# A Brief Analysis of the Architectural Forms and Architectural Culture of Courtyard Dwellings in the Luoyang, Henan, China

**Miaomiao Huo[1], Liyue Wu[1,2], Yanjun Li[1,*]**
*[1]School of Design & Art, Shaanxi University of Science and Technology, Xi'an, Shaanxi, China*
*[2]Xi'an Zhongda Shiye Co., Ltd., Xi'an, Shaanxi, China*
**Corresponding Author*

**Abstract: Luoyang, Henan is located in the core region of Heluo culture. Its courtyard dwellings are shaped by both natural geography and a rich cultural-historical context. They are an important representative of traditional residential forms in the Central Plains, integrating practical functions, spatial aesthetics, and distinct regional cultural identifiers. They are also a distinct product and living heritage nurtured by Yellow River culture and the broader Chinese civilization, with irreplaceable value. Strengthening research and conservation of traditional dwellings in Luoyang therefore has practical relevance, academic value, and historical significance. Based on a literature review, field investigation, on-site measurement and mapping, and architectural drawing, this study provides a systematic analysis of courtyard dwellings in Luoyang. It focuses on three aspects, an overview of the dwellings, architectural form, and building structure. Two courtyard forms are examined through case-based analysis, the mountain-site courtyard form and the narrow courtyard form, with attention to basic architectural form, courtyard layout, and building structure. The findings further refine and deepen a systematic understanding of courtyard dwellings in Luoyang and provide an academic basis for the conservation, inheritance, and sustainable development of dwelling architecture in Luoyang, Henan.**

**Keywords: Luoyang Courtyard Dwellings; Traditional Dwellings; Architectural Forms; Formal Features**

## 1. Introduction

Western Henan is located in the western part of Henan Province. Its administrative jurisdiction covers the two prefecture-level cities of Luoyang and Sanmenxia and spans approximately 25,166 km² (Figure1). Long-term interaction and integration among ethnic groups and cultures have shaped the region into a multicultural convergence zone that brings together Heluo culture, agrarian culture, and commercial culture [1]. As a cultural carrier, courtyard dwellings concentrate and convey the distinctive architectural culture of this region. Their spatial organization and construction know-how directly respond to local environmental conditions and vernacular lifestyles, resulting in regional identity and heritage value that are not readily replaceable.

## 2. Overview of Luoyang Traditional Dwellings

Courtyard dwellings in Luoyang have a long construction history and were strongly influenced by Heluo culture and Central Plains ritual norms. Variations in geology and topography contributed to two architectural forms, the mountain courtyard form and the narrow courtyard form. These dwellings are typically characterized by a brick-and-timber structural system that combines grey brick, grey tiles, timber framing, and stone foundations [2]. Courtyard dwellings in western Henan commonly appear either as clan-based settlements or as independent residential compounds. Several residences of substantial scale, with well-preserved architectural form and high construction quality, have become representative reference cases in the region, including the Wang Family Compound in Xin'an County and the Wei Family Compound in Mengjin County.

### 2.1 Natural and Cultural Context

Luoyang receives abundant sunshine throughout the year, with particularly favorable conditions in the Luo River Basin. Situated in

the transitional zone from the Loess Plateau to the western Henan hills, Luoyang has a typical north-temperate continental monsoon climate. Together, these environmental conditions provide both material resources and constraints for dwelling construction. In parallel, as a core bearer of Heluo culture, ritual norms and social structure accumulated over millennia shape the spatial order and cultural expression of courtyard dwellings. Accordingly, the architectural form of courtyard dwellings in Luoyang is shaped by the combined influences of the local natural setting and the region's cultural-historical context.

In terms of the natural setting, Luoyang is characterized by an interspersed distribution of mountains, tablelands, and river valleys. The terrain shows pronounced relief, forming a layered and varied geomorphological landscape [3]. Local soils are dominated by loess, which is relatively homogeneous and exhibits well-developed vertical joints. These properties provide favorable stability and workability, supplying high-quality raw material for rammed-earth walls and for firing bricks and tiles used in courtyard dwellings. Over time, courtyard dwellings have been widely adopted because their spatial configuration is highly responsive to local conditions and their construction logic reflects effective adaptation. Many traditional courtyards remain preserved and in use today, indicating sustained viability and environmental fit.

From the perspective of cultural and historical context, courtyard dwellings in Luoyang reflect a clearly defined hierarchical order shaped by Confucian ritual norms and lineage-based social organization. This order is expressed through bilateral symmetry organized around a central axis and through the primacy of the principal hall within the spatial sequence [4]. Historically, Luoyang also functioned as a commercial hub, which facilitated the exchange and integration of construction techniques from different regions and expanded the repertoire of detail-oriented decorative practices. Through the combined effects of these factors, courtyard dwellings in western Henan became material carriers of regional culture, ethical norms, and social memory.

