

A Brief Analysis of the Formal Characteristics of Kiln Dwellings in Tongchuan Area, Shaanxi*

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The unique topography and historical and cultural background have determined the diversity and uniqueness of kiln architecture in the Tongchuan area. In addition to the double-slope residential architecture, traditional kiln dwellings with regional characteristics such as Leaning on the cliff cave dwelling, ground Pit cave dwelling and Freestanding cave dwellings have also been formed. This paper takes the inheritance and protection of traditional kiln as the starting point, and through field research and literature analysis, we have systematically collected images, measured data, and drawn up horizontal and vertical profiles and three-dimensional structure drawings of the traditional kiln dwellings in Tongchuan, and concluded the three types of forms and structural characteristics and artistic form characteristics of the traditional kiln dwellings in Tongchuan. The aim is to provide a basis and reference for the protection and inheritance of tangible and intangible cultural heritage in Shaanxi, as well as for subsequent research in this field.

Keywords: Tongchuan area, Shaanxi, Cave Dwelling, feature analysis, protection and inheritance

Introduction

Shaanxi is the starting point of the Silk Road during the Han and Tang dynasties, and Tongchuan is located in the central part of Shaanxi Province, the northern part of the Guanzhong region, with a unique topography of 3,882 square kilometers (Figure 1), which is the intersection of the Guanzhong Basin and the Loess Plateau. It is a warm and semi-arid region with four distinct seasons and abundant products. Administrative jurisdiction: Yaozhou District, WangYi District, Yintai District and Yijun County. In the course of history, the famous "Yaozhou Kiln" was created, and such famous figures as Sun Simiao, Liu Gongquan, Fan Kuan, Fu Xuan and Linghu Defen were born. It can be said that the people are simple and the culture is deep. Throughout the long

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development, under the unique natural geographical environment and rich humanistic and historical conditions of the region, a place with strong local characteristics of the coexistence of cliff kilns, underground kilns and architectural forms of Freestanding cave dwellings has been formed.



Figure 1. Regional map of Tongchuan City, Shaanxi Province, China.

Overview of Tongchuan Kiln Dwellings

Kiln dwellings have a long history among traditional Chinese dwellings, mainly located in the Yellow River Basin, which is the habitat for the descendants of Yanhuang to live and reproduce from generation to generation. Due to the unique natural geographical conditions, the gradually developing social and economic level, the living habits created by history, and the local construction materials adapted to local conditions, unique kiln dwellings with different regional characteristics have been accumulated. Until today, kiln dwellings are still the main architectural type of rural dwellings in the Loess Plateau region of China. Therefore, this paper will analyze and systematically study the reasons for the formation of kiln dwellings, the distribution of kiln dwellings, the type characteristics and artistic characteristics in Tongchuan area.

Reasons for Formation

According to historical evidence, in the last stage of the middle Pleistocene of the Quaternary period, due to the difference in the rise and fall of the earth's crust, the role of erosion and denudation in the later stage and human to hide from the wind, rain, snow and wild animals in a cave, gradually evolved from cave dwellings into kiln dwellings. Today, Tongchuan is characterized by the landscape and dwelling forms of the loess mount, the original gully, mountains, rivers and terraces at all levels.

(1) **Geographical environment factors.** Tongchuan is a more typical area of the Loess Plateau in the north, with loess plateau, beam, mount, ditch, stony mountain and river valley landforms. It is located at longitude $108^{\circ}35'20''$ - $109^{\circ}29'04''$ "E and latitude $34^{\circ}48'16''$ - $35^{\circ}35'16''$ N. The average annual temperature is 8.9°C - 12.3°C , and the average annual precipitation is 555.8-709.3 mm. The climate is temperate continental monsoon climate with four distinct seasons. Due to the different terrain, the climate of each region differs significantly, thus forming different three forms of kiln caves. It also shows the wisdom of our ancestors in choosing the site to match the land, adapting to the local conditions and following the nature.

