International Journal for Housing Science and Its Applications
Publish August 10, 2025. Volume 46, Issue 4 Pages 7257-7264

https://doi.org/10.70517/ijhsa464629

Analysis of Ancient Residential Styles and Their Influence on Modern Housing Design Based on Architectural Elements in Ancient Tomb Murals

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Abstract Ancient tomb murals are the crystallization of traditional Chinese art, and the residential elements they contain serve as important carriers of culture and history. This paper selects a specific ancient tomb mural as its research subject for information interpretation. By combining digital reconstruction techniques, it discusses the inheritance and expression of ancient residential styles in modern housing design. The results show that through digital reconstruction technology, two-dimensional images of murals can be converted into three-dimensional models. For example, the “Li Fang City” depicted in Cave 85 reflects the layout and construction of ancient Chinese cities. In modern residential architecture, we can observe the projection of traditional residential forms onto modern designs, primarily manifested in elements such as roofs, ridges, eaves, columns, brackets, doors, and walls.

Index Terms ancient tomb murals, digital reconstruction, ancient residential architecture, modern residential architecture

I. Introduction

Ancient tomb murals refer to artistic works painted on the walls and partitions of ancient tombs for decorative purposes [1], [2]. They constitute an important branch of ancient Chinese mural art and serve as a concentrated reflection of the social realities, funeral rituals, and dominant ideologies of the time [3], [4]. These murals incorporate elements such as figures, daily life, social interactions, and architecture, providing valuable insights into tomb specifications, the identity of the tomb’s owner, the evolution of artifacts, the level of ancient scientific and technological achievements, and traditional culture [5]-[7]. Among these, the architectural elements depicted in tomb murals constitute an important component of China’s brilliant civilization, holding significant implications for modern people in understanding, reconstructing ancient architecture, and incorporating such heritage into contemporary housing design [8]-[10].

China is a vast and resource-rich multi-ethnic nation with a long history. Due to the differing historical backgrounds, cultural traditions, and living habits of its various ethnic groups, distinct architectural forms have emerged [11], [12]. While these architectural forms are diverse in terms of technology and artistry, they share a unified architectural style, making them unique in the world's architectural cultural treasury [13]-[15]. As society continues to develop, Chinese ancient architecture has also evolved, imbued with profound and unique connotations [16], [17]. Contemporary architectural design extensively draws inspiration from Chinese ancient architecture, incorporating its elements into modern works [18]. Among these, the architectural elements depicted in ancient tomb murals represent the most complete and comprehensive surviving relics. By systematically analyzing these murals, we can gain insights into the residential styles of ancient Chinese people. This understanding is particularly valuable in the context of the current retro trend, as it enables modern architects to draw upon national conditions, architectural styles, modern scientific and technological advancements, contemporary materials and craftsmanship, and current cultural trends to inherit and promote traditional culture, thereby creating modern architecture with Chinese characteristics [19]-[22].

Literature [23] highlights the importance of traditional residential architecture and emphasizes the current societal emphasis on traditional culture. Based on the inheritance and interpretation of traditional cultural characteristics, it explores their application in modern residential design and analyzes the future development trends and design methods of regional residential architecture. Literature [24] introduces the Ula tribe, pointing out that fully utilizing Ula traditional cultural elements can enhance the ethnic character and vitality of modern interior design. It studies the concept of Ula traditional residential design and examines the application and inheritance of

its culture in modern housing design. Literature [25] discusses the integration of mixed architectural languages from multiple cultures and the influence of globalization in this regard. Based on case studies from the Americas, Asia, and other regions, it highlights that modern design methods emphasize cultural sustainability and heritage preservation, demonstrating the inherent interconnectedness of culture, history, and architecture. Literature [26] notes that with the development of innovative engineering concepts, architects have drawn inspiration from traditional features to achieve a fusion of ancient and modern elements in contemporary architecture. Through form elements such as flat roofs and white walls, traditional elements have become a new, easily understandable language in modern architecture. Literature [27] conducted a comprehensive analysis of architectural identity characteristics, examining the role of traditional and modern architectural elements in shaping Herat's architectural identity. Through literature reviews and historical documents, it revealed that Herat's architectural features are shaped by multiple factors, including its historical and cultural significance, political dynamics, and architects' preferences.