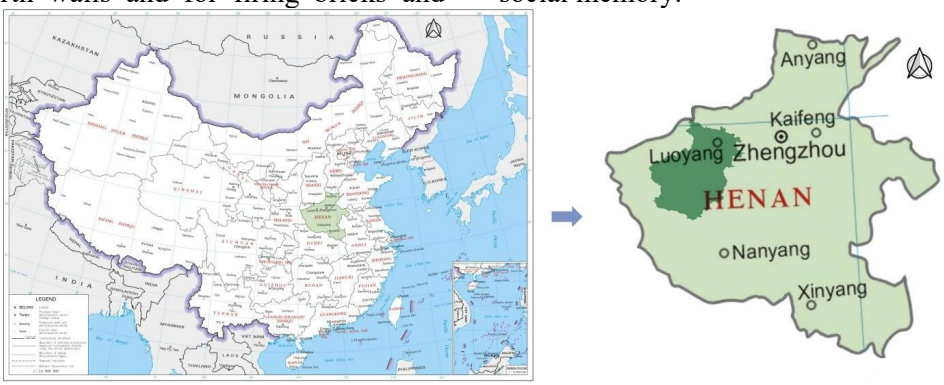



**Figure 1. Geographic Location of Luoyang in China**
**Source: Adapted from Ministry of Natural Resources of the People's Republic of China, with Modifications by the Author.**

## 2.2 Basic Architectural Forms

The basic architectural form of traditional courtyard dwellings in Luoyang is not reducible to a single template. Instead, within the shared framework of Central Plains courtyard dwellings, two regionally typical forms developed through adaptation to complex terrain and locally specific socio-cultural requirements, namely the mountain-sited courtyard form and the narrow courtyard form. The former is widely distributed across hilly and mountainous settings, whereas the latter is more common in plains and towns where buildable land is constrained. Together, these forms indicate a dynamic balance between ritual order and environmental constraints and form a diverse yet coherent regional repertoire of architectural form in western Henan.

The mountain-sited courtyard is concentrated in thin-loess hilly zones with exposed bedrock, such as the Xiong'er Mountains and the Xiao Mountains. Its construction is closely adapted to complex terrain. Regular symmetry is not retained in the layout, and the resulting architectural form is often irregular (Figure 2a). Building materials are primarily locally sourced stone, loess, and grey brick, forming a mixed system characterized by stone foundations, earthen walls, and brick facing. Site selection

follows the tradition of single-gate, single-household compounds. It also prioritizes risk avoidance for geological hazards, ensures convenient access, and favors leeward, sun-facing slopes to jointly support residential safety and outdoor thermal comfort. This form reduces reliance on rigid ritualized form and instead employs flexible construction strategies to achieve an integrated relationship between habitation and the mountain environment.

**(a) Mountain-Sited Courtyard Form**

**(b) Narrow Courtyard Form**

**Figure 2. Examples of Courtyard Dwellings with Different Architectural Forms in Luoyang**

**Source: Photograph by the Author.**

The narrow courtyard form developed primarily in response to historically high population density and constrained residential plots in the region. It represents an adaptive solution to limited land availability. Its defining features are a compact layout, an elongated and narrow courtyard, and vertical expansion. Dwellings of this type commonly adopt a two-storey arrangement and maintain the ritual spatial sequence and inward orientation of the courtyard through disciplined axial control. As a result, the facade of the principal hall is partially screened by the side wings, and gable walls directly function as courtyard enclosure walls. This form thereby maximizes usable residential space within a limited plot (Figure 2b).

### 2.3 Architectural Aesthetics

The architectural aesthetics of courtyard dwellings in Luoyang are not expressed through a single idiom. They operate within a shared regional vocabulary, yet their formal emphasis and representational focus shift with setting, courtyard form, and social standing. In mountain-sited courtyard forms, aesthetic effect derives primarily from site-responsive construction. Ornament is secondary to the making of the building. The wall base is typically built with minimally dressed local bluestone and rough stone, laid either dry or in mortar to produce a substantial, coarse-grained plinth. Above, adobe brickwork is combined with plastered finishes, and the junction between materials is clearly legible. Roofs are commonly double-pitched flush-gable types finished with grey tiles. Eaves project only slightly, and the roof silhouette tracks the undulating mountain terrain. Openings are treated with practical square-grid patterns, with design decisions guided by function and durability. Together, these choices yield an architectural expression that is plain, resilient, and closely aligned with the rocky slopes and loess ground.

Narrow courtyard forms, by contrast, rely on a highly systematized decorative program and a rigorously ordered ritual spatial narrative. Their central approach is to offset narrow and elongated plots through a vertically extended and deepened spatial sequence. Decorative work is therefore concentrated at key points, including the entrance gateway, the underside of the eaves, and door and window openings. Brick-carved lintels and finely executed wooden latticework create emphasis within limited surfaces through precise craftsmanship. Disciplined grey-brick and grey-tile workmanship, together with a subdued palette, supports an ordered residential atmosphere under tight constraints. In everyday use, this formal and decorative regime sustains both ritual norms and expectations of residential quality.

## 3. Analysis of the Architectural Form of Courtyard Dwellings in Luoyang

Terrain-adaptive combinations of courtyard forms produce layered spatial structures in Luoyang courtyard dwellings. Based on a literature review, field investigation, on-site measurement and mapping, and architectural drawing, this study identifies two representative courtyard dwelling forms for case-based

analysis and discussion.

