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Research on the Construction Characteristics of Stone-Built Folk Houses in Jiarong Tibetan Area

—Take the Stone-Built Houses in Xisuo Village as an Example

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Abstract

The Jiarong Tibetan traditional residence is a characteristic regional architecture, located in a high-intensity, high-altitude and cold area, with geographic identification, and is a typical representative of this ethnic group. It has also become an important tourist destination and has important research value. The research used the methods of field survey surveying and mapping to conduct field survey and surveying on 20 buildings in Xisuo Village, a traditional village in the Jiarong Tibetan area. Measure building plans, elevations, and building sections, and collect measurement data for statistical analysis. The results show that the average total height of the building is 10.08 m, the average total building span is 12.44 m, the average total depth is 10.87 m, and the squareness is 0.87. The square shape of the building is more in line with the seismic requirements of high-intensity areas and the local terrain environment. The maximum window-wall ratio in the building is 0.18 south for the second floor, and 0.025 west for the first floor. Smaller window-to-wall ratios have better adaptability to high-altitude cold areas. The height of the building beam section is generally from 0.17 m to 0.32 m, and the average Beam span-depth ratio is 0.10. The building space construction has a good match with the properties of wood materials. These conclusions quantitatively analyze the characteristics of stone-built houses in high-intensity, high-altitude and cold areas, supplement the research on ethnic regional architecture, and provide materials and references for the design, repair and update of related buildings.

Keywords

Jiarong Tibetan, Squareness, Window-Wall Ratio, Space Construction, Beam Span-Depth Ratio

1. Introduction

In recent years, with the continuous development of Chinese society and the acceleration of the process of urbanization, the development of traditional ethnic areas is facing a huge test. The country has issued many policies for the development of traditional ethnic areas. For example, "Rural Revitalization", "List of Traditional Chinese Villages", etc. Ethnic architecture is often an important part of traditional ethnic regions and an important representative of a nation. It reflects the nation's historical changes, cultural customs, production and lifestyles, etc. It has high historical, cultural, scientific, artistic, social and economic value.

At present, there are endless researches on ethnic architecture. Professor Lu Yuanding puts forward a research method combining humanities, dialects, and natural conditions on the laws and characteristics of the formation of traditional Chinese residential buildings, and went deep into the study of residential styles, residential behaviors and residential patterns [1]. Probe into the traditional national architectural form and the law of spatial evolution [2] [3] [4], As well as a summary analysis of the formation process and characteristics of the architectural styles of different ethnic groups in different regions [5] [6] [7]. Facing the influence of traditional national architecture by modern development, more scholars have discussed the protection and development of national regional architecture [7] [8] [9] [10] [11]. In addition, the construction craftsmanship of traditional buildings is also particularly important. The construction techniques of traditional Chinese building structures are rooted in China's special humanistic and geographical environment. The construction materials and craftsmanship of different ethnic groups and regions have unique characteristics [12] [13] [14] [15] [16]. There is also the exploration of the physical properties of stone masonry buildings, and the assessment of building seismic vulnerability [17] [18] [19], Physical performance evaluation [20] [21]. Research the existing intact buildings through field visits, surveys, and explore the construction characteristics and scale laws of the buildings, etc. [22] [23].

There are also many related studies on traditional Tibetan architecture. A spatial study of Sichuan Tibetans [24] [25], Summarize various typical construction types of Tibetan dwellings in Danba area and analyze the characteristics of ethnic expression [26] [27], Analyze the spatial function organization, spatial sequence and construction characteristics of residential buildings [24] [28] [29] [30], and its cultural and artistic characteristics [31] [32]. In addition, there is research on the thermal environment of Tibetan buildings [33] [34]. In a large number of studies, there is a lack of research on the architectural characteristics of Jiarong Tibetans, a large-scale sampling survey, and a lack of quantitative analysis and research.

This study takes Xisuo Village, a traditional Tibetan area in Jiarong, as the research site, selects 20 well-preserved typical residential buildings for quantitative statistical analysis, and gives scientific digital results of building characteristics. It is expected to provide a reference for future architectural design, heritage protection and repair work. The article first obtains a large amount of surveying and mapping data through field visits and surveys, draws architectural plans, elevations and architectural sections, and analyzes the basic characteristics of the building. Secondly, the building squareness, window-wall ratio and beam span-depth ratio are calculated through surveying and mapping data and formulas. Quantitatively analyze the regional adaptability of Jiarong Tibetans in high-intensity, high-altitude and cold areas, and provide materials and scientific basis for the renewal design, repair and renewal of rural buildings.

2. Methodology

2.1. Research Location

The Jiarong Tibetan traditional houses are mostly distributed in the Aba Prefecture of Sichuan Province. They belong to the plateau canyon area. They are located in the north-south seismic belt of China. The average altitude is between 3500 m and 4000 m. They belong to the plateau monsoon climate, with abundant sunlight and large temperature difference between day and night.

Xisuo Village is located in Zhuokeji Town, Malkang County, Aba Prefecture, Sichuan Province (**Figure 1**). The Mosuo River flows past the village. The entire village is built on the mountain. The houses retain the Jiarong Tibetan traditional architectural style of "building stones as houses". Scattered, the stone building forms a good echo with the natural environment of the surrounding mountains and cliffs. It is a relatively complete cultural and architectural practice in the Jiarong Tibetan area in western Sichuan, and has a unique Jiarong Tibetan architectural style. **Figure 2** shows the current situation of Xisuo Village. In 2013, it was included in the second batch of traditional villages in China. It belongs to the provincial cultural relics protection unit and is a typical representative of traditional houses in the Jiarong Tibetan area.

