

Design Styles and Restoration of Traditional Residential Buildings in Northern China [†]

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Abstract: The development of Chinese ancient architectural design has gone through three historical stages: primitive society, slave society, and feudal society. Due to the influence of geography, the environment, and the humanities, the regional architectural styles of each region were also formed. In particular, this is reflected in the residential architecture. Among residential architectures, the courtyard architectural style is the most typical, adapting to the microclimate and improving the comfort of living. This enclosed style of architecture was accompanied by the diffusion of Chinese culture and enriched the architectural design of the East Asian region. Nonetheless, as urbanisation accelerated, this traditional style of architecture began to be undermined. In addition, there is less discussion of the architectural content that embodies design ideas in terms of ritual, order, form, components, and color. In order to preserve this precious built environment, this study highlights the design style and its connotations. Through the use of case studies, the stylistic characteristics of a traditional dwelling in Northern China and the restoration process are assessed. Furthermore, observations on key building components, construction techniques, and materials are made in terms of architectural ideas. This leads to the proposition that conservation strategies should be appropriate to local conditions. The findings show that building restoration can contribute to the effective conservation of traditional building forms and provide an opportunity to inherit traditional culture. Moreover, it is more conducive to the presence of Chinese residential architecture that shines in the world discourse. New perspectives and contributions are offered in the fields of architectural design and conservation.

Keywords: Chinese architecture; traditional architecture; Chinese culture; conservation; urbanisation; architectural narrative; restoration; rehabilitation; Confucianism; vernacular architecture



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1. Introduction

For a long time, China's urbanisation trend has driven the implementation of land annexation programmes in many rural villages, which has led to the demolition of vernacular buildings [1–3]. The traditional culture, historical traces, and vernacular memories embedded behind them have also disappeared [4]. China's civil engineering department is also conscious of partial preservation, but the speed of urban expansion far exceeds the speed of building repair. In this era, housing, characterised by residential comfort, has disrupted the living environment and the integrity of the well-being of the inhabitants, many of whom have been forced to leave [5,6]. Therefore, the inheritance of traditional architecture is a priority for the virtuous development of villages and towns as well as a key task for the revitalisation of traditional culture [7,8]. As a matter of fact, housing structures are shaped by cultural veins, economic development, and changes in social consciousness. The architecture of the vernacular has been described as architecture without architects [9–11], whereas architecture combines multiple disciplines of science, engineering, and art [12]. Meanwhile, building materials have been proven to have a positive

contribution to realising sustainable building purposes [13]. With technologies developing and building at a rapid pace throughout the world, not only in China, there is also still a lot to be learned from the accumulated knowledge embedded in traditional structures, which is a sustainable practice [14]. Therefore, this study stands for architectural design styles and analyses of functional space in terms of architecture as a carrier of traditional Chinese culture, derived from the science and artistry of traditional building components, construction techniques, and materials. The aim is to make the proposition that strategies for the restoration of traditional buildings, for instance, material technology, are used as a key to the continuation of cultural heritage. Also, as an important sustainable housing type, the value of Chinese courtyard architecture is not just nostalgia but an in-depth exploration of building energy efficiency and sustainability, thus making a positive contribution to the field of traditional architecture.

2. Materials and Methods

2.1. Materials

Confucianism has influenced the cultures of China and even East Asian countries, of which Shandong Province is the cradle [3]. Therefore, a building in Shandong Province was selected for a long-term survey and documentation in order to better analyse the relationship between traditional architectural patterns and culture. Referring to national technical standards, the building was sorted out for utilisation, assessment, technical description, and evaluation of the effectiveness of the restoration. Simultaneously, the study of ancient architecture has paid additional attention to the aspect of architectural sustainability at a time of increasing environmental tension.

2.2. Methods

A form of qualitative analysis is used, with quantitative data as an aid. It discusses more about the physical aspects of the building components in terms of materials and technology as a vehicle to reflect on the Chinese vernacular culture and to understand the logic and connotation behind them. Thus, from historical nostalgia to specific sustainable exploration is the main method of this study.

3. Results and Discussion

3.1. Overview of the Situation

The main body of the building has experienced many years of rain and snow erosion, but overall, it still maintains the original layout of the courtyard and architectural form. However, the roof tiles and ridges are seriously damaged, and the wall bricks are brittle. As a result, the stability and safety of traditional buildings have been weakened, and building diseases are constantly developing, which also has an impact on the well-being of the residents.