### 3.1 Mountain-Sited Courtyard Form: Wang Family Compound

The Wang Family Compound is located in Dongshandi Village, northwest of Shijing Town, Xin'an County, Luoyang, Henan. In 2014, the village was included in the third batch of the China Traditional Villages List, and in 2019 it was selected for the first batch of National Forest Villages [5]. The compound was built in the mid-to-late Qing period and employs a mixed structural system combining stone, brick, earth, and timber. Overall preservation is relatively good, with the main structure intact, although some decorative details are damaged. The complex comprises a principal courtyard and a secondary courtyard, with a total site area of approximately 650 m². It is currently unused and is overseen by members of the Wang lineage. The compound provides an important physical reference for examining mountain-sited courtyard forms and lineage-based residential patterns in this region (Figure 3).

The courtyard is a two-storey courtyard dwelling, indicating an approach in mountain settlements that expands living space vertically under limited land availability. The principal courtyard faces south. Its entrance gate is on the east side. Upon entry, the east and west side wings are encountered, and a two-storey principal hall stands on the north side. On the ground floor, the central bay functions as the main hall, while the side bays are used as bedrooms. The second storey provides auxiliary living space.

**Figure 3. Current Condition of the Wang Family Compound**
**Source: Photograph by the Author.**

The courtyard extends outward on the east side. A vegetable plot is arranged to the north, and livestock sheds are placed to the east, forming a laterally integrated spatial arrangement that combines residential and productive functions. Functional zoning is clearly defined and corresponds to the practical requirements of an agrarian way of life.

The secondary courtyard is located to the west of the principal courtyard and has a compact layout. Its gate opens to the south. Side wings are placed on the west side, and the principal hall is on the north side. The building mass is smaller than that of the principal courtyard, suggesting use by collateral branches of the family or for storage. Although the two courtyards are relatively independent, they are connected by an alley, together forming a family-centered spatial cluster. This arrangement reflects a nucleated settlement pattern in mountain villages where kinship and locality overlap (Figure 4).

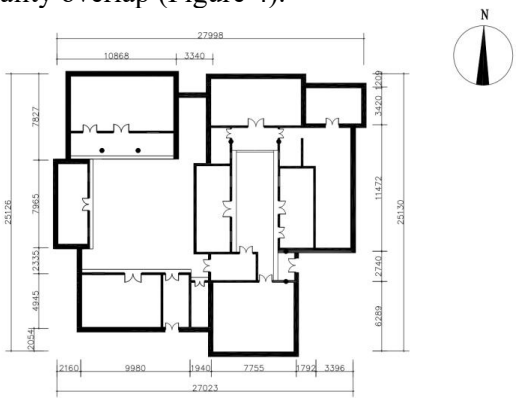



**Figure 4. Plan of the Wang Family Compound**
**Source: Drawing by the Author.**

The structural system of the Wang Family Compound reflects construction practices in the mountain areas of western Henan that respond to local conditions and rely on locally available materials. Wall construction follows a clearly articulated three-stage vertical stratification of

stone, brick, and earth. The lowest stage is a rubble foundation layer, dry-laid with irregular local bluestone and red sandstone, and it primarily provides structural anchorage and acts as a barrier against groundwater. Above this is a grey-brick plinth layer built with regular brickwork, which serves as the base for the earthen wall above. The main wall body is formed as a rammed-earth layer. The loess is sourced locally and is mixed with wheat straw and other fibers to improve toughness. It is shaped through either rammed construction using formwork or adobe masonry, producing walls with thermal insulation and heat-buffering performance (Figure 5).

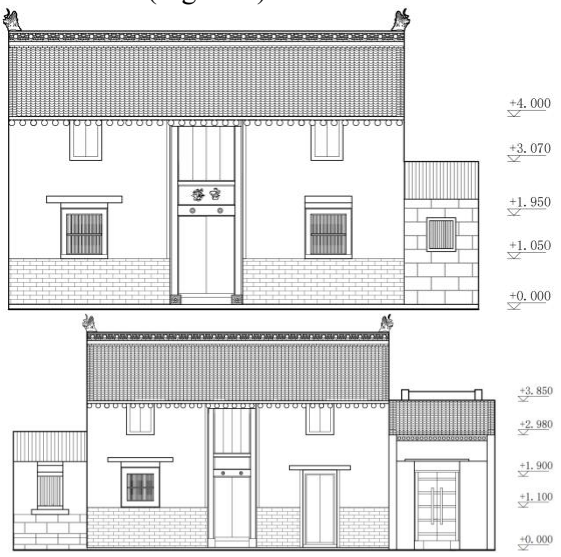



**Figure 5. Elevation of the Wing Rooms in the Principal Courtyard of the Wang Family Compound**
**Source: Drawing by the Author.**

The roof adopts a double-pitched flush gable roof. The timber frame is primarily a post and lintel construction. Beams, purlins, and rafters are made from locally sourced pine, elm, and other hardwood species. Joints use mortise-and-tenon connections, producing a flexible structural system that helps maintain overall integrity when enclosing walls are compromised (Figure 6). Roof tiling follows a dense laying method with a 7:3 overlap ratio, which helps prevent wind uplift. Ridge treatment is restrained. The main ridge is built by stacking flat tiles, and the two ends turn up slightly. The roof pitch is relatively steep, which facilitates rapid drainage. Together with the thick stone-and-earth walls, the roof assembly forms a stable protective envelope with improved wind resistance and efficient water shedding.


