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Analysis on the forms and regional characteristics of the traditional dwellings in mountainous central Shandong Province

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Abstract. The traditional dwellings in mountainous central Shandong Province show rich historic cultural deposits and distinctive regional characteristics under the influence of the geographic environment, resource endowment and historic culture. Research was done on the main construction patterns of the traditional dwellings in mountainous central Shandong Province, as well as relevant data and techniques, revealing the symbiotic interdependence between the traditional dwellings and nature in different natural and humanistic environments, providing a certain theoretical reference for the diversified conservation and heritage of the traditional dwellings.

1. A survey of mountainous central Shandong Province

Mountainous central Shandong Province, which covers an area of roughly 65,000km², is the highest-lying part of Shandong Province that consists primarily of Mount Tai, Mount Lu, Mount Yi, Mount Meng and Culai Mountain, as well as the surrounding low mountains and hills and some transitional areas extending towards the plains. It is generally recognized that “this place, which roughly covers Jinan, Tai’an, Laiwu, Zibo, Linyi and Weifang, borders on Xiaoqing River and North Shandong Plain in the north, on the hilly areas of Eastern Shandong along Weihe River and Shuhe River in the east, on Ni Mountain and Mount Meng in the south, and on West Shandong Plain along Dongping Lake and Nansi Lake in the west”. Over 3/4 of the mountains in the province are located in this place and form an approximate circle. The plains around it make it an isolated, typical region that features mesoscale terrain^[1].

2. Analysis on the forms of the traditional dwellings in mountainous central Shandong Province

The traditional dwellings in mountainous central Shandong Province show rich historic cultural deposits and distinctive regional characteristics under the influence of the geographic environment, resource endowment and historic culture. The traditional dwellings in this region have a vertically jagged, well-spaced texture since they were built according to the local topographical features based on the idea of “unity of heaven and man”. The courtyard and shape are not confined to the same size or modulus, there are relatively fewer bays and depth phases indoors, and all depends on the objective conditions. The courtyard layout is straightforward, and very few are multi-door or multi-span courtyards. Due to the difference in technical condition and habit of using local materials, the traditional dwellings in different parts of mountainous central Shandong Province are built of different materials. There are abundant stone resources in the mountains, thus stone is used as a major material for dwelling construction, such as being used to build foundations, walls, and components of all sizes.



Such stone structures, as an integral whole, look as if they grew out of the ground. In the hilly and plain areas, dwellings are primarily made of a mixture of bricks, stone and earth in a simple but sturdy style, while delicate, complicated ornaments are rarely employed. This fully reflects the simplicity and ruggedness peculiar to the traditional dwellings in the mountainous regions.


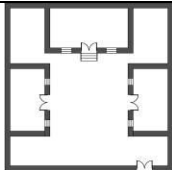

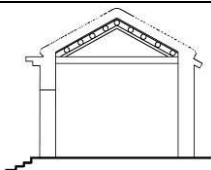

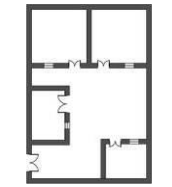

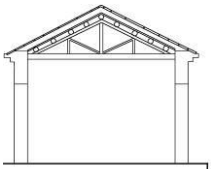

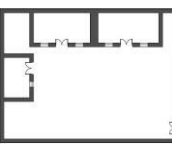

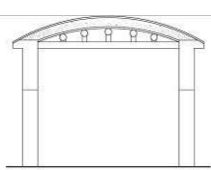
According to the field survey of the building materials and techniques, we divided the traditional dwellings in mountainous central Shandong Province into five types: the stone dwelling made of stone and straw roof; the cobblestone dwelling made of cobblestone and tile roof; the shallow-vaulted roof dwelling made of rammed earth wall and shallow-vaulted roof; the lime slab dwelling made of lime slab and tile roof; the kiln dwelling made of sagger, grey brick and grey tile (see table 1). The traditional dwellings in different areas, however, have something in common due to the similar geographical resources and historic cultural environment, but also have distinctive features owing to the difference in local environment.