(2) **Humanistic and historical factors.** Tongchuan is influenced by the rich historical background and nurtured by the northern loess culture. On the one hand, people living here cultivate the land and work with the earth, and the barren land gives people a love for life; on the other hand, people live their daily lives in the kiln with the earth, showing their deep attachment to the loess. The kiln, built in the local area, records the history of the simplest life of the residents of Tongchuan kiln, and concentrates the history of the development of Tongchuan kiln architecture, showing the kindness, simplicity, wisdom and hard work of the residents of the kiln.

Distribution

This paper takes the Tongchuan area as an example to illustrate its distribution. Due to the complex and diverse topography and climate conditions, these factors have a great impact on the distribution of Tongchuan kiln dwellings. The kiln dwellings in Tongchuan have taken advantage of the Taiyuan and remnant areas in the center of the mountainous region in the north of the Weishui River, forming the leaning on the cliff cave dwelling and the freestanding cave dwellings located in the loess hills and gullies of the Yingtai district of Tongchuan and the ground pit cave dwelling located in the terraces of the Yaozhou District, making Tongchuan a special area with three types of kilns: leaning on the cliff cave dwelling, ground pit cave dwelling and freestanding cave dwellings (see Figure 2).

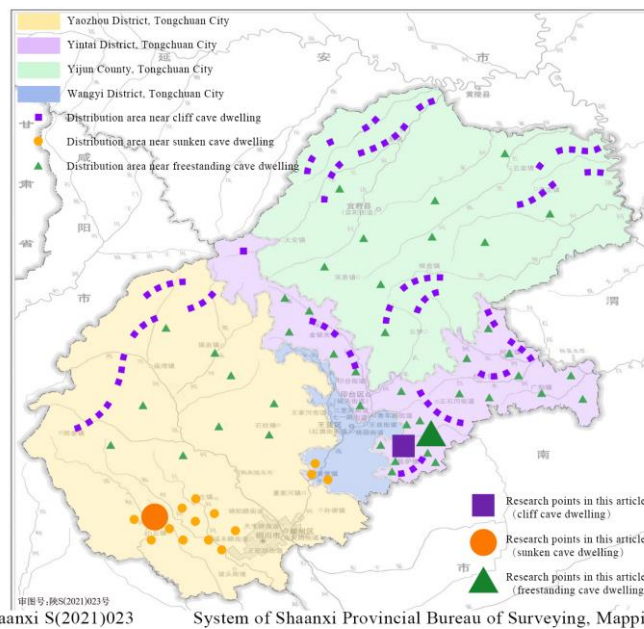


Figure 2. Schematic diagram of the distribution of cave dwellings in Tongchuan and the research points in this article.

Analysis of the Morphology of Tongchuan Kiln Dwellings

This section will elaborate, analyze and prove the three types of kiln dwellings in Tongchuan from three aspects: the basic form characteristics of kiln dwellings, the characteristics of the flat-standing and cut-through structure, and the decorative features of kiln dwellings.

Analysis of the Basic Shapes of Cave Dwellings

In the Tongchuan area, due to the different topography and landscape, the types of kiln buildings inhabited by residents are different, and the main types are Leaning on the cliff cave dwelling, ground Pit cave dwelling and Freestanding cave dwellings. In the research, the more complete and long-used traditional kiln dwelling buildings with distinctive characteristics were selected for analysis.




(1) **Leaning on the cliff cave dwelling.** There are two types of cliff kilns in Yingtai District, Tongchuan. One is built along the ditch, along the river or along the mountain and the other is the form of “interface kiln”. One of them is the “interface kiln”, which is a common form of kiln against the cliff, and this type of kiln is a kind of safety reinforcement measure to expand the area of the kiln and prevent the collapse of the cliff face on the basis of the original kiln against the cliff. Most of the kilns are 6 meters long and 3 meters wide, and are lined with bricks or stones, with kang, stove and other living places inside.

(2) **Pit cave dwelling.** The dikeng kiln is commonly called “sunken kiln courtyard”. The number of holes on each side is determined by the size of the square pit, with some having a single hole, two holes, three holes or four holes. Kilns of this shape are usually quieter, with strong privacy and security, and are very suitable for residents, which is why many residents still live here.