2.2. Sample Selection

This study selected 20 representative traditional residential buildings in Xisuo Village, and conducted on-site investigations and surveys on each building. **Figure 3** shows the locations of 20 sample buildings. **Table 1** shows the basic information of all sample buildings. The selection of these typical residential buildings is based on the integrity of the building structure and the degree of retention of ethnic and regional characteristics, while considering the practicability of surveying and mapping, they basically cover most residential buildings in Xisuo Village and are sufficiently representative. **Figure 4** shows the actual situation of all sample buildings.

2.3. Surveying and Mapping

The main tools used in surveying and mapping in this article are laser rangefinder, level, theodolite, tape measure and camera, etc. The measuring principle refers to the building surveying and mapping specification, and the building size is subject to the outline of the building's exterior wall. The height of the building is taken from the outdoor ground level of the building to the height of the roof surface layer. When the building is a sloping roof, it is calculated based on half the height of the sloping roof to the outdoor ground level.

Table 1. Basic information of sample buildings.

No.	Name of head of household	construction year	orientation	No.	Name of head of household	construction year	orientation
1	Lan Suhua	1974	South	11	Wang Shuangyuan	1820	South
2	Jia Tou	1971	southeast	12	Zha Xi	1988	South
3	Hong Su	1986	southeast	13	Ka Na	1985	South
4	Rong Zheng	1986	South	14	Na Dan	1976	South
5	Amu	1967	South	15	A Muchu	1967	South
6	Ye Ding'an	1968	South	16	Ge Sang	1969	South
7	Yang Dongfanag	1968	South	17	Awang	1971	east
8	Ze Sijia	1990	South	18	Suo Langhamu	1977	southeast
9	JunLong	1984	South	19	Yang Bajin	1987	South
10	Yang La	1987	South	20	La Mu	1996	South

Note: within 15 degrees east of south and 15 degrees west of south are counted as south.

Figure 1. Location of Xisuo village figure.

Figure 2. Panorama of Xisuo village.

Figure 3. Schematic diagram of the location of 20 sample buildings.

Figure 4. Real view of sample building.

Measure selected 20 typical architectural samples, including building area, building height, building space construction and window component size, etc. After the measurement is completed, complete data is recorded, and computer CAD drawing software is used to draw building plan, elevation and section views. Figure 5 and Figure 6 show the results of drawing the plan, elevation and section of a sample building. In this way, all selected sample buildings are surveyed and mapped, and the results are summarized.

2.4. Analysis Method

The article mainly uses descriptive analysis and data statistical analysis methods to conduct a descriptive analysis of building features through field surveys and the collection of a large number of photos. At the same time, quantitative analysis is carried out based on the numerical range, mean value and proportional relationship of the surveying and mapping data, and summarizes the architectural plane characteristics, window-wall ratio and architectural space construction characteristics.

2.4.1. Squareness C

In the design of residential buildings, the span (s) refers to the distance between the positioning axes of two adjacent horizontal walls, which is also the main lighting surface of the building. Smaller span size can shorten the space span of the floor and enhance the integrity and stability of the residence. Depth (d) refers to the actual length from the front wall to the back wall of a building, perpendicular to the span. Reasonable depth scale can ensure the lighting and ventilation conditions of the residence. Figure 7 is a schematic diagram of span and depth. There is a certain proportional relationship between span and depth. We define the ratio of depth to span as the squareness (C) of the building. Such as formula (1). The closer the squareness is to 1, the smaller the gap between the building span and the depth, and the more square the building plane is.

$$C = \frac{d}{s} \tag{1}$$

2.4.2. Window-Wall Ratio W

Window-wall ratio refers to the ratio of the total area of external windows in a certain direction to the total area of the wall in the same direction. According to the results obtained by surveying and mapping, the window-wall ratio is calculated according to the floor and window opening direction. When calculating, take the building's elevation as the standard. The determination of the window-to-wall ratio requires comprehensive consideration of many factors, the most important of which are the climate environment, indoor lighting design standards, and window area and building energy consumption. The "Code for Thermal Design of Civil Buildings" GB 50176-93 stipulates: The window-wall ratio in each direction of the residential building shall be no more than 0.25 in the north direction; no more than 0.30 in the east-west direction; and no more than 0.35 in the south direction.

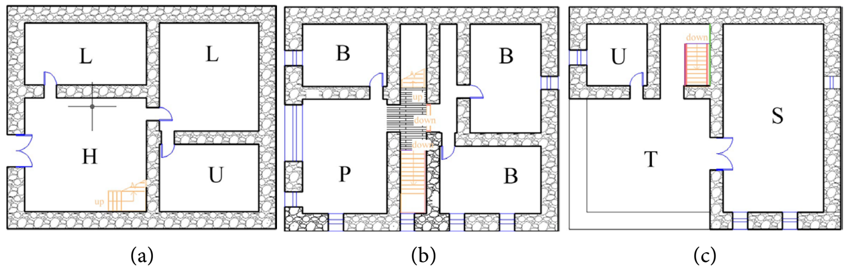


Figure 5. Floor plan of building surveying and mapping. (a) Ground floor plan (b) Floor plan of the second floor (c) Floor plan of the third floor. Note: L livestock house, H hall, U utility room, B bedroom, P parlor, S shrine, T terrace.