This paper employs a combination of literature review and field research, case analysis, and the integration of theory and practice to elucidate the manifestation and expression of the integration of ancient residential culture with contemporary residential culture. Through a digital recreation process—including identifying the restoration object, data collection, model creation, camera pre-visualization, texture mapping, lighting setup, rendering output, and post-production—the residential elements from two-dimensional ancient tomb murals are transformed into three-dimensional models for detailed analysis. Taking the murals of a certain ancient tomb spanning over 45,000 square meters as the research object, the paper discusses the projection of traditional architectural forms onto modern architectural forms.

II. The combination of ancient residential culture and contemporary residential culture

II. A. The incorporation of ancient residential culture into contemporary residences

Chinese traditional residential culture has not only withstood the trials of historical transformations over the centuries but has also endured the dual challenges of historical and contemporary civilizations, thereby ensuring its continued preservation. Chinese traditional residential culture is a major component of contemporary culture. Therefore, in contemporary residential design, we should strive to absorb, inherit, and promote the essence of traditional residential culture. However, in the process of absorption and inheritance, we must exercise restraint. The application and understanding of traditional residential culture should not merely stop at superficial forms; we should not simply replicate and paste without our own unique innovations. Instead, we should thoroughly absorb the profound connotations of traditional residential culture that are worthy of our learning. Just as we see the essence of Chinese traditional residential architecture in the Yongding Earthen Buildings—compassion, harmony, and inclusivity. Traditional Chinese residential architecture typically uses wood and earth as building materials, reflecting its reliance on nature. Therefore, we must fully understand this genuine dependence on nature and the earth. Building upon the absorption and inheritance of traditional residential culture, we should continue to create a unique Chinese culture. We can see from the preserved Daoist temples and Buddhist monasteries that Confucian and Buddhist philosophies have been widely applied in traditional Chinese residential architecture [28].

II. B. The Reflection of Traditional Chinese Residential Elements in Contemporary Housing

As an integral part of residential decoration, murals play an indispensable role in the development of both residential architecture and the arts. Tomb murals, as a branch of mural art, have a long and continuous history within the cultural traditions of ancient China. People often used murals to record events, express emotions, or convey messages, documenting the life of the deceased while also expressing the hope for a peaceful journey to the afterlife.

Most people believe that modern society is a new era that should give rise to new ideas and forms of expression, and that traditional elements should be discarded. However, this is not the case. Traditional culture has been preserved through continuous accumulation and possesses the vitality and core values of culture. As part of traditional culture, ancient residential architecture carries profound historical and cultural significance. If contemporary residential architecture were to abandon the cultural essence of traditional culture and instead follow the trends of the modern world, it would become a mundane and uninspired form of housing. This is because it would lack the unique cultural essence found in ancient residential architecture, losing the distinctive style and characteristics of its own ethnic group. Therefore, elements of Chinese ancient residential architecture should be fully integrated into contemporary residential architecture to achieve a perfect fusion of the two. This showcases the residential and cultural charm of both contemporary and ancient residential architecture. The Suzhou Museum, designed by renowned architects, has successfully integrated Suzhou's local culture into its design.

III. Key points in the digitization of ancient murals depicting residences

Ancient Chinese murals are the crystallization of traditional Chinese art and serve as important carriers of culture and history. The residential scenes depicted in these murals embody rich social structures, philosophical ideas, and emotional expressions. Ancient Chinese murals are important carriers of culture and history, and the residential scenes within them are particularly rich in social and cultural significance. The two-dimensional nature of ancient murals limits modern audiences' understanding of the artistic intent behind the works. Therefore, how to utilize digital techniques to restore these scenes and provide audiences with a richer cultural experience has become a key focus of research.

Residential scenes in ancient Chinese murals are not merely reproductions of space but also carry rich cultural philosophical ideas and emotional expressions. The goal of digital restoration is to achieve the physical reconstruction of structures while conveying the spiritual ambiance and cultural connotations of the paintings through technical means. Therefore, during the restoration process, designers must approach the design from three aspects: the construction of spatial logic, the balance between form and spirit, and the digital recreation of ambiance [29].

