ISSN: 2710-0588

Field Measurement and Climate Adaptability Study of Stilt House Environment in Langde Area of Southeast Guizhou

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Abstract

Stilt house is a traditional wooden-framed dwelling in Qiandongnan, Guizhou. This paper analyzes the advantages and disadvantages of the summer and winter climate adaptability of stilt house, provides important guiding data for building a regional dwelling construction system that adapts to the climate, and is an important basic research on the optimization strategy of the regional dwelling design and construction system. The study conducted continuous indoor and outdoor physical environment comparison tests in winter and summer on the stilt house dwellings in Langde area, and analyzed and summarized some design and construction strategies of the regional dwelling construction system through data measurement and questionnaire survey methods. The research results show that stilt house dwellings have great potential for indoor climate regulation and adaptability at the material and space organization level. It is hoped that the influencing factors of the components can be refined and translated and followed the ventilation space organization structure to improve the comfort of the indoor space.

Keywords

Traditional dwellings, Performance measurements, Climate responsive.

1. Introduction

The Miao Langde area in Qiandongnan, Guizhou, has become a hot spot for development by actively developing architectural culture, relying on its unique ecological environment, simple local customs and colorful ethnic culture[1]. There are two main reasons for this development: on the one hand, Qiandongnan is one of the protected areas for traditional ethnic cultural villages in China; on the other hand, due to the development of unique regional residential architecture and culture, traditional stilt houses are still widely used by residents in the area[2].

Figure 1. Selected stilt house test building

2. Research Subjects and Methods

2.1. Research subjects

During the investigation, the author visited nearly 100 households in Langde area and selected two typical stilt houses through surveying and mapping. Building A was built more than 80

ISSN: 2710-0588

years ago. The main body is a through-beam wooden frame, the internal and external protective structures are board walls, the roof is a double-slope roof, and the main material is green tiles. The main building has four bays, the first floor is a storage room; the second floor is the main room, and the two sides are arranged with the elderly bedroom and kitchen; the third floor is the bedroom and grain storage room. The current residents are a family of six named Chen. Building B was built more than 60 years ago. The internal and external protective structures are board walls, the roof is a double-slope roof, and the main material is green tiles. The main building has 6 bays, and the two bays on the south side have no protective board walls and are in a state of waiting to be built. They are temporarily used for cargo storage. The first floor is a livestock pen and storage room; the second floor is the main room, with a cantilevered retreat, and the master bedroom is arranged on both sides; the third floor is an inner corridor attic, with four guest rooms on both sides and a grain storage room. The current residents are a family named Chen, and the permanent population is Mr. and Mrs. Chen and their son.