**Figure 6. Elevation of the Principal Halls of the Principal and Secondary Courtyards in the Wang Family Compound**
**Source: Drawing by the Author.**

The door and window system clearly reflects a practical priority in mountain dwellings. Openings are generally small and predominantly rectangular. Window lattices are typically simple, using straight members or basic square-grid patterns. Timber frames are robust, supporting basic daylighting while reducing heat loss and improving structural stiffness. Doors are commonly solid plank doors assembled from timber boards, with substantial thickness. Overall, ornamental treatment is secondary to requirements for thermal performance, durability, and economy, directly indicating adaptation to cold mountain conditions and constrained material resources (Figure 7).

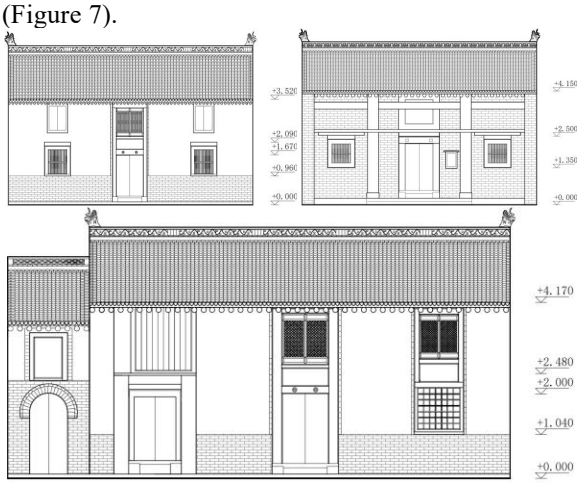



**Figure 7. Elevation of the Wing Rooms in the Secondary Courtyard of the Wang Family Compound.**

**Source: Photograph and Drawing by the Author.**

### 3.2 Narrow Courtyard Form: Wei Family Compound (Xiuba Yilin Courtyard)

The Wei Family Compound is located in Weipo Village, Mengjin County, Luoyang, in a transitional zone from loess tablelands in western Henan to the river-valley plains [6]. The village has a long history. The Wei lineage residential complex is characterized by disciplined planning and refined workmanship and is regarded as one of the most well-preserved, largest-scale, and most comprehensive Qing-period architectural ensembles in the Central Plains [7]. Xiuba Yilin Courtyard is a residence built during the Jiaqing reign of the Qing dynasty for Wei Shengsan, a wuzhuangyuan (top scorer in the imperial military examination). The total site area is approximately 1,200 m². The compound faces south and forms a composite courtyard complex consisting of street-front buildings, a passage hall, a central hall, a hall building, and an enclosing subsidiary courtyard. Its construction indicates an integrated relationship between the residential requirements of a military official and regional architectural characteristics of the Central Plains (Figure 8).

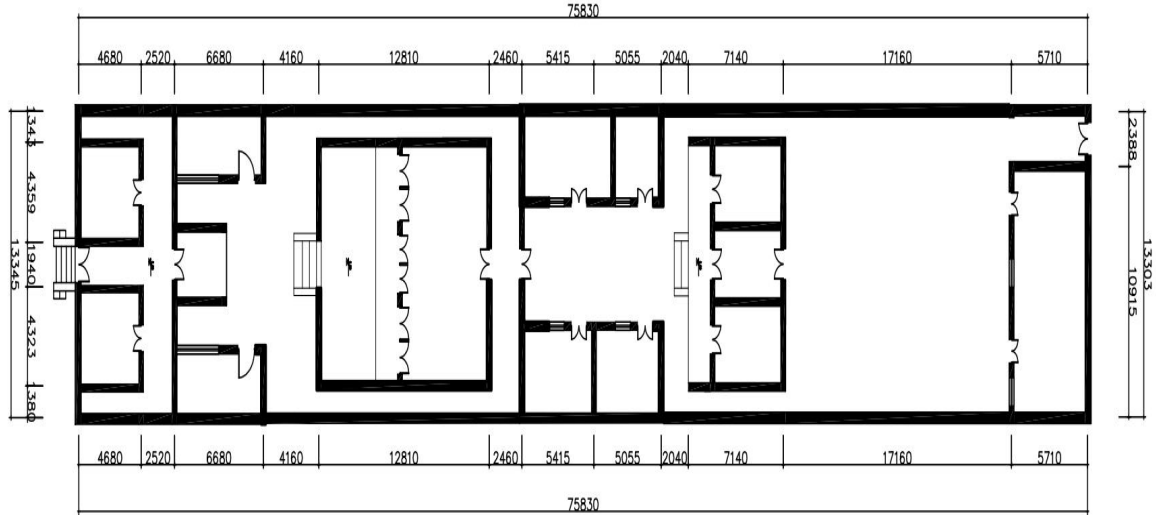



**Figure 8. Plan of the Wei Family Compound.**

**Source: Drawing by the Author.**

The first courtyard is enclosed by a two-bay street-front building and a passage hall, forming an outward-facing reception zone. The central bay contains the main gate. A brick-built entry porch frames the doorway, whose opening is square on the exterior and round on the interior, indicating the traditional cosmological concept of a round heaven and a square earth. The side bays function as the steward's room and a reception room, respectively, supporting routine management and hosting needs. Guard passages are arranged along both the east and west sides. Each passage is approximately 1.2 m wide and allows guards to circulate and stand watch, indicating defensive features characteristic of a military-official residence (Figure 9).