2.1. The stone dwelling made of stone and straw roof

This type of stone dwelling is the most unique type of dwelling in mountainous central Shandong Province. It's distributed very widely in mountainous central Shandong Province, namely there is a considerable number of such houses in this region including the mountainous areas of Tai'an, Jinan, Northern Laiwu and Southern Zibo as well as Yimeng Mountainous Areas. In their lifetime, the mountain inhabitants built dwellings with distinctive local characteristics in accordance with the local natural conditions, economic conditions and habits and customs^[2].

This type of stone dwelling is visible in the mountains, and the courtyard layout depends entirely on the topographic features. Most of such courtyards are not subject to a uniform structured layout, while some are built in picturesque disorder along winding mountain roads; some are built in ordered rows along rivers or "around mountains". As for basic pattern, most of the dwellings feature courtyard-style layout, and the courtyards look like quadrangles in a way; some courtyards are a three-section compound in which rooms aren't built on the southern side, and this type of courtyard is commonly known as "dustpan yard". "I" or "L"-shaped courtyards are built in some economically underdeveloped areas. The courtyards are small in size, the walls are low, the shapes differ on a larger scale, and there is an obvious difference in courtyard size (figure 1).

Table 1. Comparative Analysis on the Forms of the Traditional Dwellings in Mountainous Central Shandong Province.

Type	Building Facade	Building Plane	Material & Technique	Roof Construction
Stone Dwelling			 Staggered Joint Lapping	
Cobblestone Dwelling			 Dry Wall Jointing	
Shallow-vaulted Roof Dwelling			 Board Wall Building	

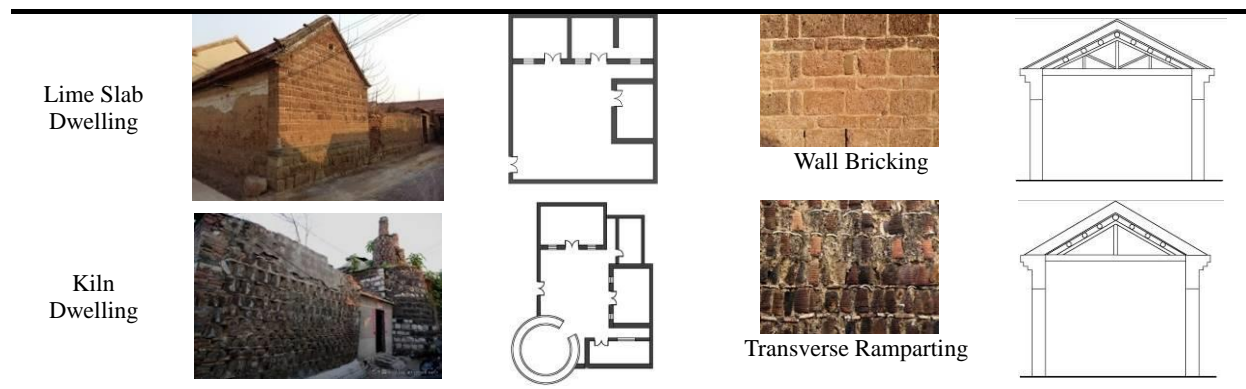


Figure 1 Stone dwelling.

The walls of such stone dwelling houses are built mostly of limestone. With off-white color, natural texture and condensed hue, limestone gives a feeling of belonging and tranquility, is as steady and pristine as Mount Tai, looks beautiful and has high durability. To maintain the intensity and stability of tone walls, the walls are usually built by staggered joint lapping. Wealthy families mainly employed big and neat stone pieces, while common families primarily adopted rubbles. Most walls are thick, and inner wall surface is pointed with lime, or leveled with muddy straw and coated with lime, and the entire maintenance structure is 500~600mm thick. Due to the high freezing resistance and low thermal conductivity of this type of wall, the material characteristics cannot be easily changed under changing climates, whereas it is warm in winter and cool in summer indoors. In inaccessible, economically underdeveloped mountainous regions, this mode of construction “based on local materials” greatly reduced the cost of dwelling construction and saved money for villagers.

This type of stone dwelling has a flush gable roof with grass carpet. The grass is divided into mountain grass and wheat straw, either of which is adopted according to the local conditions. Generally, mountain grass can be used for fifty or sixty years before roof leaks, while wheat straw can be used for only twenty or thirty years^[2]. The gable walls on both sides are usually higher than the roof, and the purlins of simple structure are directly mounted on the gable walls. The purlins are covered with reed matting beneath several layers of earth beneath mountain grass or wheat straw, flushed with cutter, and the two roof slopes are compacted with grass to prevent leakage. The grass roof, which is roughly 200~300mm thick, is sun-resistant in summer and therefore makes it cool indoors.