The digital recreation of ancient residential architecture represents a new field emerging from the interdisciplinary convergence of architecture, art, culture, history, and technology. The specific steps in digital reproduction design include: identifying the restoration object, data collection, model creation, camera pre-visualization, material mapping, lighting setup, rendering output, and post-production. The production process for digital reproduction is shown in Figure 1. On-site investigations and the collection of relevant materials, followed by analysis and processing of these materials, form the foundational steps of the digital reproduction design for the Ming City Wall in Nanjing. For this project, it is necessary to conduct on-site photography of the Nanjing Ming City Wall, collect relevant residential drawings and other supporting materials, and classify the collected materials based on their intended use. The materials are primarily categorized into material-related, residential terrain-related, and residential facade-related categories. Additionally, it is essential to analyze and organize the materials' intended use, remove redundant or irrelevant information, and systematically compile and organize the important materials.

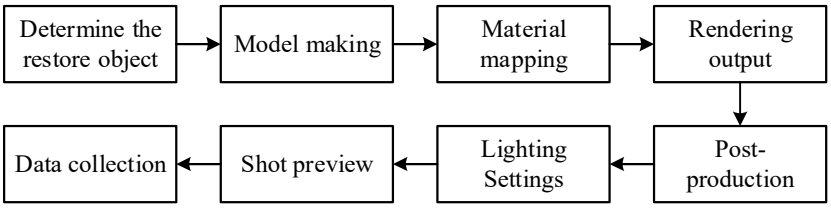

Figure 1: Digitized production flow chart

(1) The Construction of Spatial Logic

Chinese murals often employ scattered perspective, creating a spatial relationship that blends reality and illusion through multiple viewpoints. This artistic expression presents two key design considerations for three-dimensional restoration. The logical construction from scattered perspective to three-dimensional spatial reproduction. Scattered perspective is a key feature distinguishing Chinese ancient paintings from Western linear perspective, emphasizing the free switching between multiple viewpoints to present richer content and artistic intent within a limited space. However, this spatial logic often cannot be directly displayed in three-dimensional restoration, requiring reasonable inference and design to transform the hidden information in two-dimensional images into a complete spatial expression.

(2) The Balance of Form and Spirit

“Balance of form and spirit” is the core concept of Chinese mural art, requiring artists to organically combine physical resemblance with spiritual resemblance in their creations. In digital restoration, how to handle the relationship between form and spirit is a key factor in the success or failure of the work. Physical resemblance refers to the precise restoration of the physical structure and visual characteristics of the residence, which serves as the foundation of digital restoration. This includes not only the overall proportions and form of the residence but also details such as carvings, decorations, and the authentic representation of materials. In digital restoration, the texture of columns, the tactile quality of roof tiles, and the intricacy of carvings all influence viewers' immersion in the restored scene. Therefore, designers must use high-precision modeling techniques and material rendering technologies to meticulously present the physical details of the residence.

(3) Digital reproduction of artistic conception

Artistic conception is the soul of ancient Chinese paintings. A well-crafted atmosphere and emotional transmission can quickly draw viewers into the painting. In digital restoration, designers need to use multi-sensory collaborative design to construct a complete immersive scene from visual, auditory, and spatial experience perspectives.

IV. Interpretation of information depicted in murals on the north wall of an ancient tomb

IV. A. Images of residences in murals

The ancient tombs feature a large number of residential structures, widespread distribution, and diverse types. Over 45,000 square meters of murals depict residential imagery spanning ten dynasties from the Northern Liang to the Yuan Dynasty, covering a thousand years, distributed across more than 700 tombs. Murals from the same period include multiple residential types, and the same residential type appears in murals from different periods. The research value of residential elements in certain ancient tombs is undeniable, and the sheer volume, breadth of content, and wealth of information they contain are exceptionally rare. Constructing such a vast and complex content system in one's mind is virtually impossible. Research on residential structures in a certain ancient tomb originated from two academic articles written by Mr. Liang Sicheng before and after the founding of the People's Republic of China, as well as a significant historical event during that period. The two articles are titled “What We Know About Tang Dynasty Buddhist Temples and Palaces” and “Residential Structures of Ancient China as Seen in a Certain Ancient Tomb.” The former was written in 1932, using a certain ancient tomb as the primary research material, and explored various aspects of Tang Dynasty wooden residential structures, pioneering this perspective and approach. The latter article was revised and expanded upon the former and completed in 1951, further elucidating the value of the abundant residential data found in a certain ancient tomb. The major historical event refers to the discovery by Liang Sicheng and his team in 1937 of the only existing Tang Dynasty hall-style wooden residence in China at Wutai Mountain.