The second courtyard is organized around the central hall and functions as the ceremonial space of the residence. A bluestone terrace platform is set in front of the courtyard. It is 0.6 m high, 5.4 m wide, and 3.6 m deep. A transition is created through four steps, and wing rooms are arranged symmetrically on the east and west sides. Peonies are planted on both sides of the terrace platform, enriching the courtyard landscape and connoting prosperity.

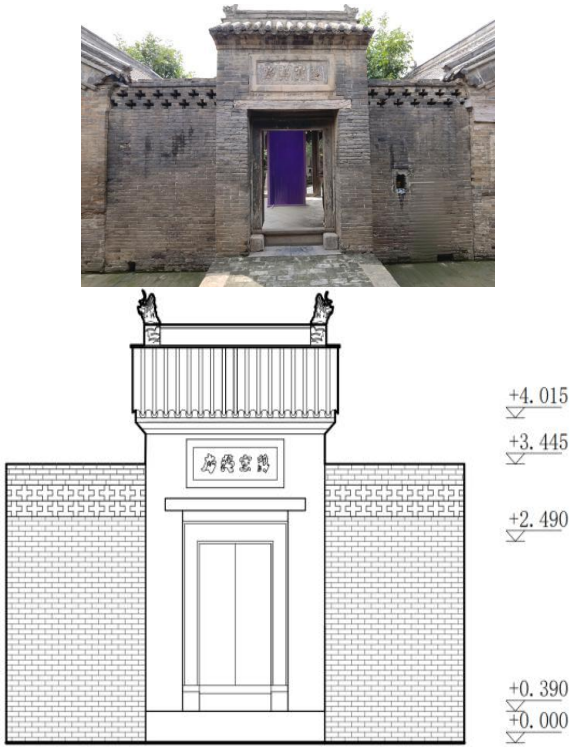
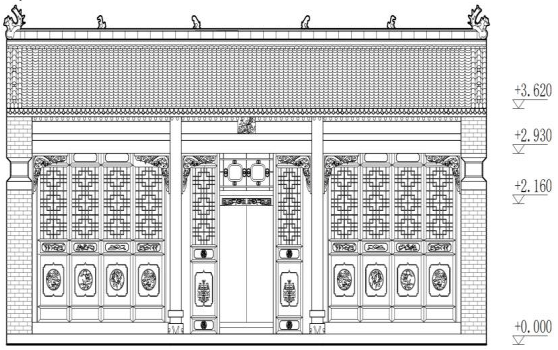



**Figure 9. Current Status and Elevation of the First Courtyard of the Wei Family Compound**
**Source: Photograph and Drawing by the Author.**

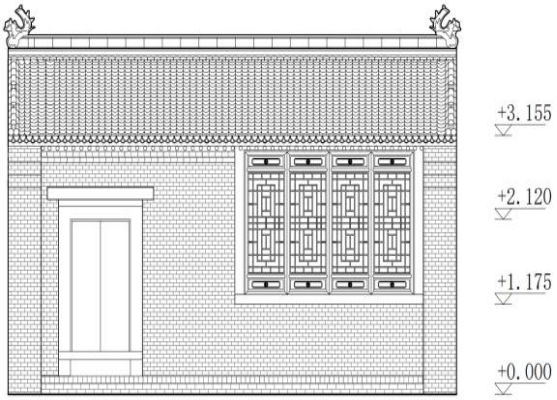
The central hall has a five-bay frontage and an eight-rafter depth. Its building mass is dominant within the courtyard and signals the owner's social standing. The central hall uses a twelve-purlin framing system. The beam frame is made of elm with diameters of 0.28–0.32 m, and mortise-and-tenon joints are executed with fine workmanship. The front eaves include eave columns with a diameter of 0.32 m that support an overhanging eave reaching 1.5 m (Figure 10).

The third courtyard is organized around a two-storey main hall as the principal building. Wing rooms are arranged symmetrically on the east and west sides, forming a complete inward-oriented layout. The ground floor of the hall building serves as the owner's bedroom, while the second floor is used as an embroidery chamber. The floor is finished with thick fir boards, supported by timber joists beneath. This assembly ensures floor stiffness while limiting material consumption.

The east and west wing rooms accommodate the eldest son and the second son, respectively. Their building scale is reduced relative to the principal hall, indicating the age-based hierarchy within the traditional household. Individual buildings are connected through transitional spaces such as the passage hall and the terrace platform. While meeting functional requirements, differences in spatial hierarchy reinforce conventional ethical norms (Figure 11).




**(a) Elevation of the Central Hall**




**(b) Elevation of the West Wing Room of the Second Courtyard**

**Figure 10. Elevations of the Second Courtyard of the Wei Family Compound**
**Source: Drawing by the Author.**

The service courtyard is connected to the main courtyards by an independent passage. It has a rectangular layout with a frontage of 11 m. It contains living quarters for the steward, maids, and servants, together with supporting service facilities. A martial training ground is set on the west side of the courtyard. The ground surface is paved with grey bricks, and the area is approximately 60 m², serving as a dedicated space for Wei Shengsan's daily training.

The service courtyard and the principal courtyard are linked by the passage. This arrangement supports efficient service circulation while maintaining the privacy of the main courtyard (Figure 12).