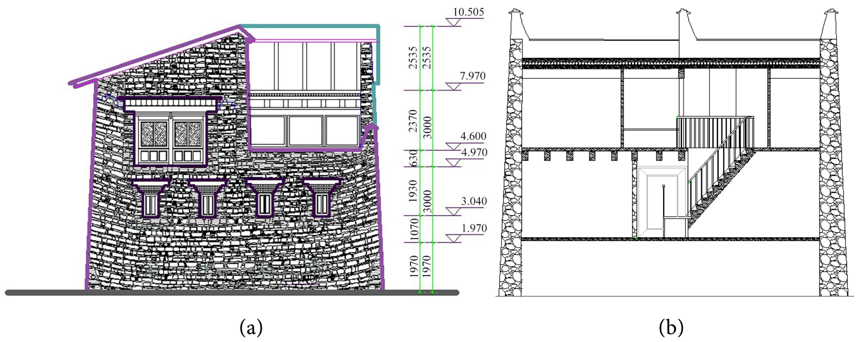


Figure 6. Building surveying and mapping. (a) Elevation (b) Sectional.

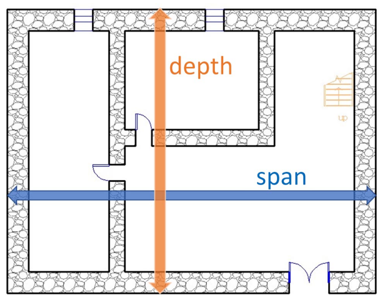


Figure 7. Schematic diagram of span and depth.

2.4.3. Beam Height-Span Ratio F

The height-span ratio is the ratio of the beam height (h) to the span (l) in the building. Such as formula (2). Figure 8 is a schematic diagram of beam height and span. In modern residential buildings, the height of the main beam can generally be 1/8 to 1/12 of the span, and the secondary beam can be 1/15. In this study, the largest span of each building was used to calculate the height-span ratio.

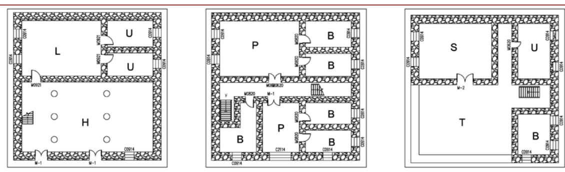
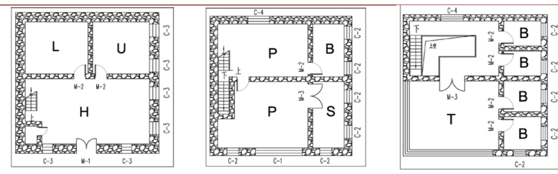
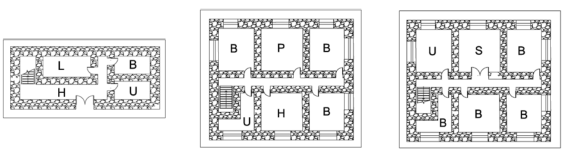
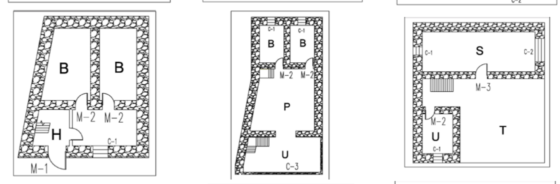
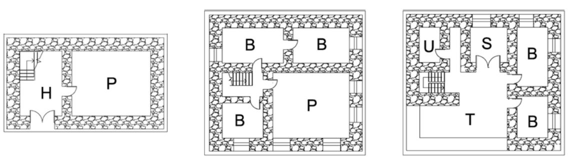
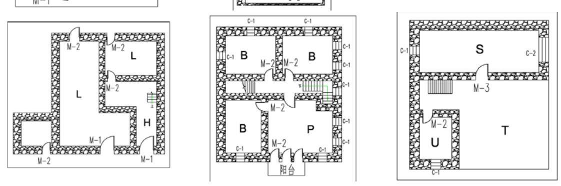
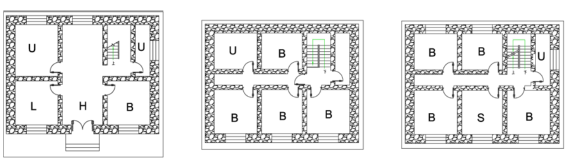
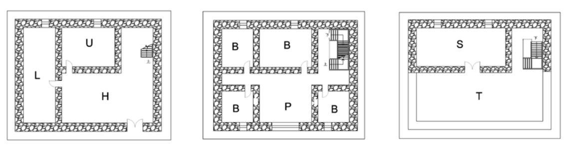
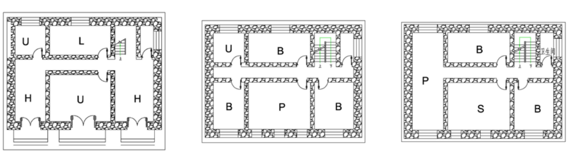
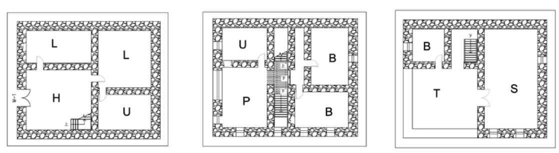
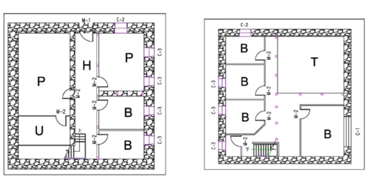
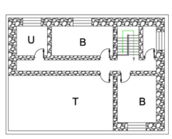
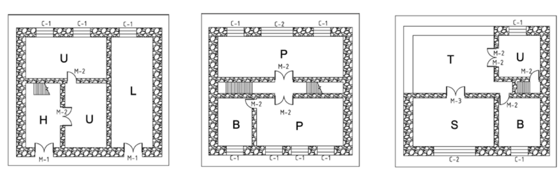
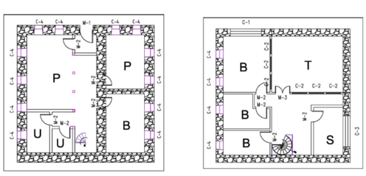
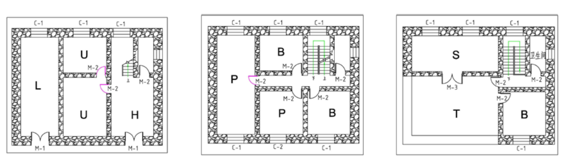
$$F = \frac{h}{l} \tag{2}$$