Such stone dwellings are practical and rarely engraved. Commonly, the cornice or gable front is carved with auspicious characters or patterns, and screen wall is embellished in some wealthy households. For instance, the screen wall of a dwelling in Fashan Village is carved with the character “blessing”, which looks concise but vigorous and reflects the villagers’ simplicity and generosity.

2.2. *The cobblestone dwelling made of cobblestone, stone band and tile roof*

Cobblestone dwelling is mainly located in the natural villages in mountainous Tai'an. Cheng Muheng, a poem annotator of the Qing Dynasty, wrote in Yancheng's Diary, "There are cobblestones everywhere along the foot of Mount Tai, which make the road the roughest and hardest to walk on...all the houses along the road have walls made of cobblestones, and this was not ever seen before." Since the stone in Mount Tai cannot be mined, the villagers nearby had to build houses of the smooth natural stone taken from river shoals, and this is why the local residents have been accustomed to building houses of cobblestone.

Influenced by both the culture of Mount Tai and the Confucian culture, the local residents rendered their dwellings unique in architectural form and cultural spirit, mediocre, well-balanced and structured. Most of the courtyards are rectangular and face south with walls around. The main building is located in the northern part, consisting of three, four or five rooms. Each room is around 3m wide and around 4m deep. The house has a flush gable roof, and the purlins are made mostly of lower-grade wood with the number being five, seven or eleven. The gate is well designed and usually faces southeast, as a local saying goes, "There is the gate in the southeast, toilet in the southwest and kitchen in the east". The inner side of the gate directly faces the screen wall, and the screen wall is basically mounted directly on the gable wall of the wing-room, commonly known as "wall-mounted screen wall", which is the starting point of the spatial order of the entire courtyard. The screen wall, which stands in concert with the gate and blocks sights from the open gate, preserves privacy and the tranquility of life inside the courtyard.

The wall-laying techniques applied to cobblestone dwelling construction have rich connotations, particularly the "dry wall jointing" technique is most characteristic (figure 2). Since the cobblestones taken from river shoals have different shapes and colors, they look lively, interesting and relaxing when being used in walls or pavements. But actually, "dry wall jointing" construction is a piece of skilled work and has very high requirements for the skills of stonecutters, who must have years of experience. The corner of wall and front side of gate are usually made of stone bands or dressed stone, the rear wall, gable wall and courtyard wall are made of quarry stone by dry jointing, the gable wall is built from foot to top, and the wall is roughly 500mm thick. Taking the traditional dwellings in Huangqian, Xiagang and Dajinkou for example, "dry jointing" technique is most used for wall building. The rear wall of some houses had to be built of adobes due to the restriction of conditions. Walls are built of cobblestones in the upper reaches of the tributary of Wenhe River, where the local people build walls of smooth round stone taken from the river by an awe-inspiring laying technique. This well confirms the local phenomenon that "walls made of cobblestones do not collapse".

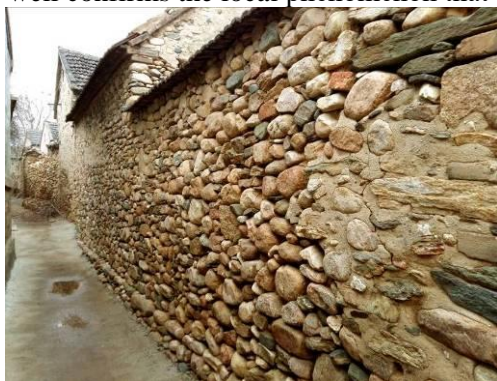


Figure 2 Cobblestone dwelling.