3.2. Restoration Notes

This study was based on specific components, and the rehabilitation of the whole was surveyed and carried out in a selective manner. For example, at the beginning of the gable wall location, the wall was built with green bricks and whitewashed walls, and there were air-permeable windows in the shape of a vase. However, after years of neglect and natural weathering, the results of the survey found that the wall is crispy alkali; crispy alkali depth of 5–15 mm green bricks there are 30; crispy alkali depth of 15–30 mm green bricks there are 15; 20% of the wall mortar joints fall off; 10% of the wall surface contamination. Therefore, the measures adopted in the depth of 5–15 mm are brick brushing and slurry pointing; in the depth of 15–30 mm, brick picking treatment; and re-plastering grey joints (see Figure 1).



Figure 1. The rivets in the gable wall area work with the beams and columns to secure the architectural ceiling.

In Shandong residential architecture, there are usually shrines on the walls of the buildings in the northern part of the courtyard (see Figure 2). This is a small space for dialogue with the gods in the family and is an expression of the family's cultural heritage. Therefore, it also needs to be preserved in the restoration.



Figure 2. A shrine is located on the wall to pray for peace.

Table 1 is a compilation of the restoration of the other main building components and analyses their meanings in Chinese culture, reflecting the architectural narratives of the traditional forms of habitation in northern China.

Table 1. Notes on the restoration of building components and their cultural significance.

Building Component	Nature of Damage	Restoration Measures	Cultural Significance
Tile	Defective	Partial tile redo to grey tiled roof; roof weeded.	Seals out rainwater infiltration, protects the flying eaves, and ensures the long-term use of the building. Tile carvings are nowadays more for decorative purposes, praying for a good meaning.
Roof ridge	Defective Loose	Re-roofed and stripped, the main ridge preserved as is, and the ridge redone.	For fireproof decoration. Mostly carved with sacred beasts, combined with local craftsmanship and characteristics, representing protection.
Roof beam	Contaminated Rotten	Minor deterioration of beams; preservation is recommended.	Representing support and pillars, it is also the key to architectural decoration. Chinese New Year couplets are put on it to represent the New Year's blessings.
Wall	Limestone Wall cracking Weathering	Brushing and pointing of bricks with a depth of 5–15 mm. Patching of 15–30 mm green bricks. Re-plastering.	Maintaining security. The need for social norms. Ensuring the foundation of family harmony.

3.3. Technical Description

The description of the techniques is interpreted in two ways: one for the roofing and the other for the repair work on the walls.

Firstly, the roof removal of tile pieces should be conducted first with an uncovered hook drop. Remove the tile pieces from the tools used for the tile knife and small shovel, which shall not be smashed with hard prying to avoid damage to the tile pieces. In the process of removing the roof, use text, drawings, photographs, video, and other tools to conduct a proper job of record-keeping. To prevent roof leakage, immediately after the removal of the tile roof, check and repair the rafters, among other procedures. The order of roof laying is as follows: 25 mm brick paving, 20 mm thick sheathing plaster, and then 50 mm thick, slippery straw mud, finished in two layers, identifying the level curves as they were applied. Finally, 30 mm of Madao lime (hemp chopped up to strengthen mortar) was applied evenly and compacted (Lime:Madao = 100:6). To dry and hang the tile, fill the two bottom tiles with lime filling and smoothing, and then hang the cover tile. Found that the broken tile must be replaced so as to avoid future leakage of rain caused by greater waste. As shown in Figure 3, the general requirements for hanging tile, in addition to being solid, include the appearance of “uniform and straight, wave curvature undulation consistent”.

In addition, the treatment of wall cracks is to fill the 15 mm gap within the stable gap with white mortar and later pay attention to the degree of its development. If the crack is larger than 15 mm, it is necessary to partially dismantle the masonry. In this process, the newly added brick and stone components should be of the same specification and quality as the original wall bricks and stones, and the wall should be masoned according to the original traditional practice. Masonry, as far as possible, uses the demolition of the brick and stone for more preservation of the building's historical information. Moreover, green brick walls are repaired by removing cement mortar or modern paint from later repairs of the walls and re-hooking the joints using whitewash mortar. The result after restoration is shown in Figure 4.



Figure 3. Roofing and tile processes and techniques.



Figure 4. Repair works to the walls.

