basic layout form of traditional dwellings in Guanzhong area [5] (Figure 5).

Figure 5 Comparative analysis of the layout of No. 77 and No. 76 courtyards in Xiaojiapo South Village  
Picture source: Self-drawing

(2) Two-in-one courtyard layout

Figure 6 Comparative analysis of the layout of No. 75 and No. 59 courtyards in Xiaojiapo South Village  
Picture source: Self-drawing
In addition to the single-yard plan layout mode, the village also has a relatively simple and clear plan layout. The building types in the courtyard are relatively single, and most ordinary villagers' houses are mainly built in the building. This type has flexible layout, economical application and relatively free arrangement of functions. Although there is no single-yard traditional house with rich levels and rigorous layout, the simplicity and simplicity will make the house more traditional and peaceful (Figure 6).

3.2. Courtyard space composition
In the overall courtyard space, the internal traffic connection is very important, and it directly affects the function use of the courtyard and the organization of the spatial relationship. That is, the courtyard is usually used to connect the concierge, the mansion, and the upper room. Liang Sicheng was once in the book mentions that the courtyard has an "outdoor living room" view. Because the courtyard is long and narrow, the houses are arranged around the courtyard, so an outdoor space is formed between the houses, which naturally forms the unique narrow courtyard form of the Guanzhong courtyard. This narrow courtyard represents the deep, narrow, and enclosed local characteristics that are unique to the traditional houses in the Guanzhong area and conform to the local natural environment.

(1) Space penetration and space organization
Although the layout of the courtyards of the traditional residences of Xiaojiapo Village is narrow, long, rigorous and regular, the spatial combination of the courtyards (quadruples, triples, courtyards) and the spatial relationship of each building can satisfy people’s needs. It can be used in daily life and can flexibly use the architectural space to create different humorous and changeable life environments by itself [6]. In several residential houses in the village, the eaves corridors, flower windows and other spaces are integrated into the entire courtyard space. The use of eaves corridor space has the effect of transition and extension between indoor and outdoor spaces, that is, "gray space" (Figure 7). The flower window patterns are changeable, and the wooden appearance and structure are exquisite and meticulous, making the originally narrow and closed courtyard space full of folk interest, and at the same time it has a space expansion function, enriching the level of space changes, and expanding the visual space effect.

(2) Facade space
Both the Shazi building and the upper building are on two floors with overhanging two-story verandah space, thereby increasing the use space and area. Whether it is an increase in function or an increase in artistic aesthetic effects, it has strong regional characteristics.

(3) Garden flowers and trees
The greening of the courtyard has a great effect on enriching the courtyard space level and artistic appreciation. Even a few flowers and trees can break the rigidity and closure of the long and narrow courtyard. According to the regional climate and planting customs, winter plum, magnolia, pomegranate, etc. They are commonly used flowers and trees in courtyard space, as well as bonsai flowers planted in residential houses, which are trimmed to form a tall and straight shape, which increases the comfortable and comfortable living atmosphere of courtyard space [7].
After on-site investigation and analysis, the characteristics of Xiaojiapo Village’s courtyards are summarized as follows: rigorous layout, vertical axis penetration, distinct levels, different heights, narrow courtyards, closed frontage, and accessible courtyards.

4. Structural characteristics of traditional houses in Xiaojiapo Village

The traditional dwellings of Xiaojiapo Village are a typical representative of the traditional Chinese architectural structure system-civil structure, which embodies the traditional construction concept of adapting measures to local conditions, drawing materials on site, and adapting to materials. As a result, the ancient traditional residential buildings can continuously and continuously follow the whole process of historical development. At the same time, they also reflect the adaptability characteristics of adapting to the climate and the geographical environment, and the better seismic function, which makes the traditional buildings not collapse.

4.1. Features of residential building structure

The dwellings of Xiaojiapo Village are earth-timbered houses or brick-timbered houses with wooden structure as the frame of the house. The wooden structure is composed of wooden pillars, wooden beams, wooden purlins, and wooden rafters. The weight of the roof is transferred layer by layer to the stone pillar foundation and foundation through the wooden structure. The wall alone bears its own weight and separates the space and protects the internal wooden structure. It has the characteristics of "the wall collapses and the house does not collapse" [8], which also provides great flexibility for opening doors and windows and space division. Through different combinations of components and components, the house can meet the ever-changing functional needs of people's life and production under different geological conditions and different climates.