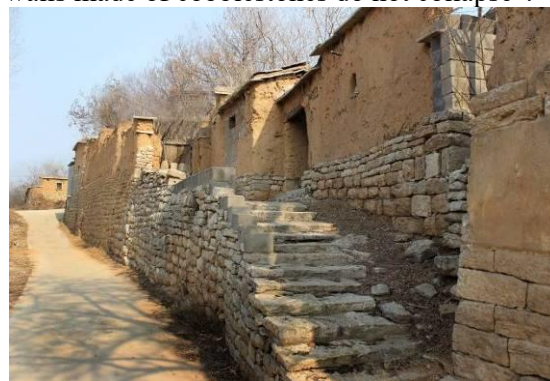


Figure 3 Shallow-vaulted roof dwelling.

2.3. *The shallow-vaulted roof dwelling made of rammed earth wall, stone and shallow-vaulted roof*

Shallow-vaulted roof dwelling is mainly located in western mountainous Jinan, especially Pingyin and Changqing. The local climate is featured by concentrated rainfall, frequent spring drought, quick temperature rise in spring, frequent drought in summer and dry-hot wind in early summer^[3]. Shallow-vaulted roof can prevent strong winds from causing destruction and meet the requirements of

drainage and water resistance. Also, on snowy winter days, it can prevent snow from accumulating on roof, so as to relieve the stress on roof.

Most shallow-vaulted roof dwellings have a three-section compound, while some have a quadrangle courtyard with rooms of two or more storeys around. The courtyard is of simple structure, low, thick and solid, but irregular. The central building is composed of three rooms, and on both sides of the narrow courtyard tightly enclosed by walls there are wing-rooms.

The wall is built of rammed earth and quarry stone. There are large-area warm grey walls made of loess and lime around the ordinary dwelling buildings (figure 3). Due to the specificity of this geographic location where there are many earth piled hills, loess is adopted as a main building material. For higher solidity of wall, wall base is generally built of stone, and upper wall is made of “rammed earth” (rammed earth board frames). In other words, the loess prepared in proportion is poured into molds and rammed, and after the first layer of wall will soon dry, the second layer of wall is made with the first layer as a supported formwork^[4]. Holes are generally reserved in doors and windows, whose upper part carries a lintel made of an entire piece of stone, both sides are installed with a stone frame that is 300mm wide, and lower part is made of a stone band. The windows are mullion windows, and the door leaf is made of wood. It usually takes nearly a month to complete walling. The rammed earth wall, which is roughly 600mm thick, is thick and solid, seeming to be an integral part of the earth piled hills around. Masonry structure was adopted by some wealthy families, and the bearing wall in the lower part is built of stone, while the upper part is built of grey bricks. In order that water could be drained off and wall could be protected, a low wall pier was built on the eaves, which pours the rainwater on the roof down to the courtyard through the eaves gutters. This design can effectively protect walls from rainwater.

The middle of the roof is slightly arched, which is actually an arc beam frame composed of straight girder and short column. The purlin rafters are covered with sorghum straw beneath a thick layer of mixture of lime, earth and sand, and the surface layer is shaped like an arc gentle slope coated with lime, seeming firm and pristine. Compared with a steep slope roof, a gentle slope roof is more practical, where habitants could take a rest to enjoy the cool or store something or have something aired. For convenience's sake, some families built a parapet wall on the roof, so that the roof could be safer for human activities.

2.4. The lime slab dwelling made of lime slab and tile roof

The traditional dwelling made mainly of lime slab is located primarily in eastern hilly Jinan and plains. Jinan Prefecture was an important administrative and commercial center during the Ming and Qing Dynasties, around which were many official roads leading to other parts of China. Compared with ordinary villages, there were commercial development opportunities for the villages long the official roads, where higher-quality houses were built on a larger scale. The traditional villages in Boping Village and Yangguan Village in Zhangqiu are most typical.

In terms of architectural form, the lime slab dwelling has a layout and structure the same as that of the traditional quadrangles in northern China. The north-south axis runs through the house and courtyard including gate, second gate, screen wall, reverse seat, principal room and wing-room. The house usually has a flush gable tile roof and wood lattice windows, and the thick walls and roof make it warm in winter and cool in summer indoors.

