The traditional building technology against cold and the cultural significance of Daur

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Abstract

The Daur people are an ethnic minority in northern China, traditionally residing in cold, high-latitude regions where winter temperatures often drop to 40 ℃ or lower. Under such long and harsh winter conditions, the Daur people have developed a unique set of traditional building techniques for surviving in the cold weather. These techniques entirely use natural resources, adapting to frigid environments through site selection, materials, structural design, and internal layout. For example, houses are built on sheltered terrain facing south to utilize solar heat; walls are constructed with local wood and earth; straw covers the roofs to enhance insulation; the indoor heated brick system provides warmth and optimizes heat distribution. These cold-resistant techniques not only meet the living needs of the Daur people but also carry rich cultural significance, reflecting their wisdom in adapting to nature, their core values of family harmony, and the symbolic identity of the ethnic group. However, as modernization accelerates, these traditional buildings are gradually being replaced by modern structures, posing a risk of losing their cold-resistant techniques and cultural significance. This article systematically analyzes the cold-resistant techniques and cultural

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significance of Daur traditional architecture, proposing specific recommendations for protection and inheritance and providing insights for cultural heritage preservation and modern architectural design.

Keywords: Daur nationality, traditional architecture, cold resistance technology, heated bed design, cultural inheritance

Introduce

The Daur people are one of the smaller ethnic groups in China, with a total population of about 130,000. They are mainly distributed in the Morin Dawa region of Hulunbuir City and the Meilis region of Qiqihar City in Inner Mongolia Province, as well as in the Ili and Tacheng regions of Xinjiang Province in the northwest. The rest live scattered across the country, forming a pattern of large mixed settlements and small concentrated communities. According to statistics, there are 469 main villages, including 281 in Heilongjiang Province, 177 in Inner Mongolia, and 11 in Xinjiang (QMCLH & MDABCLH, 1993). They have lived under icy climatic conditions for a long time, with winter temperatures often dropping to 40 °C or even lower. The Daur people have developed a unique traditional building technology system through rich life practices and accumulated wisdom in such a natural environment. These techniques cover site selection, materials, structural design, and internal layout, demonstrating excellent environmental adaptability and embodying the harmonious coexistence between humans and nature.

The traditional Daur architecture employs cold-resistant techniques that fully utilize local resources, such as wood, earth, and straw for insulation; houses are located in sheltered areas facing south to capture more sunlight and heat; the ingenious design of heated brick beds provides a heat source and optimizes indoor heat distribution. These techniques not only meet survival needs but also carry rich cultural significance. The heated brick bed, the core device in living spaces, serves as a winter heating tool and a venue for family activities, reflecting the Daur people's

emphasis on family harmony and social cohesion. Moreover, these buildings' unique designs and styles have become important symbols of ethnic identity, documenting Daur culture's distinctiveness and heritage value.

However, the advancement of modernization is accelerating the disappearance of traditional Daur architecture. While modern buildings offer greater convenience, they fall short in adapting to extreme cold environments and reflecting cultural significance. Therefore, researching and protecting the cold-resistant techniques of Daur traditional architecture is not only a respect for historical heritage but also provides new ideas and inspiration for modern architectural design. This paper will systematically explore the unique cold-resistant building system and cultural connotations of the Daur people through literature review, oral interviews, and field investigations, focusing on two aspects: first, summarizing its functional applications and overall design characteristics under icy conditions; second, examining the materials used (such as wood, earth, and straw) and their insulation mechanisms and modern application values. By analyzing its design features, cultural value, and conservation challenges, this paper will propose feasible pathways for inheritance and protection, providing references for the continuation of ethnic culture and the optimization of modern architectural design in cold regions.

Literature review

1. Cold resistance technology of traditional Daur architecture

1.1 Site selection and orientation of buildings

The architectural site selection of the Daur people in Northeast China is characterized by distinct ecological wisdom and adaptability, typically choosing to build on sheltered mountain slopes or river valleys. This site selection strategy takes into account local climatic conditions, particularly the impact of cold winter winds. The region falls under Category I severe

cold zones, with an annual average temperature of relatively low, ranging from-1.1℃ to 2.1℃ (see Table 1). The temperature distribution exhibits significant regional variation, decreasing gradually from south to northwest. In terms of interannual variations, temperatures are relatively stable, with the highest annual temperature usually between 18.2℃ and 22℃, and extreme highs reaching up to 39.5℃; the lowest annual temperature is approximately between-24.4℃ and and-20℃, with extreme lows dropping as low as-45℃ (Xue, B., & Qi, Z., 2018).