Exterior decoration at the Wei Family Compound indicates design choices associated with a military-official residence. The main gate is equipped with local bluestone mounting blocks arranged as two steps, with heights of 0.4 m and 0.7 m, respectively. The drum-shaped

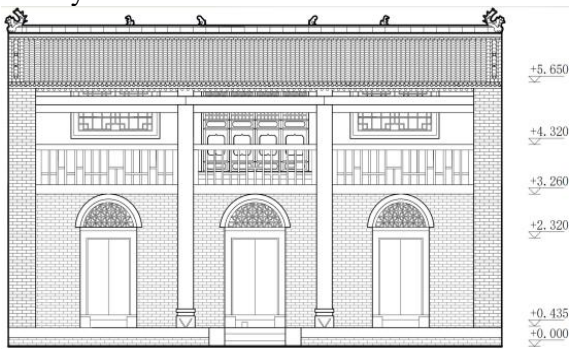
 

gate piers feature peony and scrolling-vine motifs on the drum face, while the bases are ornamented with lotus patterns, connoting prosperity and integrity. A plaque inscribed with Xiuba Yilin, granted by the Jiaqing Emperor, is suspended above the lintel. The plaque uses large characters finished in gold paint, indicating the elevated status attributed to the residence (Figure 13a).

Brick carving is concentrated at elements such as the chitou (pier head), the screen wall, and the corridor infill walls. High-relief carving and openwork carving are used to depict auspicious themes, including the Fu–Lu–Shou triad, bogu motifs, and auspicious beasts. Fine workmanship, together with the material contrast created by grey brick and white mortar joints, conveys auspicious meaning within a disciplined ritual framework and produces an overall decorative effect that is three-dimensional and restrained (Figure 13b).

Wood carving is concentrated beneath the eaves, on beams and brackets, and in door and window latticework. At focal points within the beam-and-bracket system, the Longmen beam is executed in high relief and depicts subjects such as Kunpeng spreading its wings and a rhinoceros gazing at the moon, indicating aspirations toward elevated ambition. Beneath the eaves, purlin pads and interlocking transverse members are densely covered with continuous motifs, including scrolling passionflower vines and the Three Friends of Winter (pine, bamboo, and plum). Door and window design shows deliberate craftsmanship. On the panelled folding doors of the principal hall, the lower panels are carved in relief with the emblems of the Hidden Eight Immortals and with scenes of fishing, woodcutting, farming, and study. These images convey an auspicious subtext associated with future success as well as health and longevity (Figure 13c).

The main ridge uses hollow openwork brick-carved ridge elements. A treasure vase is set at the center, and chiwen ornaments are placed at both ends. At the front end of each vertical ridge, a sequence of ridge figures and animals is arranged (Figure 13d). Along the eaves, round tile-ends are consistently molded with the seal-script character shou, and the drip tiles are decorated with lotus motifs. These components follow official-style construction practice. At the same time, their craft detailing and proportional control exhibit regional characteristics of the Central Plains. Together with the overall palette of grey brick and grey tiles, they create a residential image that is restrained and dignified while retaining visual vitality.




**(a) Elevation of the Two-Storey Hall**


**(b) Elevation of the West Wing Room**

**Figure 11. Elevations of the Third Courtyard of the Wei Family Compound**
**Source: Drawing by the Author.**

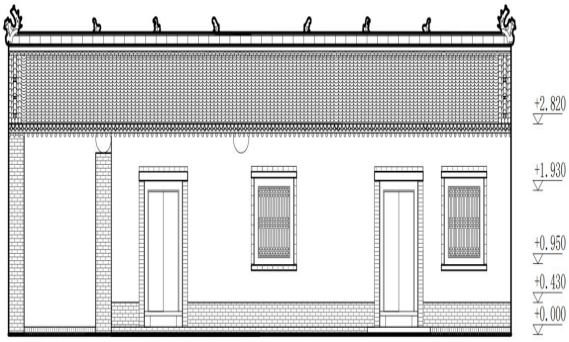
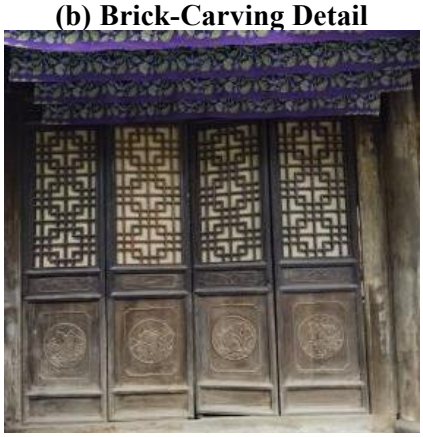



**Figure 12. Elevation of the Service Courtyard of the Wei Family**
**Source: Drawing by the Author.**

**(a) Elevation of the Main Gate**

**(b) Brick-Carving Detail**



**(c) Door-and-Window Detail**

**(d) Roof Detail**

**Figure 13. Decorative Details of the Wei Family Compound**
**Source: Photograph by the Author.**

## 4. Analysis of Building Construction

Compared with Henan kiln dwellings, courtyard dwellings are distinguished by the systematic integration of timber framing with an enclosing courtyard layout. The mountain-sited courtyard form is used as the example for the discussion. In addition, building components such as walls, doors and windows, pedestals, and entrance gates have clearly defined structural configurations. These components contribute to overall structural stability, spatial layering, and the articulation of ritual order within courtyard dwellings.