(3) **Freestanding cave dwelling.** Freestanding cave dwelling is not affected by the cliff and ditch wall, and it is a kind of independent kiln. The kiln box is dug out on the ground, then the middle wall and kiln legs are built, followed by the repair of the cliff surface, and finally the loess is backfilled to the kiln roof. Compared with the cliff kiln and the pit kiln, this type of kiln has high construction cost but good heat preservation effect, so it is the most common type of kiln dwelling in Indai District.

In conclusion, by compiling research data on the kiln architecture in Tongchuan and comparing the overall form of the leaning cliff kiln and the Freestanding cave dwelling in the Chenxu town area and the underground kiln in the Xiaoqiu town area (see Table 1), we understand the distribution range, real-world photos, structural features, and material applications of the three types of kiln architecture, starting from the overall morphological characteristics, so as to understand the basic morphological characteristics of the kiln architecture in the area more intuitively.

Table 1
Comparison of Basic Shapes of Cave Dwellings

Type	Leaning on the cliff cave dwelling	Pit cave dwelling	Freestanding cave dwelling
Examples of cave dwellings			
Distribution	Yongxing Village, Napo Village,	Yicun, Xiaoqiu Town, Yaozhou	Most villages in Chenlu Town,

area	Lidipo Village, Chenlu Town, Yintai District, etc.	District	Yintai District
Characteristic	The cave dwellings built on the cliffs or along the two walls of the river are distributed in a straight line and L-shaped layers, and they are scattered.	Disribed by the locals as when you enter the village, you don't see the village, you don't see the tree, you don't see the house, and you hear no one.	Build with relatively flat terrain
Materials	loess	loess	Masonry

The Vertical Section and Three-dimensional Structure of the Cave Dwelling

Kiln architecture is an important form of traditional dwelling in the Loess Plateau area in northern China, and is an important part of Loess culture. The development of kiln is the crystallization of the dwelling under the witness of history, through the wisdom of ancient people and the optimization of evolution through continuous failure, therefore, it is very important to study the basic form of kiln architecture. This part will take the basic form of kiln architecture as the main research objective, and elaborate the morphological characteristics of leaning on the cliff cave dwelling, pit cave dwelling and Freestanding cave dwelling respectively, starting from the layout of kiln plan, the form of kiln façade, kiln section and three-dimensional structure.

(1) **Plan layout analysis.** As an important type of traditional dwelling on the Loess Plateau, kilns are selected on the basis of their location in the north and south, mountains and water, and other feng shui theories, and a more suitable area is selected for the construction of kilns according to its topography and geomorphology.

The kilns are attached to the cliffs and ditch walls, and their layout is often arranged in an “L” or “I” shape, and the courtyard pattern is arranged according to the surrounding environment. On the basis of the single-hole kiln, the residents have updated the layout of the kiln to meet more living needs, thus creating a combination of mother and son kilns, two kilns in parallel, sets of kilns and interface kilns to better meet the living needs of the residents.

The kiln is located about 10 meters below the ground and has a regular shape, so the kiln is like a chessboard from a top view. The kilns are square, rectangular, and specially shaped, and the common layout of the kilns includes eight, ten, twelve, and sixteen heads, with one hole connected to the entrance and exit, and the number of holes varies with the size of the compound, with each hole being about 7 meters long and 3 meters wide.

Most of the kilns rely on the lower cliffs, most of them are arranged in a single row in the shape of “one”, and the layout is relatively free and flexible, the number of kiln holes is mainly 2 or 3 holes, the length of each hole is generally 9-10 meters, the width is 3-5 meters, and the openings are large, which is unique and exquisite in the kiln architecture.

Through the analysis of the plan layout patterns of Leaning on the cliff cave dwelling, ground Pit cave dwelling, and Freestanding cave dwellings (see Table 2), it is concluded that the three types of kiln buildings have their own distinctive features in terms of site selection, topography, map base relationship, and common types (see Table 3).