3. Results

3.1. Building Plan Features

According to the above method, the building samples of Xisuo Village were surveyed and mapped, Table 2 lists the floor plans of 20 buildings. According to on-site survey information and measurement results, The main entrance of the building is generally on the south side. The first floor is mainly the entrance hall and the livestock house, the second floor is the parlor and living space, and the third floor is the shrine and terrace. Table 3 summarizes the building plan surveying and mapping data, the building height is between 12.15 m and 7.86 m, with an average of 10.08 m. The total building area is 668.8 m^2 at the largest and only 175.6 m^2 at the smallest. The gap is large. In the sample building, the largest span is 14.4 m and the smallest is 8.75 m. The maximum depth is 14.5 m and the minimum is 8.9 m.

Table 2. Sample building surveying floor plan.

No.	First floor	second floor	third floor	No.	First floor	second floor	third floor
1				11			
2				12			
3				13			
4				14			
5				15			
6			 (No.5 fourth floor)	16			
7				17			

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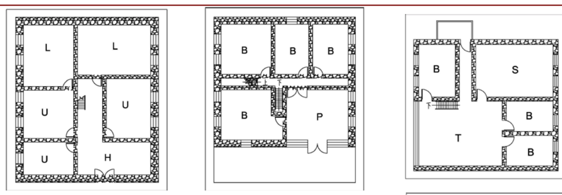
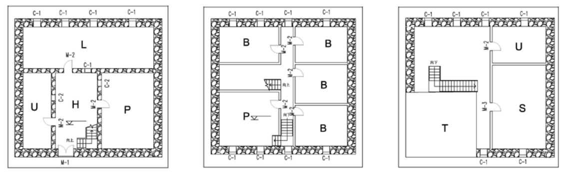
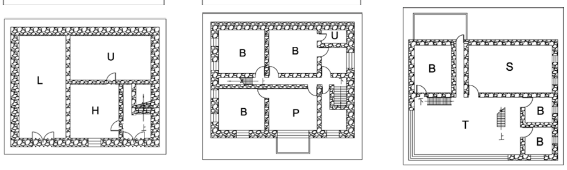
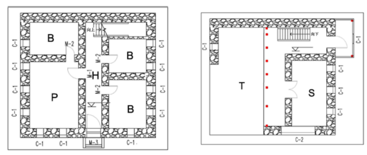
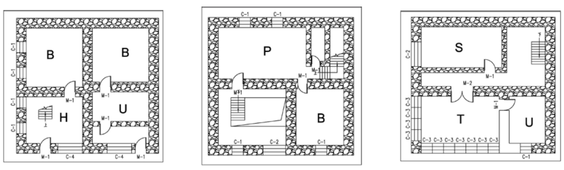
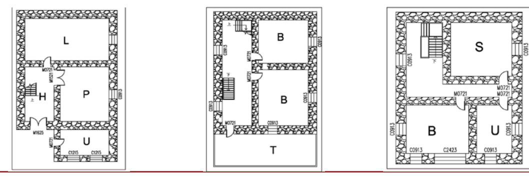
8		18	
9		19	
10		20	

Note: L livestock house, H hall, U utility room, B bedroom, P parlor, S shrine, T terrace.

Table 3. Summary of sample building dimensions.

No.	Span/m	Depth/m	floor	building area/m^2	Height/m	squareness
1	14.40	14.50	3	626.4	10.65	1.01
2	11.69	9.70	3	278.2	9.06	0.83
3	8.75	7.66	3	175.6	8.20	0.88
4	13.60	10.50	3	428.4	10.20	0.77
5	15.20	11.00	4	668.8	12.00	0.72
6	10.60	10.60	2	224.7	8.60	1.00
7	10.60	10.60	2	224.7	10.51	1.00
8	14.20	13.50	3	575.1	11.70	0.95
9	14.00	11.30	3	474.6	12.15	0.81
10	11.60	11.00	3	382.8	10.47	0.95
11	9.81	9.63	3	283.4	9.81	0.98
12	12.00	11.20	3	324.4	8.70	0.93
13	11.20	12.00	3	403.2	9.10	1.07
14	13.00	9.81	3	382.5	10.27	0.75
15	11.75	9.50	3	334.9	10.47	0.81
16	12.60	11.20	3	423.4	11.00	0.89
17	13.50	10.50	3	425.3	11.45	0.78
18	13.30	12.50	3	498.8	8.80	0.94
19	12.80	11.84	2	303.0	7.86	0.93
20	14.30	8.90	3	381.9	10.63	0.62
mean	12.44	10.87	2.9	391.0	10.08	0.87

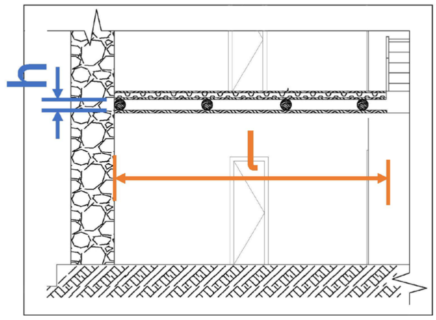


Figure 8. Schematic diagram of height-span ratio.