In terms of structure, the basic form of wooden frame is beam-lifting type, of which three beams are the majority, followed by two beams (locally known as Anjian building), and five beams are less. The building structure is relatively simple, and lintels are often used to connect the front eaves column and the rear eaves column, thereby increasing the use of building space. This structure is generally used in upper and hall buildings. This is a common wooden frame form in Xiaojiapo Village. This type of structure is commonly seen in the inverted house and upper house of traditional dwellings. Shazi building is a unique architectural form in the Guanzhong area, and its internal architectural structure also has unique regional characteristics.

(1) Features of three-beam structure

Some houses add fork hands on both sides of the spine, in order to strengthen the stability of the spine purlin; some houses directly save the spine and retain the two fork hands; some houses replace the fork hands with a beautifully carved large horn back And the spine supports the spine purlins (Figures 8, Figures 9); when the length of the rafters is too short, a child column is usually added between the steps of the frame, and the child column is used to support the cloud beam and waist purlin, cloud beam The other end of the spine is connected to the spine, forming four frames and two pillars, also known as four frame beams.

Figure 8 Fork hands, and the carved big horn back supports the spine purlin
Picture source: Self-photo
(2) Structural features of a few large-space five-frame beams

Usually under the five beams, there is a follower beam, and there are "three purlins" under the purlin, that is, under the eaves purlin, there are eaves pads and eaves beams (also known as head beams), and gold pads and gold beams are set under the purlins. There are ridge pads and ridges under the purlins, which allow the overall traditional residential building to obtain "tension" in the horizontal and vertical directions, making the overall building structure more stable (Figures 10).

(3) Structural characteristics of the ovary in Shazi building.

In addition to the architectural structure of the gate house and the upper house in the folk house, the architectural structure of the Shazi building is quite distinctive. Although the main building of the Shazi building is also a load-bearing system based on a wooden structure, the beams, purlins, and rafters mainly bear the load of the roof, but the difference from the concierge and the upper room is that the Shazi building has no gables, back walls, and eaves walls. The four connected uprights are built by Hu Qi into an adobe wall to bear the load, which is a "semi upright" structure. Due to the relative lack of timber resources in Guanzhong area, in order to save timber, most traditional residential buildings adopt this "semi-pillar" structure (Figure 11).
Indoors, a small number of official families will add shed slabs to the building to make two floors for storage of sundries. At the same time, the roof beam structure is exposed with exquisite carvings. Most families will use bamboo and wood strips to intersperse and lap, and lay straw mats on them to make ceilings to increase the overall decoration of the building. There are also some undecorated suspended ceilings, and the wooden structure is basically exposed.

Guanzhong area is located in the core area of central Shaanxi Province, with developed transportation and rich products. Officials and dignitaries and business people are relatively wealthy. It can be reflected not only in the layout of residential courtyards and architectural structures, but also in stone carvings and brick carvings in the decorative art of Guanzhong residential buildings. Wood carving can also reflect. Exquisite workmanship is fully reflected in the construction of traditional houses. Detailed carvings are both components and artistic decorations. These decorations make the original simple and plain traditional houses become gorgeous and fascinating [9].
5. The conclusion
Through the research on the regional environment, settlement location, courtyard layout and single building structure of the traditional houses of Xiaojiapo Village, the following conclusions are drawn: First, Xiaojiapo Village is located in a superior geographical environment, abundant natural resources and long-standing folk customs. Culture makes the entire settlement a stable and stable survival. Second, the traditional houses of Xiaojiapo Village are, in a sense, an expression of the adaptability to the natural environment and the philosophical concept of "Harmony between Man and Nature". The settlement form takes the courtyard style as the basic unit and forms a large complex through the combination of courtyards. Settlement space, the layout of the settlement space is rigorous and distinct, and the buildings are scattered in height. Third, the layout and spatial organization of the courtyard still belong to the architectural model of traditional Chinese courtyard houses. Its characteristics are: along the vertical axis, the upper house is the core, and the annex buildings are surrounded by the outer layer to form a large courtyard space. With the vertical advancement of the courtyard, the structure of the residential buildings also increases the floor space of the houses, in order: the gate house, the mansion house, and the upper house. Fourth, the building unit is a civil and brick-wood hard mountain structure with a wooden frame as the skeleton. The overall structure is smooth and unassuming. The walls are tall and thick, the appearance is simple, the outline is rich and closed, and the roof is gently lifted and folded. The ornate decoration makes the traditional houses more colorful. After the above several aspects of research, it provides an early stage for exploring the protection and development of traditional houses in the Guanzhong area, provides relevant ideas for the construction of traditional house construction techniques in the Guanzhong area based on cultural inheritance, and also provides research on traditional Shaanxi and even traditional Chinese houses and buildings. Its culture lays the foundation.

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