This type of dwelling is in general built with bluestone as the foundation, black bricks as the wall corners and lime as the walls. There were many coal pits in Zhangqiu in the past, where the local villagers made coal and clay into coal cakes, which burnt to form slag, a raw material of building. The following are brickmaking steps: scrunch slag, mix powdered slag with lime by 7: 3, add water to the mixture and stir it to make slag paste; then fabricate 400mm×180mm×100mm adobes in molds and make them lime adobe bricks after drying them. In the locality, a lime adobe brick wall is built of lime adobe bricks and earth: the wall base is built of bluestone, the wall is built of earth covered with bricks, and that the wall surface is covered with single bricks. Generally, the wall is coated with a layer of single bricks vertically, and then a layer horizontally. After every four or three single bricks are laid, a

brick will be inserted into the earth wall vertically, to enhance the firmness of the wall surface (figure 4). Such wall is low-cost, sturdy and durable, and can be used for one hundred years or so. Additionally, the beautiful shape of the arch over the gateway, windows, ridge and eaves reflects the local high construction technique and cultural level.

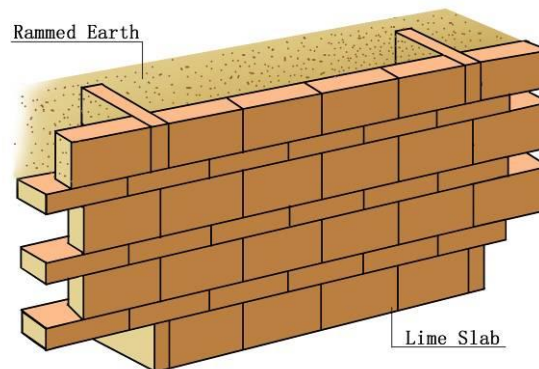


Figure 4 Brick-coated wall structure.

2.5. The kiln dwelling made of sagger, grey brick and grey tile

Boshan is located in the northern part of mountainous central Shandong Province, consistently known as the “home of ceramics” since it has abounded with ceramics since ancient times. There were many kilns around this region, and products sold well, even to “remote villages hundred miles away”. Ceramic production had its heyday before and after the reign of Emperor Qianlong of the Qing Dynasty, particularly Shantou, Yaoguang, Badou, Beiling, Wudian and Fushan became famous for kilns.

Most of the kilns in Boshan were family-style round kilns, which are also known as “dome kiln” since they look like a steamed bread. To facilitate production and life, kiln workers built dwellings near to dome kilns, thus bringing ceramic dwellings into being with the lapse of time. The materials used were made of ceramic wastes and ceramic raw materials, such as rejected sagger, yellow sticky board and kiln moraine, etc., which were mainly used in building walls, enclosing walls and floors. Sagger was a kind of protective kiln furniture used in the process of ceramic firing, which is usually made of high-temperature-resistant coarse materials. After repeated use, sagger would get damaged and no longer be used for ceramic production, and simple, economical kiln workers would bring them home and use for wall or courtyard construction. Hollow pot sagger was light, firm, weatherproof and corrosion-resistant. Here, kiln workers made the most of such rejected materials, and even applied pot bottom and potsherd to paving or inserted into earth to enhance skid resistance. Yellow sticky board was made from dried ceramic clay by furnace roasting, mainly applied in roof, overhanging eaves and tile tip^[5]. In the locality there is another special fire-resistant material—kiln moraine, which is square or rectangular, thicker than ordinary bricks, and looks yellowish brown. Rectangular kiln moraine is 320mm long, 160mm wide and 35mm thick, usually used for walling; square kiln moraine is 320mm long and 35mm thick, usually used for indoor paving.

3. Conclusions

Despite much similarity between the traditional dwellings in mountainous central Shandong Province in similar geographic and geomorphic conditions, they also show some differences under the influence of social and natural factors. Thus it can be seen that regional condition has great impact on dwellings, and local residents carried out creation according to local natural resources, thus forming a variety of vernacular dwelling forms^[6]. This feature is not only a physical embodiment of the local spiritual culture, but also the intelligent crystallization of the local residents’ dialogue with nature and adaption to nature, which endows the dwellings with a unique aesthetic and practical value. Undeniably, with

the development of new rural construction, the traditional dwellings with regional characteristics are subject to extinction, appearing as that the traditional materials and techniques are being replaced with new materials and techniques. Also, the construction techniques are subject to extinction. Therefore, it is very important to conserve the traditional dwellings in a diversified way, so that the regional characteristics could draw sufficient attention and be handed down.

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