Figure 9 shows the distribution of span, depth and height of the sample buildings. It can be seen that the difference between the building span and the depth is relatively small, the average building span is 12.44 m, and the total depth is 10.87 m. The squareness of the building is 0.87 through the calculation formula (1), the difference between the span and the depth is small, and the whole building presents a relatively square plan feature.

Use the SPSS software to analyze the correlation between the total building span, the total depth and the building height. Table 4 lists the relationship between the building pan, the depth and the building height. Among them, between span and building height $R = 0.683$, $P < 0.001$, between depth and building height $R = 0.455$, $P < 0.5$. At the same time, between span and depth, $R = 0.586$, $P < 0.01$, two stars. Explain that there is a significant correlation among the span, depth and building height, and they are all positively correlated. The span, depth, and height of the building are coordinated and restricted, and the shape of the building is more square.

3.2. Building Window-Wall Ratio

According to the mapping and calculation formula (2), Table 5 shows the surveying and mapping elevations of the sample building, and Table 6 summarizes the ratio of window and wall area of different floors and different directions of the sample building. It can be seen from the observation of the building facade and field visits, The old time building had a certain defensive function, so the windows on the first floor of the building were small, occasionally no windows were opened, only air holes. The outer windows on the second floor are mainly divided into two types. One is installed on the stone wall. The opening size is small, and the periphery of the window is decorated with white gray painted trapezoid wide edges. The other is a wooden window installed on a wooden wall, which is mostly used on the south side of the main room. The opening is larger and the decorative patterns are complicated.

Figure 10 shows the ratio of window to wall area of different floors and different orientations for all sample buildings. The maximum window-wall ratio in the building is 0.18, and the second floor faces south. Except that no windows are installed on the fourth floor, the minimum window-to-wall ratio is 0.025, and the first floor faces west. The remaining floors and orientations are around

0.03 - 0.08. Figure 11 analyzes the window-wall ratio of all sample buildings in different orientations. In the basic information survey of the sample buildings, it is found that the building orientation is south or southeast, with good lighting, Therefore, the building has the most windows in the south direction, with a window-wall ratio of 0.10, followed by a north direction of 0.05, and a west-facing window with fewer windows, with a window-wall ratio of only 0.03.

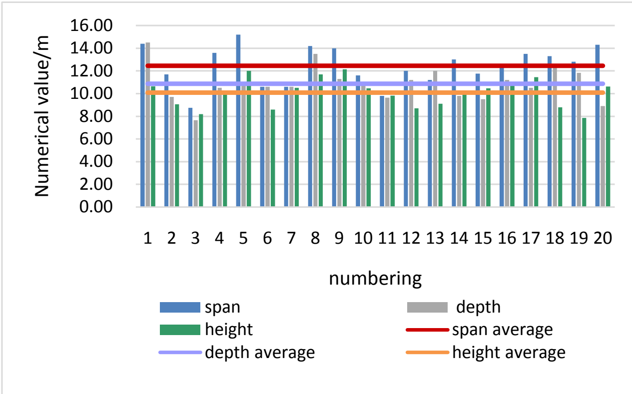


Figure 9. Analysis of building span, depth and height.

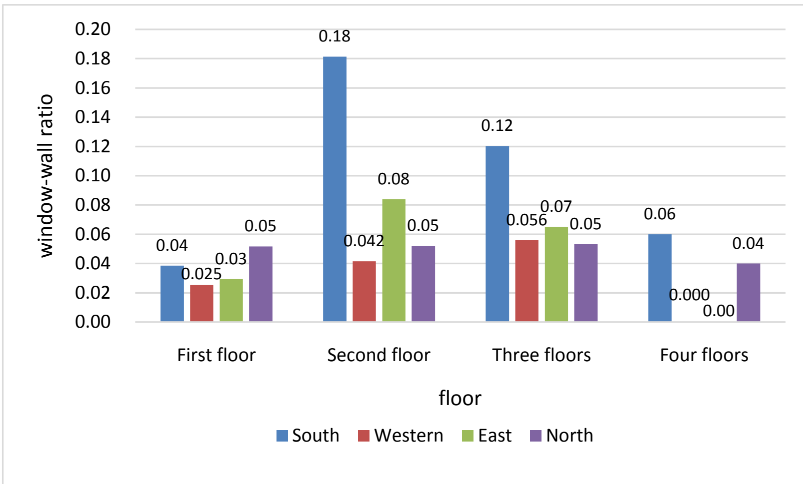


Figure 10. Analysis of window-wall ratios on different floors and different orientations of the building.