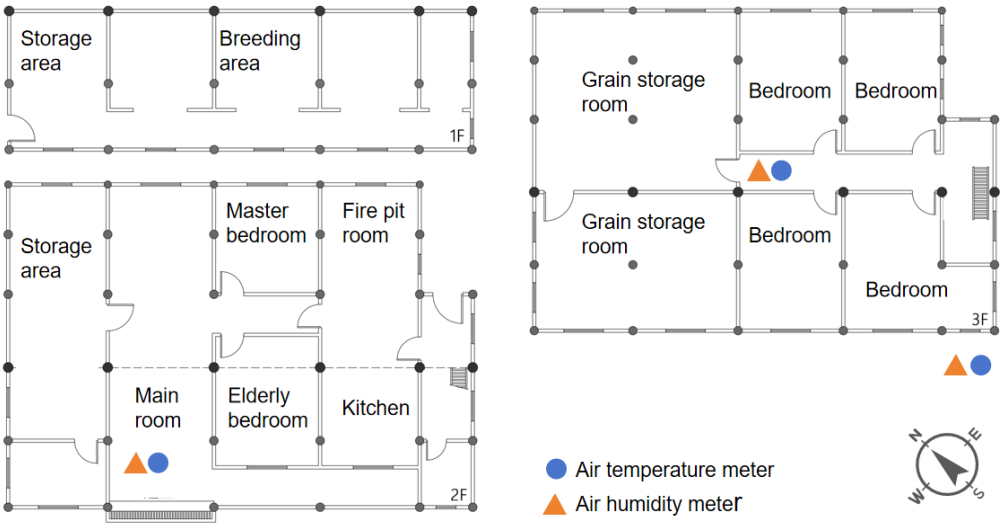

Figure 2. Test plan for stilt House A

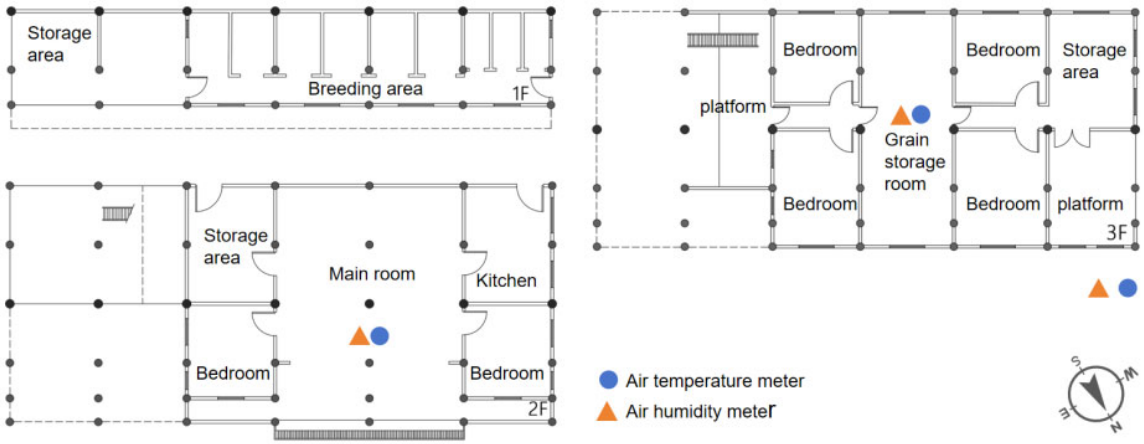

Figure 3. Test plan for stilt House B

2.2. Research methods

The methods of field research and testing mainly include: architectural surveying: recording the basic architectural form of stilt houses; field investigation of residents' family structure, lifestyle, space usage patterns and related information of house construction; physical working

ISSN: 2710-0588

condition testing: selecting indoor and outdoor physical environmental parameters of typical residents, such as temperature, relative humidity, solar radiation heat and other parameter variables related to space comfort. Finally, the design response strategy is summarized through post-test data analysis.

3. Test Plan and Test Results

3.1. Research and testing plan

The test plan adopts a multi-point layout to test the internal and external parts of the building simultaneously. The specific measurement point layout is shown in Figures 2 and 3; the physical environment test mainly includes indoor and outdoor temperature, relative humidity, and outdoor solar radiation heat. In the thermal environment test, the test time and test parameters are shown in Table 1. During the test, the data collection intervals of the main instruments used are shown in Table 1. The instruments used in the experiment have been calibrated and tested. At the same time, in order to prevent the temperature and humidity recorder from being directly exposed to the sun and human influence, the instrument is controlled to be 1.5~1.8 meters above the ground in a dark place.

Table 1. Measured time and interval

Object	Test Date	Time	Content	Interval
A	June 29, 2023	9:00 - 21:00	Air temperature	5 min
	February 17-18, 2024	9:00 -9:00T/N	Air humidity	5 min
B	June 30, 2023	9:00 - 21:00	Air temperature	5 min
	February 17-18, 2024	9:00 -9:00T/N	Air humidity	5 min

3.2. Measured data analysis

3.2.1. Summer measurement analysis

From the test results, it can be seen that the outdoor air temperature of Building A of Chen's House varies more than that of the indoor air, the air temperature is higher, and the relative humidity is larger. During the test, the average outdoor air temperature was 29.6℃, reaching a peak between 13:00 and 15:00, with a maximum value of 32.1℃. After 18:00, the air temperature dropped to a minimum of 27.3℃, with a daily range of 4.8℃. In terms of outdoor air relative humidity, due to the abundant precipitation in the area and strong solar radiation during the day, high evaporation occurs. The average outdoor relative humidity is 83.8%, the maximum is 87.2%, the minimum is 82%, the daily range is 5.2%, and the relative humidity varies slightly. As the core space of the main functions and activities of the stilt house, the highest air temperature in the main room during the test was 28.4℃. After 19:30, the solar altitude angle was small, the lowest temperature was 24.9℃, the average temperature was 26.8℃, and the daily range was 3.5℃. The temperature fluctuated regularly with a small amplitude. The horizontal space of the main room was open, and there were air buffer interlayers on each floor in the vertical direction. The overall trend of relative humidity in the main room is opposite to the change of air temperature, with an average value of 77.2%. It was a sunny day on the test day, with high relative humidity, and the highest value was 81.1%. After 13:30, the air temperature rose due to solar radiation. Because the traditional stilt houses have good ventilation, ventilation can take away a lot of moisture, so the relative humidity decreased, with the lowest value being 72.8%, and the daily difference being 8.3%, which is larger than the outdoor variation.