Table 2
Cave Dwelling Morphology Analysis

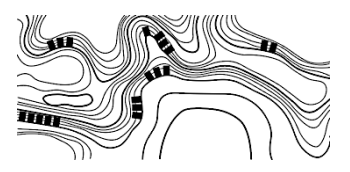
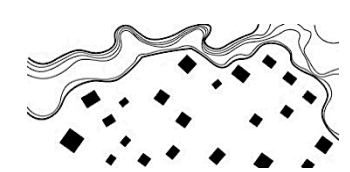
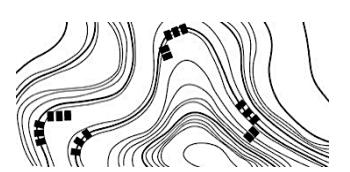


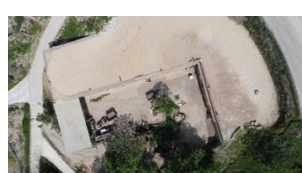
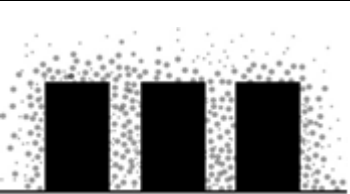
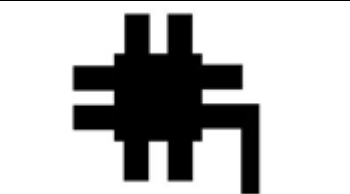


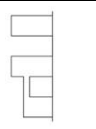
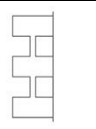
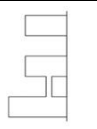
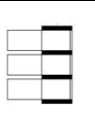
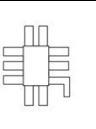
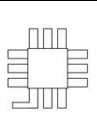
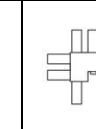
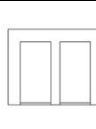
Type	Leaning on the cliff cave dwelling	Pit cave dwelling	Freestanding cave dwelling
Layout and location			
topography	Mountains, beams, valleys, hills	Flat area	On the ground
Example photos			
Plane symbol			
Research location	Shangjie Community, Chenlu Town	Villagers' homes in Yi Village	Villagers' homes in Lidipo Village

Table 3
Common Types of Single Structure of Cave Dwellings

Type	Leaning on the cliff cave dwelling					Pit cave dwelling			Freestanding cave dwelling
Common type									
	mother and child cave dwelling	Mother and child cave dwelling	Two cave dwellings in parallel	Cave dwelling	Interface cave dwelling	Ten-hole cave dwelling	Twelve-hole cave dwelling	Special-shaped cave dwellings	Freestanding cave dwelling

(2) **Analysis of façade form.** Kiln is a building with strong regional characteristics, and its front façade is the most important part of the kiln building. The front façade is commonly known as the “kiln face” and consists of windows and doors, arches, cliff walls, cliff eaves, and daughter walls from the bottom up (see Table 4). The inhabitants of kiln buildings, whether rich or poor, strove to reflect their most beautiful and superior skills on the front façade of the kiln.

(a) Doors and windows: In kiln buildings, doors and windows are the visual center of the whole “kiln face”, which not only can divide the interior and exterior, but also have the functions of introducing light, ventilation,

heat insulation, heat preservation and wind and rain protection for the interior to a certain extent. The doors and windows of the kiln buildings in Tongchuan can be divided into two types: “independent” and “integral”. Most of the Leaning on the cliff cave dwelling and Freestanding cave dwellings in Chenxu Town, Yintai District, are mainly independent doors and windows, while most of the underground kilns in Xiaoqiu Town, Yaozhou District, are mainly integral doors and windows, with the doors and windows interconnected and interdependent, becoming an organic whole.

(b) Arches: Arches not only have a decorative role in the façade of kiln buildings, but also have a good load-bearing role, and are the only structural form for kiln construction. Due to the influence of geographical factors, the form of arches varies from region to region. They can be summarized as semi-circular arch, pointed arch, three-centered arch, three-centered round arch, and double-centered round arch. The arch curves commonly found in kilns by cliffs, ground pits or Freestanding cave dwellings are mostly semi-circular arches, with some arch coupons acting on the whole of high windows, doors and side windows, and some acting on doors and side windows alone.