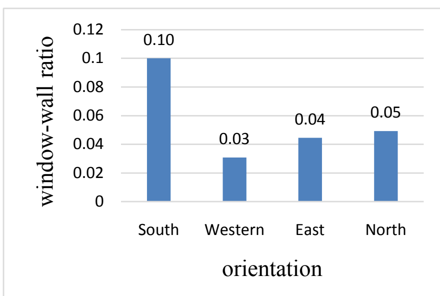


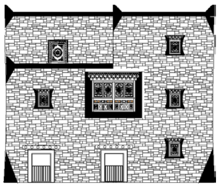
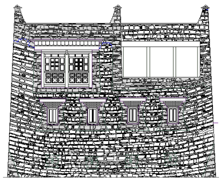
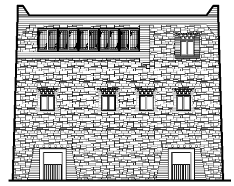
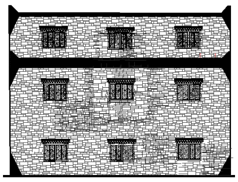
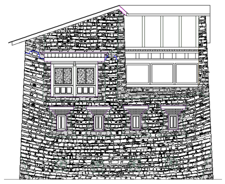
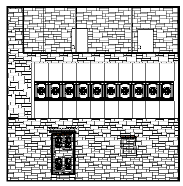
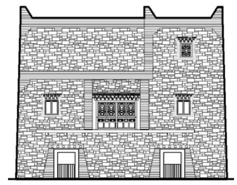
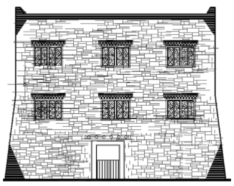
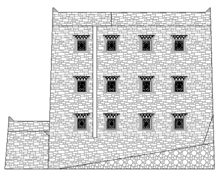
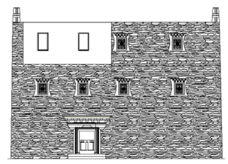
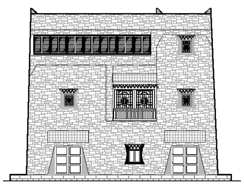
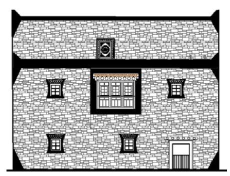
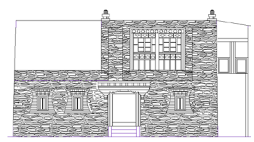
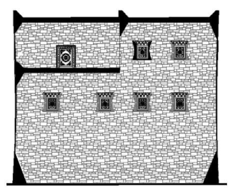
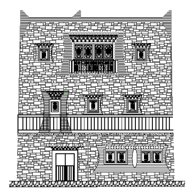
Figure 11. Analysis of window-to-wall ratio of buildings with different orientations.

Table 4. Correlation analysis of building span, depth and height.

variable	1	2	3
1 span	1	0.586**	0.683***
2 depth	0.586**	1	0.455*
3 height	0.683***	0.455*	1

Note: *P < 0.05, **P < 0.01, ***P < 0.001.

Table 5. Survey and mapping elevations of sample buildings.

No.	elevation	No.	elevation	No.	elevation	No.	elevation
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

3.3. Architectural Space Construction

Table 7 lists the sample building surveying and mapping sectional, It can be seen that the building is mainly load-bearing with stone masonry walls, and all walls, whether they are load-bearing walls or enclosing walls, are connected together. Wall thickness is about 1 m, strong integrity. In addition, there are mainly wooden pillars and beams for load-bearing. The indoor wooden pillars are generally about 2.2 m, and the partition wall can be flexibly set.

Table 6. Summary of window-wall ratios of sample buildings.

No.	floor	South	west	east	north	No.	floor	South	west	east	north
	First	0.122	0.149	0.149	0		First	0.064	0	0.130	0
1	Second	0.167	0.050	0.100	0	11	Second	0.335	0	0.134	0.050
	Third	0.082	0.112	0.105	0		Third	0.077	0	0.100	0.037
	First	0	0	0	0		First	0.046	0	0	0
2	Second	0.175	0.045	0.075	0.21	12	Second	0.814	0	0.1806	0.124
	Third	0.180	0.047	0.094	0.180		Third	0.109	0.036	0.420	0
	First	0	0	0	0		First	0	0	0	0
3	Second	0.292	0.071	0.213	0	13	Second	0.077	0.036	0.181	0.077
	Third	0	0	0.116	0.158		Third	0.180	0.180	0.036	0
	First	0.053	0	0	0.053		First	0	0	0	0.054
4	Second	0.191	0	0	0	14	Second	0.186	0	0	0.056
	Third	0.086	0	0	0.057		Third	0	0	0	0.058
	First	0	0	0	0.501		First	0	0	0	0
5	Second	0.105	0	0	0.051	15	Second	0.123	0.254	0.038	0
	Third	0.085	0	0	0.051		Third	0.142	0.083	0.040	0
	Fourth	0.060	0	0	0.04		First	0	0	0	0.139
6	First	0	0	0.045	0.018	16	Second	0.188	0	0	0.188
	Second	0	0.047	0.341	0.025		Third	0.181	0	0	0.110
7	First	0	0.045	0.045	0.045		First	0	0	0	0.113
	Second	0	0.041	0.131	0.118	17	Second	0.227	0	0	0.128
	First	0	0.074	0.059	0		Third	0.112	0	0	0.124
8	Second	0.017	0.075	0.075	0.017		First	0	0	0	0.111
	Third	0	0.039	0.075	0	18	Second	0.122	0	0	0.122
	First	0.020	0	0	0		Third	0.124	0	0	0.131
9	Second	0.119	0.066	0.048	0	19	First	0.075	0.108	0.108	0
	Third	0.063	0	0.052	0		Second	0.234	0.079	0.093	0
	First	0.276	0.129	0	0		First	0.114	0	0.050	0
10	Second	0.214	0	0	0.065	20	Second	0.041	0.068	0.068	0
	Third	0.342	0.386	0	0		Third	0.283	0.068	0.068	0