Table 1 Climatological table of three Daur ethnic regions in northeast China

Main populated areas	Inner Mongolia AutonomousRegion Moridawa Autonomous Banner	Helongiang Province Meris Daur Ethnic Township	Helongiang Province Longjiang County
Geographical location	The Middle Section oftheEastern Daxinganling andtheRight Bank of the Nenjiang River	South foot of Daxinganling With the right benk of the midde reache s ofthe Nenjang River	Southern Daxinganling and Pine Transition zone of Nen Plain
Climatecharacteristics	Temperate continental climate, four seasons, Rizhao foot, moderate rainfallwindy spring rain, wet summer short, autumn sunny frost, cold dry and long winter		
Average annualtemperature	**1.3℃**	**3.2℃**	**46℃**
Minimum temperature	**-45℃**	**-42℃**	**-41℃**
Max imum temperature	**39.5℃**	**39℃**	**22.9℃**
Annual amount ofprecipitation	**450 mm**	**415mm**	**469.8mm**
Rizhao hours	**2530-2875hours**	**2861.9 hours**	**2661.1 hours**
frost-free period	**115 days**	**136 days**	**148 days**
Freezing period	**5 months**	**5 months**	**5 months**
Averageannual relative humidity	**60%**	**63%**	**55%**
Average windspeed	**3.5m/s**	**3.2m/s**	**2.9m/s**

By utilizing the barrier effect of natural terrain, the invasion of cold winds into living environments is effectively reduced, enhancing winter comfort. Using natural barriers reduces heat loss from building exteriors and significantly decreases energy consumption for heating, demonstrating exceptional environmental adaptability. Buildings on sunny slopes receive more sunlight and have temperatures about 10℃ higher than those on shaded slopes (see Figure 1). In cold regions during winter, solar radiation serves as a natural heat source; therefore, building sites should be chosen to maximize sun absorption with a slight angle of inclination, considering topographical features to optimize the local climate environment.

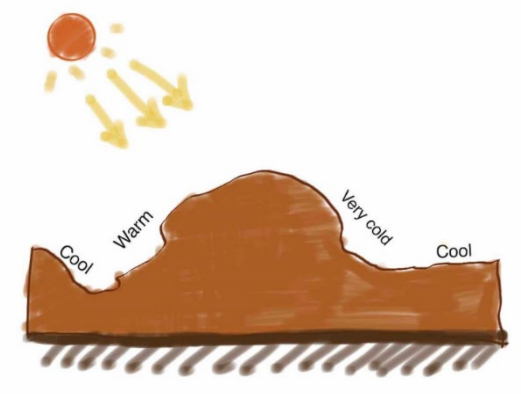

Figure 1: Schematic diagram of solar radiation and ground temperature distribution

In the Daur dwellings of Northeast China, the orientation of the main house is typically aligned with that of the entire building (see Figure 2). As shown in the figure, by marking the solar altitude angles and duration of sunlight during winter and summer, it can be seen that a north-facing south-tilted layout maximizes winter sunlight while reducing solar radiation in summer, thus achieving warmth in winter and coolness in summer. At the same time, to address winter's cold climate and lighting needs, the building's long axis should be as perpendicular as possible to the prevailing winter winds to enhance wind resistance and reduce heat

loss. Since north-facing rooms receive little sunlight in winter and are easily affected by cold air, they are typically unused.