### 4.1 Building Components

(1) Beam frame and roof. The roof framing system of mountain-sited courtyard dwellings in Luoyang mainly includes two structural types, post and lintel construction and column and tie construction, with mixed application as a typical feature (Figure 14). Post and lintel construction relies on tiered support through beams and columns, producing a relatively lofty interior space and an extended roof silhouette. It is therefore commonly used in primary buildings such as the principal hall and major halls to obtain a more open interior with fewer obstructing supports. Column and tie construction places columns in direct support of purlins, forming a dense and linearly organized frame. It is typically used in spaces with narrower frontage width and shallower depth and is widely applied to wing rooms and other secondary service spaces. This selection is directly related to local timber-resource conditions, inherited craft practices, and functional hierarchy requirements. The combined use of the two framing systems differentiates primary and secondary buildings structurally and clarifies distinctions between interior and exterior domains and spatial hierarchy [8].

Roofs commonly adopt a double-pitched flush gable roof, and the roof covering is primarily locally fired grey flat tiles. The construction sequence is straightforward. Rafters are set on purlins, with reed matting or roof boarding laid above as a bedding layer, followed by overlapping courses of flat tiles and barrel tiles. The roof pitch is generally controlled within a four- to five-tenths slope, which supports rapid drainage. The ridge is formed by stacking flat tiles. On both sides, the gable walls directly enclose the roof edges. Eaves are absent or only slightly projected, producing a restrained and stable silhouette. This roof form not only sheds rainwater effectively, but the substantial tile work and relatively steep pitch also correspond to the local climate, characterized by rainy summers and cold winters in Luoyang. It represents a direct technical response in dwelling construction to environmental conditions (Figure 15).

(2) Walls. A typical wall system is a layered composite assembly. The lower section is built as a solid foundation using locally sourced rubble or dressed stone. The middle section uses grey brick to form a damp-proof plinth, and the upper section forms the main wall body in rammed earth or adobe [9]. This vertical material sequence of stone, brick, and earth enables a transition from rigid load-bearing

support to more compliant enclosure. Functionally, it also addresses stability, moisture resistance, and thermal insulation, representing a construction strategy that integrates economy and practical performance.

**Figure 14. Beam Frame System of Mountain-Sited Courtyard Dwellings in Luoyang. Source: Photograph by the Author.**

**Figure 15. Roof of Mountain-Sited Courtyard Dwellings in Luoyang. Source: Photograph by the Author.**

(3) Doors and windows. The construction logic of doors and windows is centered on functional adaptation. Stone or heavy timber lintels are commonly used to carry the wall mass above openings. Door and window openings are narrow and relatively small in proportion, which reduces heat loss. In detailing, window lattices typically adopt restrained patterns such as straight members and square grids, balancing daylighting needs with structural stability. Door leaves are mainly assembled from solid timber boards, and the door pivot is often set directly into a stone door socket. This localized expression under shared functional requirements indicates adaptation to both regional resources and climatic conditions.

(4) Entrance gate. The placement of the entrance gate is commonly conditioned by terrain. It is often set on the side of the courtyard or approached through a turning alley rather than being strictly centered. The gate form is typically wall-integrated and structurally plain. The opening is commonly framed with stone jambs and a stone lintel. Gate leaves are thick and robust. Overall, gate construction does not prioritize axial symmetry as a ritual device. Instead, it emphasizes circulation convenience, integration with the surrounding landform, and basic security protection, indicating an effective response to local environmental conditions.

### 4.2 Drainage Facilities

The drainage system of mountain-sited courtyard dwellings in Luoyang forms an integrated sequence from roof surfaces to the courtyard and then to areas outside the compound. Through coordinated construction detailing and spatial organization, it directs rainwater in a controlled manner across the building and site. The primary objective is to protect rammed-earth walls and brick-and-stone wall bases and to keep the courtyard dry. This

system can be described at three functional levels, the roof, the courtyard, and the exterior of the compound.

(1) Roof drainage. The double-pitched flush gable roof uses a pronounced pitch, typically a four- to five-tenths slope, corresponding to a relatively steep roof pitch, together with a tightly overlapped grey-tile covering, allowing rainwater to collect quickly and shed downslope [10]. A critical factor is the eave projection depth at the front and rear eaves. Rafters extend 60–100 cm beyond the wall line, creating deep eaves. This projection carries roof runoff away from the wall face so that dripping or concentrated flow remains at a safe distance from the wall base. It helps throw water as far as possible from the foundation zone and reduces direct scouring and splash erosion on wall surfaces, especially where adobe or rammed-earth sections are present [11].

(2) Courtyard drainage. Courtyard drainage performs the core functions of organization and transfer. The courtyard ground is typically paved with grey brick or formed as a compacted clay layer. It is graded with a subtle slope toward a drainage inlet, commonly referred to as a floor drain or water eye [12]. Rainwater concentrates along this slope and enters a pre-buried underground brick-and-stone covered channel through the inlet. In narrow and elongated courtyards, drainage routes are usually arranged along the central axis or along one side. In mountain courtyards, by contrast, drainage is organized in relation to terrace level differences, using stepped open channels or stone-lined culverts to convey flow in stages.