Table 8 summarizes the maximum span, beam height and height-span ratio of all sample buildings. The maximum building depth is 11.3 m and the minimum is 4.65 m. Set up a pillar in the middle, simple structure, tight connection. The maximum span of the beam is 2.647 m and the minimum is 1.8 m. The beam height is distributed between 0.17 m and 0.32 m, with an average of 0.209 m. The height-span ratio of the building is calculated by formula (2), the maximum is 0.20, the minimum is 0.07, and the average is 0.10.

Table 7. Sectional drawing of sample building.

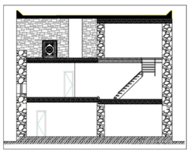
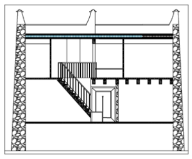
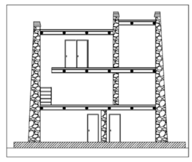
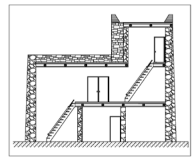
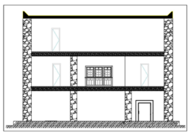
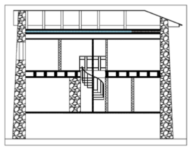
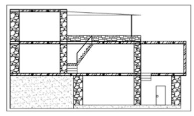
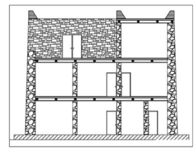
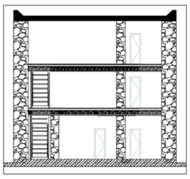
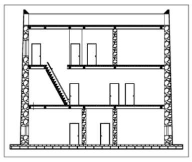
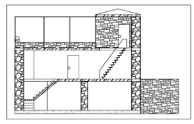
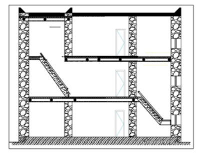
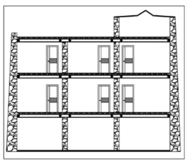
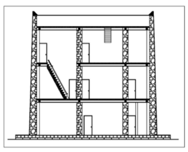
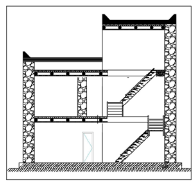
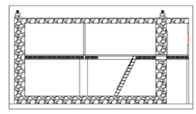
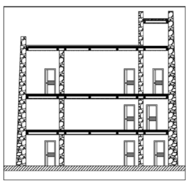
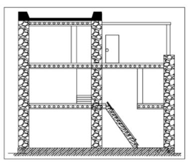
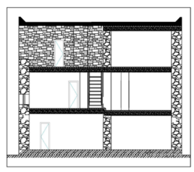
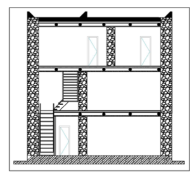
No.	section	No.	section	No.	section	No.	section
1		6		11		16	
2		7		12		17	
3		8		13		18	
4		9		14		19	
5		10		15		20	

Table 8. Summary of height-span ratio of sample buildings.

No.	span/m	height/m	height-span ratio	No.	span/m	height/m	height-span ratio
1	1.891	0.20	0.11	11	2.647	0.20	0.08
2	2.323	0.17	0.07	12	2.120	0.20	0.09
3	2.580	0.20	0.08	13	1.800	0.17	0.10
4	2.050	0.18	0.09	14	1.800	0.20	0.11
5	2.233	0.21	0.09	15	1.900	0.20	0.11
6	2.280	0.32	0.14	16	1.833	0.20	0.11
7	2.233	0.32	0.14	17	1.967	0.20	0.10
8	2.450	0.21	0.09	18	1.975	0.19	0.09
9	1.900	0.21	0.11	19	2.222	0.19	0.09
10	1.857	0.19	0.11	20	2.000	0.20	0.10
Mean					2.075	0.21	0.10

4. Discussion

4.1. Influencing Factors and Deviations of Squareness

Modern residential buildings span generally do not exceed 3 m - 3.9 m, and brick-concrete houses generally do not exceed 3.3 m. Smaller span size can shorten the space span of the floor and enhance the integrity, stability and earthquake resistance of the residential structure. In order to ensure that the completed houses have good natural lighting and ventilation conditions, the depth of modern residential buildings is usually 3 m - 6 m in design. The squareness is about 0.667, which is much smaller than the 0.87 squareness of the buildings in Xisuo Village.

According to the National Building Seismic Design Code, the seismic fortification intensity of Xisuo Village is 7, which is a high-intensity area. The multi-storey stone building shall not exceed four stories and the height is less than 13 m. The square building plan is more conducive to the seismic performance of the building. On the other hand, it may be affected by the terrain and climate environment, there are fewer flat areas, and square spaces are more conducive to healing. Therefore, the building size with a squareness of 0.87 is more suitable for the local environment and meets the building safety performance and people's production and living needs.

There is no toilet or kitchen space in the main building. These spaces are often attached to the periphery of the main body (Figure 12), with deformation joints between them to form a combined plane. Or the building plan is irregular due to the topography. It is ignored when calculating the squareness of the building, which will cause a certain error to the result.