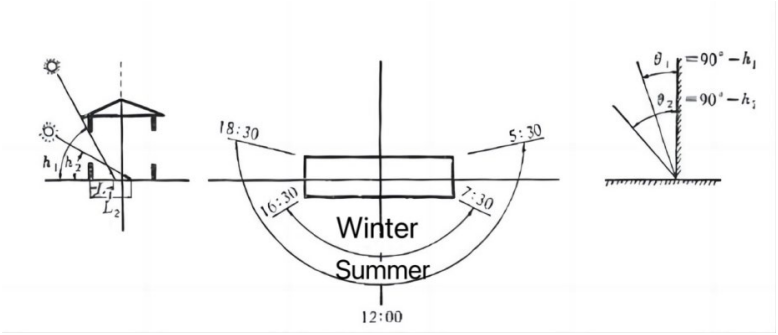

Figure 2 Schematic diagram of solar radiation and building sunshine Angle in Daur dwellings

1.2 Building material selection

The Daur people select building materials according to local conditions, reflecting a distinct local style.

Wall Material Selection: In the early days of the Heilongjiang River Basin, the Daur people mostly used large logs or all-wood structures; after relocating to the Nenjiang River Basin, they gradually adopted a combination of earth and wood. According to oral accounts from elderly Daur people, the Daur would cut tower heads (a mixture of soil and grass) into blocks, pound them with a large hammer, and build walls using these blocks. The grassroots in the tower head grip the soil tightly, making the wall solid once it dries. After the wall is built, sheepgrass is applied inside and out along with mud to smooth the surface, and fine sand is used internally for a smooth finish. Wooden poles are inserted at both ends of the house pillars, integrating the wall with the wooden structure and enhancing stability and durability (see Figure 3). Whether on plains or in mountainous areas, the Daur people skillfully utilize local materials to

construct sturdy and warm walls, showcasing the unique characteristics of earthen dwellings.

Roof Material Selection: Material selection involves multiple layers of craftsmanship. First, a layer of willow mats woven from willow branches is laid on the roof. Then, sheep grass and mud are applied to level it out. Next, thatch, reeds, or wheat straw is spread over the mat. Finally, a saddle-shaped wooden frame is used to press down the thatch (Xu, R. Y., & Wang, X. L., 2000). During construction, willow-woven thatch is first laid on the rafters, followed by a leveling layer of about 3.3 centimeters thick made of sheep grass and mud. Subsequently, thatch is layered from the eaves to the ridge, each layer approximately 0.6 to 0.7 meters thick. Each layer is secured with mud, and a saddle-shaped wooden frame presses down the thatch to the ridge (see Figure 4). This "earth-and-thatch house" uses simple and primitive materials and techniques, respecting the natural texture and color of earth, wood, and grass, thus exuding a strong sense of rural charm.

Figure 3 Material selection of walls in Daur dwellings

Figure 4 Material selection of roofs in Daur dwellings

1.3 Structure and design

Daur settlements typically extend east-west, with households arranged in a linear row. Due to the prevailing northwest winds during winter in this region, buildings that are wind-blocked and oriented perpendicular to or

at an angle greater than 45° relative to the dominant winter winds can achieve larger wind shadow areas (Hu, Y. D., & Qi, X. Y., 2018).

The horse frame house is a mature type of residential architecture developed by the Daur people after they migrated to the Nen River Basin. It not only adapts to the cold climate of Northeast China but also carries strong ethnic and cultural characteristics. In the 1650s, when the Daur people moved to the Nen River Basin, they introduced the grass hut and courtyard culture from the Heilongjiang River Basin into their new homeland. After a century of improvement, it gradually formed a complete system of residential architecture.

1.3.1 Appearance design

The courtyard is a space without a roof and is enclosed on all sides. It is an essential component of residential architecture, typically consisting of two parts: the internal space refers to the living area and its enclosing structures. In contrast, the external space encompasses the area between the house and the wall (Yan, Y., 2000). The traditional Daur main house has an ancient and rough "Jie" character shape, with walls made of light yellow primitive rammed earth. A row of large windows and a front door are set on the south facade, and there is a west window in the middle of the west facade; other facades generally have no windows. The roof features a double-slope roof covered with thatched grass, presenting a primitive and straightforward "thatched mud steps" appearance (see Figure 5).