After years of effort by numerous scholars, approximately seven sets of the “Victory Sutra Transformation” can currently be identified in the tomb, as shown in Table 1, with the earliest being the one on the south wall of Cave 220. The few existing sets of the “Victory Sutra Transformation” in the Dunhuang Mogao Caves provide us with more vivid and concrete visual materials for further exploring the origins of the sutra stupa (stone sutra stupa).

The Zunsheng Jingbian on the south wall of Cave 220 On the lower eastern side of the south wall, from east to west, there is a two-story building, a tall stupa, and a high mountain. Although the painting is blurred, it can still be seen that there is a sutra stand inside the two-story building, on top of the tall stupa, and on the summit of the high mountain. The sutra stand holds a scroll of the sutra, namely the Zunsheng Jing. This part of the painting depicts the content of the Sutra of the Victory of the Buddha, which states, “The Buddha told the Heavenly Emperor, ‘If a person can write this dharani on a tall pagoda, or place it on a high mountain, or on a building, or even place it in a stupa...’” It can be confirmed that this tall pagoda is the Sutra of the Victory of the Buddha pagoda, which is fundamentally different from the pagoda banners used for offerings before the Buddha. This sutra stupa is of the silk-woven stupa style, with a design nearly identical to that of a stupa banner, featuring a single stupa pole as the frame, topped with three layers of stupa covers, and colorful banners hanging below the covers. The only difference from a stupa banner is that the stupa top houses a sutra stand holding the *Sutra of Supreme Victory*. A similar sutra stupa can also be seen in the Zunsheng Sutra transformation in Cave 25.

Table 1: Dunhuang Buddha top zenith dunronnie's statistical table

Age	Grottoes	Position	Quantity (pave)
Shengtang	220	South wall	1
Shengtang	114	South wall	1
Shengtang	25	The east of the fight	1
Shengtang	36	The east of the fight	1
The evening of the night	167	The front room is on the south side	1
When cao was in the army	58	North wall west first spread	1
Cao's rebellion	468	North wall west first spread	1

The results of the survey on architectural components in murals are shown in Table 2. According to the data we collected, sunshade panels are abundant in residential murals, totaling 36 panels. They first appeared in murals from the Northern Wei Dynasty and were also found in the murals of tombs from the Sui and Tang Dynasties, such as those in tombs numbered 312, 345, 346, 458, 338, 368, 78, 331, 218, 114, 69, 174, and 89 of a certain ancient

tomb from the Sui and Tang dynasties. Additionally, sunshade panels are also depicted in the murals of the tomb of Prince Yide of the Tang dynasty.

Caves 250 and 296 are dated to the Western Wei period. Cave 69 belongs to the second category of tombs from the third phase of the early Tang period, while Cave 174 belongs to the fourth phase of the early Tang period. We agree with the above scholars' dating of the tombs and murals. At this point, we have a relatively clear understanding of the dating of the sun-blocking board images in each cave. The following is a description of the sun-blocking board images in each cave in chronological order. Cave 250 sun-blocking board image: The western side of the cave ceiling features a painting of the “Asura” story, depicting two halls, each with a sun-blocking board above it. The two halls are similar in structure, made of a combination of brick and wood, and consist of three parts: the roof, the body of the building, and the base. The main body of the halls is built on the base, with walls made of bricks and rammed earth. The middle of the walls is constructed with a ring of bricks. The roof is a gabled roof without any brackets, and the eaves are fitted with sun-blocking panels that curve upward at an angle. The sunshade panels have a relatively simple structure, with a framework composed of intersecting horizontal and vertical wooden strips, divided into a 4×3 grid pattern. Based on the content of the murals, the length of the sunshade panels is approximately half the width of the hall, and the width is nearly equal to the length.