4. Conclusions

This study is pioneering research on the restoration of an architectural courtyard in northern China and its grounding in cultural connotations. It is also a real attempt to preserve traditional Chinese courtyard architecture. For researchers in the field of architectural conservation or architectural culture, it provides a feasible way of thinking, not only about the restoration of the building itself but also about the historical context of the city in which the building is located, the cultural narrative behind it, and the living experience of the residents, for better-targeted restoration and conservation. As one of the vernacular architecture types, it has absorbed the experience and lessons of climate and nature, which has explored a new direction with more sustainable implications for the present time when resources are scarce. Moreover, it has a sustainable impact on the

harmonious coexistence of people and nature, as well as cultural heritage. Additionally, this study makes the following recommendations:

- Protect the historical authenticity of the buildings and ensure the safety and renewability of conservation methods and materials.
- Pay attention to the collection of cultural materials to enrich the rationality and narrative of traditional architectural styles.
- Focus on the promotion and transmission of culture and the role of culture, thus supporting the subsequent impact on the restoration of the building.
- Besides the preservation of building types and cultural history, the exploration of sustainability continues for energy efficiency, occupant comfort, climate change, human well-being, and so on, to be urgently needed and essential.

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References

1. Guan, X.; Wei, H.; Lu, S.; Dai, Q.; Su, H. Assessment on the Urbanization Strategy in China: Achievements, Challenges and Reflections. *Habitat Int.* **2018**, *71*, 97–109. [\[CrossRef\]](#)
2. Cheng, H. Forced-Urbanization: The Alienation of Urbanization in China. *Asian J. Agric. Ext. Econ. Sociol.* **2015**, *6*, 126–135. [\[CrossRef\]](#) [\[PubMed\]](#)
3. Rong, W.; Bahauddin, A. Heritage and Rehabilitation Strategies for Confucian Courtyard Architecture: A Case Study in Liaocheng, China. *Buildings* **2023**, *13*, 599. [\[CrossRef\]](#)
4. Malpas, J. Building Memory. *Interstices J. Archit. Relat. Arts* **2012**, *13*, 11–21. [\[CrossRef\]](#)
5. Fu, Y.; Wang, H.; Sun, W.; Zhang, X. New Dimension to Green Buildings: Turning Green into Occupant Well-Being. *Buildings* **2021**, *11*, 534. [\[CrossRef\]](#)
6. Orlenko, M.; Dyomin, M.; Ivashko, Y.; Dmytrenko, A.; Chang, P. Rational and Aesthetic Principles of Form-Making in Traditional Chinese Architecture as the Basis of Restoration Activities. *Int. J. Conserv. Sci.* **2020**, *11*, 499–512.
7. Pan, M.; Shen, Y.; Jiang, Q.; Zhou, Q.; Li, Y. Reshaping Publicness: Research on Correlation between Public Participation and Spatial Form in Urban Space Based on Space Syntax—A Case Study on Nanjing Xinjiekou. *Buildings* **2022**, *12*, 1492. [\[CrossRef\]](#)
8. Oliver, P. *Built to Meet Needs: Cultural Issues in Vernacular Architecture*; Routledge: London, UK, 2006; ISBN 978-0-08-047630-8.
9. Rudofsky, B. *Architecture without Architects: A Short Introduction to Non-Pedigreed Architecture*; University of New Mexico Press: Albuquerque, NM, USA, 1987; ISBN 978-0-8263-1004-0.
10. Drazin, A. Architecture Without Architects: Building Home and State in Romania. *Home Cult.* **2005**, *2*, 195–220. [\[CrossRef\]](#)
11. Rong, W.; Bahauddin, A. A Bibliometric Review of the Development and Challenges of Vernacular Architecture within the Urbanisation Context. *Buildings* **2023**, *13*, 2043. [\[CrossRef\]](#)
12. Kołata, J.; Zierke, P. The Decline of Architects: Can a Computer Design Fine Architecture without Human Input? *Buildings* **2021**, *11*, 338. [\[CrossRef\]](#)
13. Omer, M.A.B.; Noguchi, T. A Conceptual Framework for Understanding the Contribution of Building Materials in the Achievement of Sustainable Development Goals (SDGs). *Sustain. Cities Soc.* **2020**, *52*, 101869. [\[CrossRef\]](#)
14. Nguyen, A.T.; Truong, N.S.H.; Rockwood, D.; Tran Le, A.D. Studies on Sustainable Features of Vernacular Architecture in Different Regions Across the World: A Comprehensive Synthesis and Evaluation. *Front. Archit. Res.* **2019**, *8*, 535–548. [\[CrossRef\]](#)

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