(c) Cliff wall: Cliff wall is the façade of the cliff wall or soil layer where the kiln is excavated. There are generally three types of cliff walls: masonry cliff wall, finish cliff wall and trim cliff wall. Freestanding cave dwelling is made of brick or stone masonry, which belongs to masonry type cliff wall. The kiln against the cliff is made of loess, grass or white lime and loess mixed and coated on the surface of the cliff wall, which belongs to the finishing cliff wall. The ground pit kiln is an artificially excavated cliff surface, which is generally more regular and neat, so it is a finishing type cliff wall. Most of the kilns in Tongchuan area are masonry-type cliff walls and finish-type cliff walls, which are simple and neat and have a rhythm. Most of the kilns in the ground pit are decorated cliff walls and rectified cliff walls, which are as if they were made in heaven and have the beauty of history.

(d) Cliff eaves: The cliff eaves are located at the lower part of the daughter wall and the upper part of the arch coupon. During the field research, it was found that most of the cliff eaves of the lean-to kilns, the ground Pit cave dwelling and the Freestanding cave dwellings in Tongchuan area adopt a single eave, which is stacked outward layer by layer with bricks to form a half funnel shape, with a strong sense of three-dimensionality and a high level of craftsmanship, and such a structure is designed to prevent rain from washing away the kiln face and play a role in protecting the kiln building.

(e) Daughter wall: The daughter wall is located at the very top of the kiln face, and its purpose is to protect people or animals from falling. Most of the daughter walls of the Chenxu town’s Yaiya kiln and Freestanding cave dwellings are made of cans and jars, which have very strong regional characteristics, due to the influence of the kiln culture in the area. The daughter walls of the kilns in Xiaoqiu Town are made of bricks, some of which are impermeable and solid, and some of which are hollowed out and have various forms. It has been used from ancient times to the present, and has a strong inheritance and vitality.

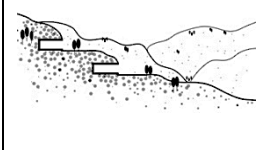
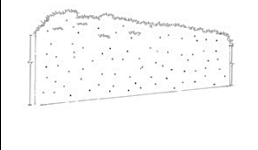
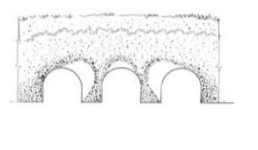

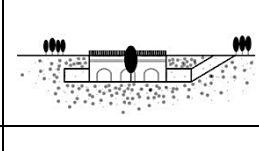
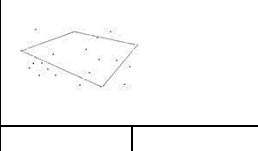
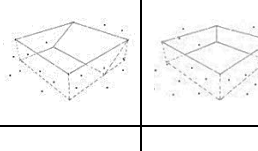
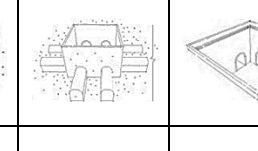
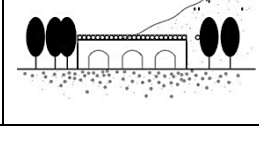
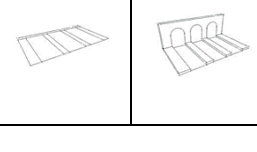
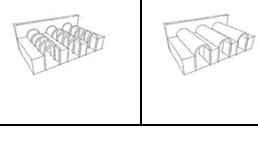
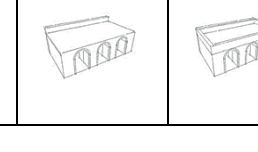
Table 4
List of Cave Dwelling Shapes

Type	Leaning on the cliff cave dwelling		Pit cave dwelling		Freestanding cave dwelling	
Floor plan						
Facade						
Doors and arches						
Windows and arches						
Cliff wall	Brick, stone, loess		Loess and forage		Brick, stone, loess	
Cliff eaves						
Parapet wall						
	Simple form, brick parapet		Hollow style parapet		The parapet of porcelain jars	