Figure 5: The century-old dwellings of Hala New Village, Daur Ethnic Group (Image source: self-photographed by the author)

1.3.2 Structure of Stables

According to historical records, the Daur people originated from the Khitan clan of the Great Hei in ancient China. Since prehistoric times, their living forms have evolved from "nest dwellings" and "cave dwellings" to felt tents, "cuoluozi" (a simple cone-shaped tent made of tree branches), "majiazi" (a simple wooden house), and finally to the "shangdongxiayu" style (Wu, B. A. (1983)). The layout of a ma jiazi is horizontally rectangular, typically with two or three bays, featuring a fire pit on two or three sides, making the space compact. Its structure utilizes traditional timber frame systems, consisting of columns, beams, purlins, and rafters; walls are constructed using tower heads or reed mats, as appropriate. The overall shape is a "Jie" character with double-sloped ridges, and the thatched roof and earthen walls retain an ancient appearance reminiscent of "thatched cottages and earthen steps." The design features multiple windows, an independent chimney, and western-facing windows, creating a unique residential style (see Figure 6).

Figure 7 External form and internal structure of the stables (Image source: self-photographed by the author and the Daur residential museum in Woniutu Town)

The Daur architecture faces south and is oriented north, designed to minimize heat loss. The layout is a regular rectangle with a compact structure, typically featuring two bays (Fig. 8 for the double-bay plan) or three bays (as shown in Fig. 9), while five-bay layouts are relatively rare (as shown in Fig. 10). In the two-bay layout, the eastern bay serves as the entrance hall and kitchen, where the stove is located on the west side of the entrance and the east side of the north wall. On the west side of the north wall, there is a pit hearth (storage hearth) connected to the stove for drying grain, while water jars and pickled vegetable jars are placed on the east wall for daily use. The western bay is the bedroom, with a "wrist hearth" connecting the south, north, and west walls. The indoor hearth is linked to the kitchen's stove through a hole in the hearth, and the outdoor part is connected to an independent tall chimney via a flue. A horizontal beam is reserved above the bedroom for hanging cradles and other items (as shown in Fig. 11).

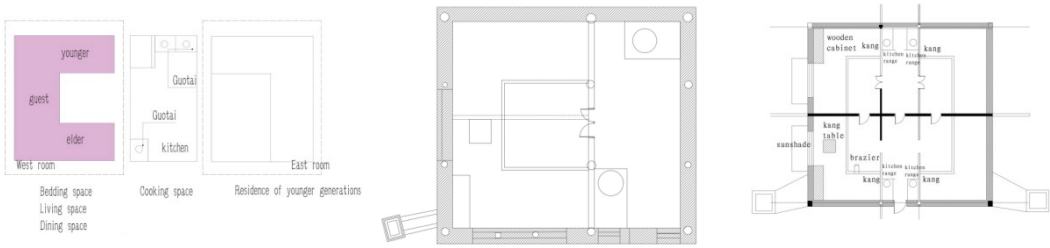

Figure 8, 9, 10: Two-door plan (drawn by the author), Three-room plan, Five-room plan

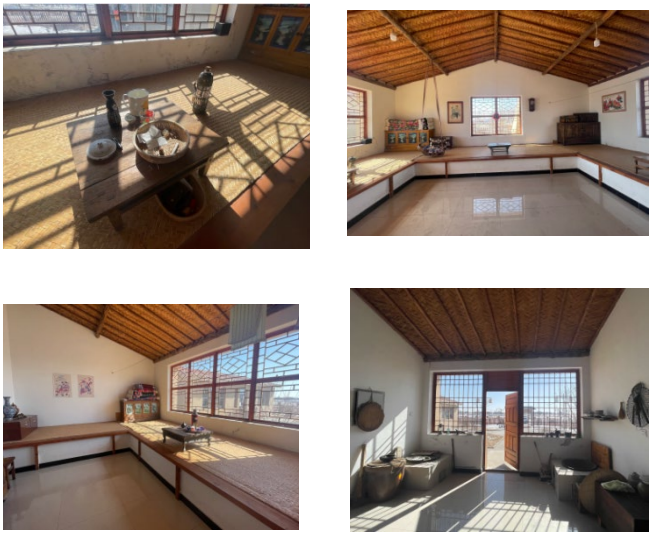

Figure 11 Internal structure of Daur dwellings (photographed by the author in the Daur dwellings exhibition hall, Ermengqin Village)