4.2. Building Window Characteristics

According to the function of the building, there are obviously fewer windows on the first floor of the building in Xisuo Village, and the second floor is the main living space with larger windows, especially in the south-facing main room with

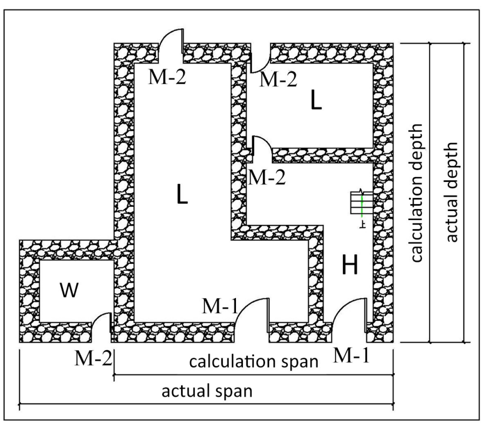


Figure 12. Deviation of span and depth calculation.
Note: L livestock house, H hall, W washroom.

large windows to meet the lighting needs. Secondly, organize the layout with the living room as the center, The living room is used most frequently and for the longest time. The traditional fire pond culture is also carried out here. The three-floor shrine is a completely private space with fewer windows.

In modern buildings, the requirements for window-wall ratio are no more than 0.25 in the north, no more than 0.30 in the east-west direction, and no more than 0.35 in the south direction. The southward window-wall ratio of the buildings in Xisuo Village is the largest, but it is only 1.0, followed by 0.05 for north, 0.04 for east, and 0.03 for the west. Xisuo Village is located in a high-altitude and cold area with almost no heating facilities. A small window ratio helps keep the building warm. Secondly, in the old times, buildings had a certain defensive function in addition to residential functions, and window openings were often used as lookouts. The prevailing wind direction in Xisuo Village is northwest wind throughout the year, so there are fewer windows in the west. With the continuous development of society, traffic is becoming more convenient, and economic conditions are constantly improving. Buildings can appropriately increase the proportion of windows opened to provide better lighting and ventilation, thereby improving the comfort of living.

At the same time, there are some errors in the research. The building orientation is not all due to the south and north. We define that within 15 degrees east of south and within 15 degrees west of south are counted as south, so the calculation results have certain errors within the allowable range.

4.3. Space Construction and Material Properties

In modern architectural design, the main beam section height h can be determined according to (1/8 - 1/12) l, l is main beam span, the ratio of the beam net span to the section height should not be less than 4, and the beam section width should not be less than 0.2 m. The cross-sectional height of the building beams in Xisuo Village is only between 0.17 m and 0.32 m, and the average height-span ratio is only 0.10, which is smaller than that of modern buildings. On the one hand, the Jiarong Tibetan area is located in a high-altitude, cold area, and it is difficult to transport due to the influence of the terrain. The building construction uses local materials, and the wood is generally cut into short materials of about 2 m - 3 m. Therefore, the length of the wooden column of the building is generally about 2 m - 3 m, and the column diameter is between 0.2 m - 0.4 m. Affected by the properties of wood, the height-span ratio of the building is much smaller than the conventional ratio. On the other hand, beam as a flexural member, the section height mainly depends on its own span. Restricted by the requirement of anti-deformation ability, the span that the beam can adopt cannot be too large, otherwise it will cause the section height to be too large, which will cause material waste and increase the self-weight load of the structure. Therefore, it matches the building's relatively square span and depth ratio, adapts to the local environment and adapts measures to local conditions.

5. Conclusions

This article takes the Jiarong Tibetan Xisuo Village as an example to study the architectural characteristics. The results show that the average total building span is 12.44 m, the average total depth is 10.87, and the average height of the building is 10.08 m. There is a significant positive correlation between height and span and depth, the squareness of the building is 0.87. The earthquake fortification intensity of Xisuo Village is 7 degrees, and the square building characteristics are more suitable for high seismic intensity, ensuring the safety performance of the building. The largest window-to-wall area ratio in the building is 0.18, the second floor faces south, except for the windows on the fourth floor, the smallest window-wall ratio is 0.025, and the first floor faces west. For the overall analysis of the building, the window opening in the south is the most, with a window-wall ratio of 0.10, followed by 0.05 in the north, and there are fewer windows opening in the west, with a window-wall ratio of only 0.03. Xisuo Village is located in a high-altitude cold area, and its smaller window-wall ratio is more suitable for the local environment and climate. As for the construction characteristics of the building space, affected by the properties of wood materials, the height of the building beam is generally between 0.17 m and 0.32 m, and the average height-span ratio is 0.10.

This research obtained a large amount of surveying and mapping data of the buildings in Xisuo Village in the Jiarong Tibetan area through investigation and measurement, scientifically quantified the architectural features through typological research and mathematical-statistical methods, and enriched the research on ethnic regional architectural features, and Research on the architectural characteristics of high-intensity, high-altitude and cold areas. At the same time, it provides scientific and reasonable materials and references for related architectural design, repair and renewal. This study also has certain limitations: 1) This study only surveys the buildings in Xisuo Village, and the sample range is relatively limited. 2) The sample size is slightly smaller, and the study only measures the data of 20 buildings. In order to have a more comprehensive understanding of the architectural characteristics of the Jiarong Tibetan area, it is necessary to conduct field surveys and data surveys in other traditional villages to obtain a wider range of data, while increasing the number of samples and measurement content, and more fully and comprehensively explain the architecture The characteristics of all aspects enrich the research of ethnic regional architecture.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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