Table 2: Barrier sheet of moko cave mural

Age	Grottoes	Position	Murals	Number of Barrier sheets
Xiwei	250	Daisy	Asura	4
Xiwei	296	Middle middle	Shai committed suicide	2
Sui dynasty	312	Daisy	French warp	5
Elementary tang	345	North wall	mails	3
Elementary tang	346	South wall	Infinite life	5
Elementary tang	458	Western wall	Sixteenth view	2
Elementary tang	338	North wall	Amida longitude	3
Elementary tang	368	South wall	Amida longitude	3
Elementary tang	346	North wall	Amida longitude	1
Elementary tang336	78	North wall	Amida longitude	4
Shengtang	218	North wall	The view of life changes	5
Shengtang	114	North wall	The view of life changes	4
Shengtang	69	North wall	Western land change	5
shengtang	174	Daisy	asura	4
Late tang	89	Middle middle	Shai committed suicide	2

IV. B. Analysis of the “quantitative space-qualitative hierarchy” of residences in an ancient tomb

The visual dimension categorizes and organizes information about mural-decorated residences from the perspective of residential typology, dividing them into categories such as Buddhist residences, secular residences, and decorative residences. Each category contains different types of residential information trees, covering a wide range of ancient residential information at multiple scales, including residential scenes, residential groups, individual residences, and detailed structures. This also includes some rarely recorded residential types, such as the images of Tang and Song dynasty prisons found in the mural depictions of the Lotus Sutra. The spatio-temporal dimension analyzes the dynamic processes of overall changes and local evolution in mural residential architecture across different time points and periods using residential morphology as a coordinate system. Taking the unique component “dougong” (bracket system) in traditional Chinese timber-frame residential architecture as an example, it is depicted with great frequency and richness in certain ancient tombs, with its developmental trajectory and evolutionary patterns clearly traceable. particularly in some Tang Dynasty dou-gong, which not only provide temporal information about the evolution of dou-gong—such as the transitional period of the early Tang Dynasty, the rapid development into a fully mature phase during the prosperous Tang Dynasty—but also include new information at specific time points, such as the appearance of double interlocks in the mid-Tang Dynasty, the emergence of four-step dou-gong in the prosperous Tang Dynasty, counting the number of steps, and multiple combinations. The imagery dimension explores the interconnection between explicit and implicit information in mural residences based on residential phenomenology theory. For example, the “Li Fang City” in Cave 85 is derived from the original 108 Li Fang districts of Tang-era Chang'an and Luoyang. The imagery information of this “heavenly realm on earth” reflects the layout and construction principles of ancient Chinese cities, as shown in Table 3.

Table 3: Analysis of the "spatial quality grade" of the dunhuang mural

Information dimension	A. image dimension information (visual characteristics)	B: spatial and temporal dimensional information (dynamic characteristics)	C. image dimension information (comprehensive characteristics)
Place	L;P	S;P	L;S
Complex	M;S	S;J	M;J
Single	L;S	L;S	M;S
Details	L;J	M;S	S;J

IV. C. Research on residential craftsmanship

The residential images found in a certain ancient tomb not only reflect the grandeur of residential architecture but also reveal the exquisite craftsmanship of ancient construction techniques, showcasing the great beauty of Chinese residential architecture. Chinese ancient residential architecture primarily utilized wooden frameworks, with its artistic characteristics being a concentrated expression of wooden structural construction styles and a direct manifestation of technical craftsmanship. This unity of technology and art is evident throughout the residential structures in the ancient tomb. For instance, in the wall murals depicting palace towers, pavilions, and waterfront pavilions, the reasonable proportions and interplay of beams, columns, brackets, and dovetail joints in the timber work reveal the beauty of point, line, and plane composition, as well as the harmonious integration of technical prowess and spatial aesthetics. However, due to the spatial emptiness and loneliness of mural images, research on residential techniques based on mural images lacks depth and has a single layer in terms of residential scale and detailed studies. Digital reproduction and reconstruction can achieve a refined display and data integration of two-dimensional residential images into three-dimensional residential spaces through the integrated application of digital technology, which aids in the exploration of research content and the refinement of layers. The results of the analysis of the research value of a certain ancient tomb residence in a new context are shown in Table 4.