(3) Morphological analysis of sectional elevations and three-dimensional structure drawings. Kiln architecture is a radiant residential form attached to the loess and has a very important relationship with the loess. Firstly, in terms of the relationship between kiln architecture and loess, leaning cliff kiln and ground pit kiln are architectural forms embedded in loess, and Freestanding cave dwelling is a form of kiln architecture built on flat ground. Secondly, in terms of the construction of kiln buildings, the leaning kiln and the underground kiln are a kind of subtractive construction, in which the excavation volume of the leaning kiln is small and the construction period is shorter. In contrast, the excavation volume of the underground kiln is large, and the construction period is long. In contrast, the Freestanding cave dwelling is a kind of additive construction, which has a higher cost, and the final form of the kiln is different. Finally, by elaborating and analyzing the series of drawings of kiln buildings, the structural and morphological characteristics of kiln buildings can be more intuitively understood from the

sectional and three-dimensional structural drawings of kiln buildings (see Table 5), so that the intrinsic connection between kiln buildings and loess can be more intuitively felt.

Table 5
Sketch Map of Cave Dwelling Section, Three-dimensional Structure and Morphological Analysis

type	Relationship with loess	Cave dwelling construction process					
Leaning on the cliff cave dwelling							
Pit cave dwelling							
Freestanding cave dwelling							

Aesthetics of Cave Dwelling Forms

The kiln is a kind of raw earth architecture fused with nature and a three-dimensional art work. By summarizing and analyzing, the artistic characteristics of kiln architecture will be elaborated from the overall, stylistic, practical and decorative beauty of kiln architecture.

(1) Overall beauty. The overall beauty of the cave architecture is reflected in the overall planning idea and the planning of the total composition method. From the overall planning idea: the cave architecture is integrated with nature and responds to nature. From the general composition approach: kiln architecture follows the natural pattern and makes full use of the loess resources. It achieves the realm of unity of heaven and man.




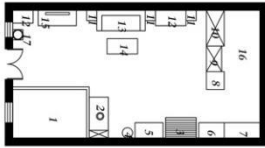
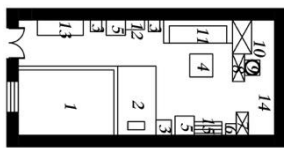
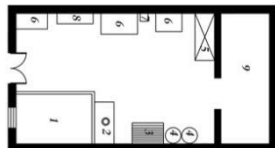
(2) Modeling beauty. Since ancient times, kiln architecture is simple, rugged and has a strong vernacular atmosphere, with the architectural aesthetic principles of unity, balance, proportion, scale and rhythm. The composition of space, the arrangement of virtual and real layout, the arrangement of high and low, the process of sparse and dense, the material texture and color application, no matter from what angle, can be discussed in detail, all reflecting the modeling beauty of kiln architecture.

(3) Practical beauty. The interior of a kiln can be divided into three parts: bedroom, kitchen and living room, carrying the living and living of a family with many members. The kang is located on the side of the first entrance, connected to the side window, and serves the functions of rest, meeting, entertainment, working and dining. The stove is located inside the kang, and along it is the area for dining and storage. Other areas are routinely placed with furniture such as square tables, sofas, and chairs (see Table 6).

(4) Decorative beauty. In the development of the simple traditional kiln, people pay extra attention to the pursuit of the beauty in order to get the aesthetic needs and spiritual satisfaction. The decorative beauty of the kiln is reflected in the earthy colors of the building, the red, yellow and black colors of the doors and windows, and the reasonable use of colors makes the traditional kiln form more colorful and aesthetic value; it is reflected in the

style of regular arrangement of bricks and stones, which forms a strong sense of unity, symmetry and rhythm; it is reflected in the beautiful symbolic meaning of the decoration of the doors and windows in the form of wanzhi pattern, well pattern, lantern brocade and back pattern, which conveys the beautiful vision of the people of Huangtu. vision.