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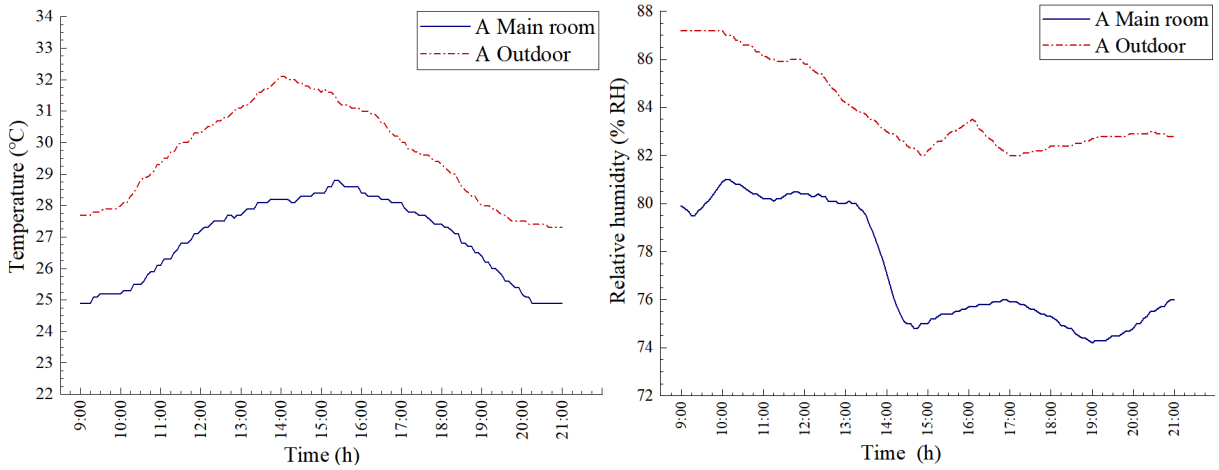

Figure 4. Summer measured data of House A

From the test results, it can be seen that the indoor and outdoor air temperature and relative humidity of Building B of Chen's House have similar changes to those of Building A of Chen's House. The outdoor air temperature changes more, the air temperature is higher, and the relative humidity is larger. During the test, the average outdoor air temperature was 28.8℃, reaching its peak at 13:00-15:00, with a maximum value of 32.8℃. After 18:00, the solar altitude angle decreased, and the air temperature decreased, with a minimum value of 26.8℃, a daily range of 6℃, and a large fluctuation. In terms of outdoor air relative humidity, due to the abundant precipitation in the area and strong solar radiation during the day, high evaporation was caused. The average outdoor relative humidity was 85.1%, the maximum was 87.8%, the minimum was 81.5%, and the daily range was 6.3%, with a large range of changes. During the test, the highest air temperature in the main room occurred between 13:30 and 14:30, with a maximum temperature of 29℃, a minimum temperature of 24.4℃, an average temperature of 25.9℃, and a daily range of 4.9℃. The overall trend of relative humidity in the main room is opposite to the change of air temperature, with an average value of 78.3%. It was a sunny day on the test day, and the relative humidity was high, with the highest value being 81.6% and the lowest being 72.7%. The daily range was 9.1%, which was larger than that outdoors.