Table 4: The study value analysis of dunhuang mural buildings in new language

	Architectural history	Architectural evolution	Building system	Construction structure	Architectural recovery design	Architectural creation	Architectural skill
Improve efficiency	√	√	√	√			
Content update			√	√	√	√	
Deepening level				√	√		√

IV. D. Projections of Traditional and Modern Residential Forms

Combined with the relevant modern residential phenomena in Xi'an, it is found that the design method of "new Han style" residential design in Daxing New District coincides with the decomposition method in analytic philosophy, and the formal vocabulary of residential buildings in the Han Dynasty is taken as an example to explain the theory. By using analytic philosophical methods to "thoroughly" decompose the formal vocabulary of housing in the Han Dynasty (excluding the "traditional housing facts" that can be further decomposed), a series of "traditional housing affairs" can be obtained. It should be added that since this paper intends to explore a method of residential design rather than to study the specific expression of "new Han style" houses, this paper only takes the typical traditional residential form vocabulary as an example for analysis, such as the decomposition of Wuliang Temple and Muma Mountain Cliff Tomb Pottery House, we can obtain traditional houses such as "short roof ridge", "straight roof ridge", "hard roof ridge line", "far-reaching eaves", and "warped ridge end". In fact, the "traditional housing situation" that has been broken down into the vocabulary of Han Dynasty housing forms is much more than what is listed below.

“The fundamental propositions of modern residential architecture” can be judged as either ‘true’ or “false.” We can create “fundamental propositions of modern residential architecture” that have evaluative significance and correspond to “traditional residential conditions.” “Fundamental propositions of modern residential architecture” are evaluative and indivisible descriptions of traditional residential forms, such as “the roof has curves.” “Modern residential basic propositions” are mutually independent and non-contradictory. “It is impossible for a basic proposition to contradict another; this is a hallmark of a basic proposition.”

“Traditional residential states” are descriptions of the attributes of traditional residential forms that are derived from the vocabulary of traditional residential forms, are indivisible, and have evaluative significance. “Traditional

residential states" exhibit indivisibility relative to "traditional residential facts." The "traditional residential states" described by the "fundamental propositions of modern residential architecture" encompass two residential information elements, such as the 'existence' and "non-existence" of a "short roof ridge," corresponding to the two possibilities of "short roof ridge" and "non-short roof ridge." Both scenarios are logically expressible and thinkable. The "modern residential basic proposition" also contains two pieces of information about traditional residential forms that residential architects can directly grasp, and through the 'existence' of this information, they can judge, express, and imagine the possible "non-existence" scenarios. In the projection of "traditional residential conditions" and "modern residential basic propositions," the analytical philosophical method differs from the traditional "projection" method in residential design. The traditional "projection" method is limited to the 'existence' level, while analytical philosophy emphasizes thinking about future possibilities through language, thus placing greater emphasis on the projection of "non-existence." This projection offers more possibilities for the expression of traditional residential forms in modern residential forms. The following modern residential case studies, as shown in Table 5, can serve as theoretical illustrations.

Table 5: Related modern residential cases

Member	The basic proposition of traditional construction and modern architecture	
Roof	Ridge	The tomb of the tomb of the tomb of the village of the carbon kiln in tanghe county, henan province
Roof	The back of the ridge has a spring	Chang 'an tomb murals (don)
Roof	Roofing	Chang 'an tomb murals (don)
Eaves	The roof is straight straight	The ridge of the two cities
Eaves	The back of the ridge has a spring	The tomb of the tomb of the mountain cliff
Column	Shore	The han tomb of the two cities is a stone
Column	Rafter	The han tomb of the two cities is a stone
Arch	The column has a collection	A stone carving in xi 'an
Arch	The column is killed	A stone carving in xi 'an
Arch	The height of the column is equal to the width of the open	The ratio of "column" to "between" in tang dynasty
Arch	The head is arch	The wild goose pagoda
Door	Door fan with rivet	The temple of the tower of the temple of zhenjiang, jiangsu province, was unearthed in the tang dynasty of the temple of the temple of the temple of the temple of the
Wall	The wall has a score	The tomb of yan county, sichuan province

V. Conclusion

This paper proposes a new research method for digital reproduction and reconstruction, integrating the characteristics of the new era into the cultural traditions of ancient residential architecture depicted in ancient tomb murals, thereby achieving a perfect fusion of contemporary residential culture and ancient residential culture. Taking the murals of a certain ancient tomb spanning over 45,000 square meters as the research subject, the analysis of the research value of the residential structures in the ancient tomb reveals that traditional Chinese residential architecture primarily utilized wooden frameworks, with its artistic characteristics being a concentrated expression of wooden structural construction styles. In modern residential architecture, we can observe traditional residential form vocabulary manifested in elements such as roofs, ridges, eaves, columns, bracket systems, doors, and wall bodies.

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