2.4 Unique heating method

2.4.1 Warm bed and stove

The heated brick bed in Daur dwellings is an essential part of the building, favored for its scientific design, comfortable insulation, and aesthetic durability, possessing high architectural and artistic value (Na, R. S. 2008). The design of the heated brick bed emphasizes practicality and ergonomics, typically with equal length and width, ranging from 1.8 to 2.2 meters in width and about 0.6 meters in height. The edge of the bed is

made of wooden or bamboo strips, while the three sides of the bed walls are carved wooden boards, combining both beauty and decorative functions. Inside is a strip-shaped heated bed constructed of adobe or bricks, which heats the bed surface through circulating hot smoke. To enhance comfort and insulation, the bed surface is covered with bricks, adobe, or stone slabs, pressed flat with mud and lime, and finally lined with a mat. This design ensures excellent heating effects and a comfortable winter living environment (as shown in Figure 12)

Figure 12 Daur U-shaped Heated Bed (Daur Museum,2023)

The heated bed in Daur dwellings has a southern stove outside the wall opposite the heated bed, with smoke expelled through the flue inside the heated bed. The smoke from the northern stove is also discharged via the flue to the chimney outside the west wall. The heated bed surface naturally heats up during cooking without requiring additional fuel, thus conserving resources. The kitchen is separated from the living quarters to maintain warmth and cleanliness indoors. The flue extends nearly 2 meters along the outer wall, connecting to the chimney to prevent fires (see Figure 13). There are three windows on the south wall and two on the west wall, making the interior spacious and bright. In summer, windows can be opened for ventilation, and sometimes, a stove is set up outside the kitchen window, but the heated bed still needs to be burned once daily to prevent dampness. Daur dwellings typically have three connected heated bedrooms; a narrow heated bed called "Grain-drying heated bed"

is set up north of the kitchen to dry grain, with the flue connected to the northern heated bed, reflecting the Daur people's agricultural culture and social values. The heated bed's construction methods and related customs have become part of intangible cultural heritage.

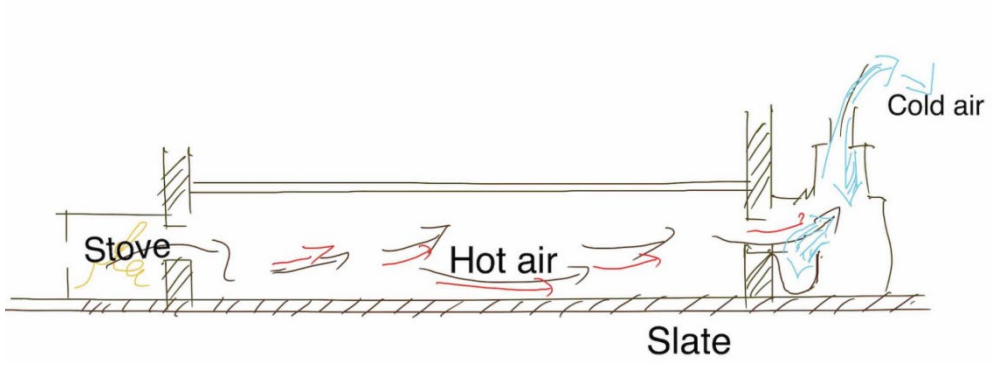

Figure 13 Diagram of heat transfer and ventilation of Daur fire bed

The stove platform is essential to Daur dwellings, reflecting their wealthy lifestyle and culinary culture. The design of the stove platform is closely linked to that of the heated bed, usually featuring two or more square stove platforms, approximately 1.2 meters in length, 0.5 meters in width, and slightly lower than the heated bed in height. These platforms utilize the residual heat from the heated bed for cooking. This design saves space and reflects the Daur people's emphasis on practicality and functionality in their traditional dwellings (see Figure 14).

Figure 14 Daur residential stove

1.4.2 Characteristic Doors and Windows

Windows are the most common part of residential art decoration, serving as ventilation and lighting and enriching the facade. Traditional Daur dwellings are renowned for their numerous windows. If the main house has two bays, there will be three windows on the south side of the west room, two windows on the west side, and one window on each side of the door, totaling seven windows; if the main house has three bays, the number of windows can reach up to 9, with a maximum of 13 (Ni, C., 2005).