Table 6
List of Conventional Indoor Layout and Furnishings

Type	Leaning on the cliff cave dwelling	Pit cave dwelling	Freestanding cave dwelling
Instance			
Interior layout			
Serial number name	1: Kang; 2: stove; 3: cutting board; 4 buckets; 5: small kitchen table; 6: gas stove; 7: cabinet; 8: refrigerator; 9: locker; 10: wardrobe; 11: chair 12: table; 13: sofa; 14: coffee table; 15: TV cabinet; 16: storage area; 17: wash stand	1: Kang; 2: Bed; 3: Chair; 4: Mahjong table; 5: Square table; 6: Small kitchen table; 7: Cabinet; 8: locker; 9: wash stand; 10: wardrobe; 11: sofa; 12: small cabinet; 13: TV cabinet; 14: storage area 15: chopping board	1: Kang; 2: stove; 3: cutting board; 4: water tank; 5: locker; 6: small locker; 7: chair; 8: TV table; 9: storage area

The Conservation and Inheritance Value of Kiln Dwellings in Tongchuan Area

Traditional kiln dwellings have strong regional characteristics and are valuable historical and cultural research materials and ornamental objects for future generations to understand and witness history. In the same way, the kiln architecture in Tongchuan is constantly maintained by the local geographic environment and humanistic and historical background, forming the local characteristics of the leaning on the cliff cave dwelling, the pit cave kiln and the freestanding cave dwelling. Therefore, in the process of urbanization and industrialization, the work of protecting and inheriting the kiln dwellings must be done.

Conservation Methods of Kiln Dwellings

(1) Protection of the environment in the Tongchuan area. Protecting the environment in the Tongchuan area is conducive to the sustainable development of the kiln dwellings in the Tongchuan area. The kiln dwellings are

integrated complex made up of loess, ecology and human beings. So, it is necessary to focus on protecting the environment. Protect the surrounding ecological environment such as mountains, water systems and forest, prohibit mining, sewage and other bad behaviors, increase the ecosystem such as greenery, create an ecological landscape of kiln dwellings, and improve the overall appearance of Tongchuan.

(2) Protection of kiln dwellings. The layout of traditional kiln dwellings is ingenious, the construction techniques are exquisite. Their form characteristics and artistic features reflect the uniqueness of the kiln dwellings in Tongchuan area. Firstly, it is necessary to prevent damage and reduce or eliminate the damage caused by natural or unnatural factors. Secondly, we should regularly repair the kiln dwellings and strictly preserve the original spatial form, facade form and artistic form of the kiln dwellings.

Inheritance Methods of Kiln Dwellings

(1) Raising the awareness of all people about kiln dwellings. Raising the awareness of all people about kiln dwellings is the only way to make more people have the responsibility and obligation to protect and inherit the traditional Chinese kiln dwelling architecture. We should make full use of current social resources such as the internet, media, educational institutions and museums to carry out and publicize knowledge about traditional culture, stimulate interest and pride in the culture of kiln dwellings, and make all people consciously participate in the protection and inheritance of kiln dwellings.

(2) Renewing and renovating the current kiln dwellings. The best way to inherit the kiln dwellings is to update and renovate the current kiln dwellings. Only when the kiln dwellings are inhabited will their service life be extended. Under the condition of ensuring the internal structure of the kiln dwellings remains unchanged, paying attention to the actual conditions of the residents and meeting their living needs, the internal space can be reasonably divided to improve the living conditions, so that the updated kiln dwellings can better serve the residents.

Conclusion

This paper mainly discusses the field investigation of the kiln architecture in the Tongchuan area, and the review and comprehensive analysis of related materials, and concludes that, firstly, most of the kiln architecture in the Tongchuan area is influenced by the topography and landscape, and the types of kiln architecture formed include the leaning cliff kiln, the ground pit kiln and the Freestanding cave dwelling. Secondly, through the analysis of the plan, elevation, section, perspective, interior furnishings, material texture and color application of the kiln architecture in Tongchuan, it is concluded that Tongchuan kiln residential architecture has strong regional characteristics. Thirdly, it summarizes the methods of protecting and inheriting the kiln dwellings, and fundamentally promotes the protection and inheritance of the kiln dwellings. To sum up, it is very meaningful and valuable to study the kiln dwellings in Tongchuan area, not only to provide reference for the construction of kiln dwellings, but also to better protect and inherit the historical heritage and regional characteristics of the kiln dwellings in Tongchuan area.

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