(3) Drainage outside the compound. Drainage outside the compound functions as the terminal outlet of the system. Covered channels convey collected runoff to public drainage ditches outside the courtyard, to natural gullies, or to dedicated soakaway pits. A soakaway pit filters and infiltrates water through layers of sand and gravel. It thereby supports groundwater recharge and provides buffering capacity during heavy rainfall [13]. The overall system is hierarchically organized and largely concealed in construction. It provides key infrastructural support for the long-term persistence of mountain-sited courtyard dwellings under the semi-arid monsoon climate of western Henan.

### 4.3 Heating Facilities

Heating in mountain-sited courtyard dwellings in Luoyang is achieved primarily through an independently built kang system, a traditional masonry bed–stove with internal flues that stores and releases heat from cooking activities. The kang is typically constructed in brick or adobe and incorporates a winding internal flue network. It is connected to the kitchen stove to reuse residual heat from cooking. Placement varies with room function. In the principal hall or in the side bays of wing rooms, it is commonly set beneath the south-facing window and is also referred to as a front-window kang. In secondary rooms, it is placed against an interior wall and is referred to as a wall-side kang to improve heat retention. Heat is released from the kang surface and is buffered by the thermal mass of thick walls, supporting a relatively stable indoor temperature. This facility indicates an adaptive energy-use strategy within a timber-and-masonry dwelling system, based on locally available materials and coordinated thermal organization.

## 5. Conclusion

This study provides a preliminary discussion of courtyard dwellings in Luoyang from two perspectives, the natural conditions shaping their formation and the region's cultural-historical context. It summarizes key aspects of architectural aesthetics and architectural forms. Two representative cases are examined, the mountain-sited courtyard form of the Wang Family Compound in Xin'an County and the narrow courtyard form of the Wei Family Compound (Xiuba Yilin Courtyard) in Mengjin County. The analysis further clarifies courtyard form, building structure, and decorative characteristics of courtyard dwellings in Luoyang.

The Wang Family Compound shows a flexible spatial arrangement. Its structural configuration centers on thick composite stone–brick–earth walls together with mixed timber framing. Decorative treatment is restrained, and the overall expression aligns closely with the surrounding mountain terrain. The Wei Family Compound presents a highly developed articulation of ritual order under land constraints. Its layout is disciplined and axis-based, the spatial sequence is deep, and decorative practice is more systematized and symbolic, producing a residential aesthetic that is inward, refined, and orderly. Together, these two courtyard forms constitute a diverse and

coherent regional repertoire of courtyard dwelling forms in western Henan.

On this basis, the study indicates that courtyard dwellings in Luoyang exhibit strong regional specificity. Their structural configurations and decorative content embody regional cultural meanings, and they provide material evidence for the architectural aesthetics of local dwellings. Continued scholarly investigation, together with conservation and transmission, is required to sustain this architectural heritage.

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**References**

[1] Wang, W. Research on the renovation design of western Henan rural traditional residence. Nanjing: Nanjing Tech University, 2022.

[2] Ge, Y. P. Study on the spatial form of traditional villages in western Henan. Guangzhou: South China University of Technology 2021.

[3] Zhao, R. Study on landscape optimization of traditional courtyard houses in western Henan: Taking the ancient village of Zhaogou in Mianchi County as an example. Xi'an: Xi'an University of Architecture and Technology 2022.

[4] Hu, Z. S. Research on the activation of traditional village public space based on spatial syntax: Take Suqin Village, Sanmenxia City as an example. Zhengzhou: Henan Agricultural University 2023.

[5] Xiong, X. W. Zeng, H., & Jiang, X. J. Evaluation and optimization of traditional village cultural landscape from the perspective of resilience: Taking Dongshandi Village in the Henan section of the Yellow River Basin as an example. Chinese & Overseas Architecture, (08), 27–32, 2024.

[6] Luan, Y. K. Research on government behavior in protecting and developing Weipo traditional village in Mengjin County. Zhengzhou: Henan University 2021.

[7] Zong, X., Li, Z. Y., & Zhou, S. H. Research on space design of Chen Sili former residence at Mengjin County of Luoyang City. Journal of Zhengzhou University of Light Industry (Social Science Edition), 21(06), 99–108 2020.

[8] Dang, Z. H. Study on the application of regional cultural elements in the landscape planning and design of traditional folk houses in western Henan Province: Taking the ancient village of Weipo in Luoyang as an example. Nanchang: Nanchang University 2023.

[9] Liu, J. Research on the protection and renewal strategies of residential historic buildings in the east, west and south of Luoyang Old City from the perspective of HUL. Zhengzhou: Zhengzhou University 2021.

[10] Feng, W. T. Research on the value evaluation and protection and development strategy of traditional villages in western Henan Province. Zhengzhou: Henan Agricultural University 2024.

[11] Zhang, N., & Li, Y. W. Parametric study on outdoor wind comfort parameters of traditional dwellings based on CFD simulation: A case study of Liu's Courtyard in Kaifeng. Architecture & Culture, (09), 62–64 2025.

[12] Zuo, M. C. Folk dwellings in Henan Province. Beijing: China Architecture & Building Press 2007.

[13] Yang, H. C. Overview of ancient architecture in Henan. Culture Relics of Central China, (03), 60–65 1989.

 