1.4.2.1 Large Windows and many of them

The traditional main house of the Daur people usually has large windows to increase natural light. For example, on the south facade with three bays, there are three large windows on each side, one above and two below (see Figure 15). The entrance door is in the middle, with a "horse window" on each side. The south windows help improve indoor lighting and thermal environment, reflecting the architectural features adapted to the climate. Windows are not only decorative elements but also serve ventilation and lighting functions. Traditional Daur dwellings typically have multiple windows; a two-bedroom main house has seven windows, while

a three-bedroom house can have nine to thirteen windows, with larger south windows to enhance sunlight penetration.

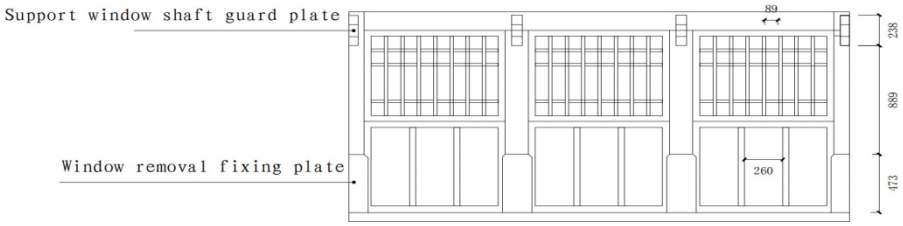

Figure 15 Daur Windows CAD diagram

2.4.2.2 West window

The Daur people's dwellings feature a sizable square skylight window in the center of the west wall (as shown in Figure 16), which facilitates ventilation and increases winter daylight. The Western window not only meets the physical needs of the interior but also carries forward traditional ethnic culture. Due to the influence of the Daur ancestors, the Khitan people built their buildings with a west-facing orientation and large windows in the center of the south wall. After migrating to the Heilongjiang River basin and being influenced by the Manchu, their buildings shifted to a north-facing orientation, with the south wall becoming the west wall. The original large window on the south wall evolved into the western window, becoming a prominent symbol and cultural emblem of Daur architecture.

Figure 16 Traditional window decoration of Daur dwellings (Image source: self-photographed by the author).

2. Cultural significance of traditional Daur architecture

2.1 The wisdom of environmental adaptation

The traditional architecture of the Daur people demonstrates their profound wisdom in adapting to harsh environments. By fully utilizing local natural resources, they ingeniously constructed "earth and grass houses" with excellent thermal insulation properties. This architectural design reflects the practical experience of the Daur people in their struggle against nature. It embodies their survival philosophy, which respects natural laws and adapts to local conditions. The integration of terrain and orientation in building designs, such as north-facing south layouts and wind-protected, sun-facing site selection strategies, highlights their high adaptability to climate conditions. This technique and philosophy have transcended mere architectural function, symbolizing ethnic survival wisdom and conveying the cultural value of harmony between the Daur people and nature.

2.2 Cohesion of social culture

The heated brick bed is an indispensable part of traditional Daur architecture, serving as an efficient heating facility and a core space for

family life. On the heated brick bed, one can warm up and rest, while it also plays a crucial role in family activities, communication, and emotional exchange. In the cold winter, family members gather around the heated brick bed to chat, keep warm, dry grain, and prepare delicious food, creating a unique family cultural atmosphere. As the central space of Daur families, the heated brick bed profoundly reflects the artistic value of the Daur people's emphasis on family harmony and collective living. This architectural layout emphasizes intimate interactions between individuals, serving as a significant manifestation of cohesion in Daur social culture, fully demonstrating the concept of family unity and shared life.

2.3 Symbol of national identity

The traditional architecture of the Daur people serves practical purposes and carries significant symbolic meanings for their ethnic identity. Its unique architectural styles, such as the "Jie" character-shaped roof structure, double-pitched roofs covered with thatch, and window door decorations symbolizing family happiness, all represent the cultural symbols of the Daur people. These designs meet the practical needs of cold regions while reflecting the Daur people's deep historical memory and cultural traditions. Every detail in traditional buildings, like the design of west windows, the structure of independent chimneys, and the symbolism of carved patterns, is an essential expression of the uniqueness of the Daur people. These cultural elements make traditional buildings functional structures and crucial carriers for transmitting the national spirit, serving as key ties that maintain ethnic identity and cultural continuity.

3. Lessons for protection and inheritance

As modernization accelerates, traditional Daur architecture is gradually being replaced by modern buildings due to its complex structure and high construction costs. This change brings about a shift in lifestyle and poses a risk of losing the cold-resistant techniques and rich cultural connotations

embedded in traditional Daur architecture. To protect this valuable cultural heritage and rejuvenate it, the following measures need to be taken:

3.1 Records and research

Due to the lack of a written language, the Daur people rely solely on their spoken language for cultural transmission. Coupled with the acceleration of modernization and intermarriage with the Han people, the traditional living environment is gradually disappearing, putting many ancient ethnic cultures at risk of being lost. Therefore, comprehensive documentation and in-depth research have become fundamental to protecting Daur's traditional architecture. This should be achieved through text, images, and digital modeling, systematically recording buildings' structure, materials, construction techniques, and decorative features, and forming detailed archives and databases. These records serve as evidence for cultural inheritance and essential resources for subsequent restoration and innovation. Using digital technology, virtual models can be created to reproduce the spatial layout and details of traditional buildings vividly. Combining historical documents and oral histories, we can uncover the cultural stories and social significance embedded within them, providing a deeper interpretation of their value in national history.

3.2 Education and Communication

Education and communication are crucial means to enhance public cultural identity. Promoting the traditional architectural culture of the Daur people in communities and schools can help more people understand the unique charm of Daur architecture through cultural exhibitions, curriculum design, and thematic lectures. Schools can incorporate Daur traditional architectural culture into local cultural courses to foster cultural pride and conservation awareness among young people. Meanwhile, communities can organize traditional building experience

activities, such as making tower wall models or constructing thatched roofs, allowing participants to personally experience the wisdom and appeal of Daur's architectural skills. Additionally, modern media platforms should be utilized to expand the social influence of Daur traditional architecture through documentaries, short videos, and interactive displays, making this cultural treasure widely known.

3.3 Modernization application

Combining the cold-resistant techniques of traditional Daur architecture with modern building design is a crucial direction for protection and inheritance. Introducing traditional eco-friendly materials into modern buildings can reduce the environmental burden of construction materials; integrating traditional orientation design with modern lighting technology further optimizes energy efficiency, drawing on the heat circulation principle of heated brick beds and developing efficient and energy-saving indoor heating systems. Additionally, exploring integrating traditional architectural aesthetics with modern functions can create culturally creative buildings that combine regional characteristics with practicality. For example, constructing eco-friendly Daur-style buildings in tourist attractions or cultural exhibition centers can meet contemporary needs while showcasing the beauty of traditional culture, thus achieving unity of protection and inheritance (as shown in Figure 17).

Figure 17 Design effect of Daur residential buildings combined with modern technology (drawn by the author)

Conclusions

In summary, the site selection and orientation, material choice, structural design, and fire pit system of traditional Daur architecture, formed under icy conditions, reflect the Daur people's survival wisdom adapted to local conditions and carry profound social and cultural significance. Through comprehensive research involving literature review, oral interviews, and field investigations, several key points can be identified (see Table 2 Table: Daur House Thermal Factors vs. Cultural Value):

Table 2: Daur House Thermal Factors vs. Cultural Value)

staple	Warmth effect	cultural significance	operability	remarks
Site selection and orientation	√√√	√√	√√	It is sheltered from the wind and sunny, with significant benefits in winter.
Wood, earth, and grass	√√√	√√	√	It is easy to obtain

building materials combination				materials, but construction requires experience.
Thick walls and grass roof structure	√√√	√	√	The traditional approach is slightly more expensive.
Fire bed system	√√√	√√√	√	It saves energy and has social functions.
Multi-window design (including west window)	√	√	√√	Good lighting and ventilation; pay attention to insulation.
Cooking stove and flue layout	√√	√	√	Energy saving and efficient, integrated design
Courtyard and neighborhood space	√	√√	√√	Promote community communication and emotional maintenance.

When the above elements are implemented and inherited at multiple levels in the design and construction, the cold resistance performance and cultural connotation of Daur dwellings will be more effectively preserved and developed, providing reference and inspiration for the architectural practice and national cultural continuation in cold regions in contemporary times.

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