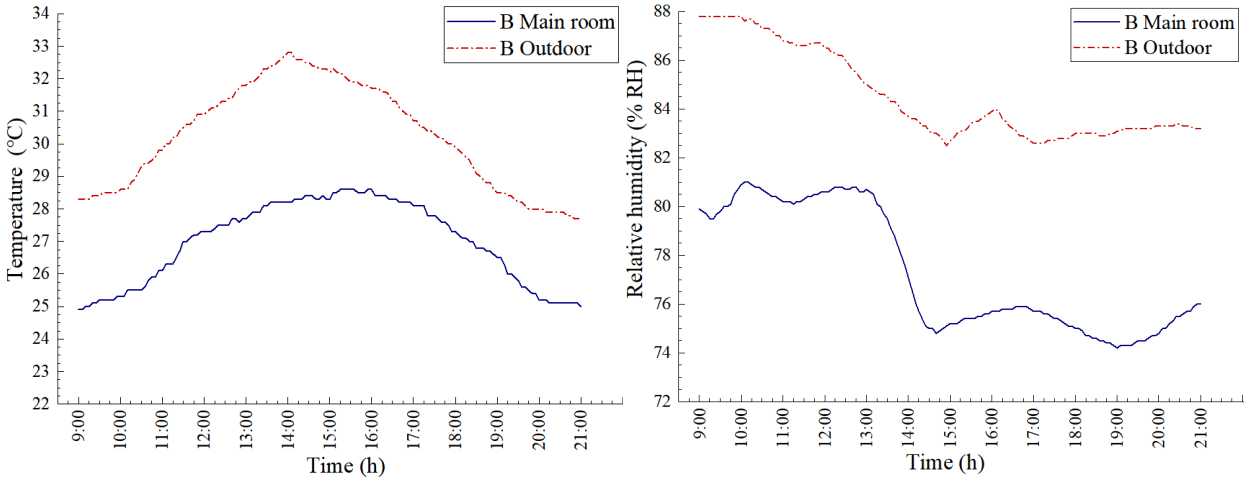

Figure 5. Summer measured data of House B

3.2.2. Winter measurement analysis

From the test results of Building A of Chen's House, it can be seen that the outdoor air temperature and indoor air temperature change range are similar, the indoor air temperature

ISSN: 2710-0588

is generally higher than the outdoor temperature, and the indoor relative humidity is generally lower than the outdoor humidity. During the test, the average outdoor air temperature was 0.7°C, the daytime air temperature was stable, the highest value was 1.7°C, and the nighttime air temperature dropped, the lowest value was -0.2°C, and the daily range was 1.9°C. In terms of outdoor air relative humidity, due to winter snowfall, occasional cloud cover during the day, weak solar radiation, the average relative humidity was 83.1%, the maximum was 87%, the minimum was 76.9%, the daily range was 10.1%, and the relative humidity fluctuated greatly. During the test, the highest air temperature in the main room appeared at 19:30-21:00, with the highest temperature of 3.3°C. The lowest temperature was reached after 1:00 at night, with the lowest temperature of 2°C, the average temperature of 2.6°C, and the daily range was 1.3°C. The change range was small. The main reason was that the curtains were often drawn in the main room and the retreat in winter, and the indoor air flow rate was slow. The overall trend of the relative humidity of the main room air is similar to that of the outdoor relative humidity, with an average value of 73.5%, the highest relative humidity of 76.4%, the lowest value of 69.7%, and a daily difference of 6.7%.

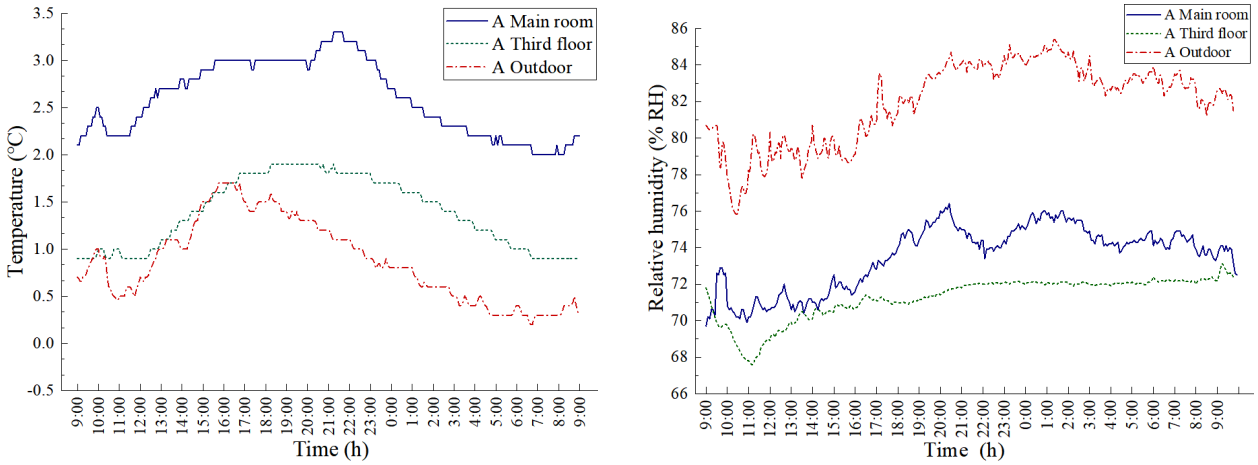

Figure 6. Winter measured data of House A

From the test results of Building B of Chen's House, it can be seen that the outdoor air temperature varies greatly, the indoor air temperature is generally higher than the outdoor temperature, and the indoor relative humidity is generally lower than the outdoor humidity. During the test, the average outdoor air temperature was 2.1°C, the air temperature was relatively stable during the day, and the nighttime variation was large. The highest air temperature was 3.8°C, the lowest was 0.7°C, and the daily range was 4.5°C. In terms of outdoor air relative humidity, due to occasional cloud cover during the day and snowfall at night in winter, the average relative humidity was 76.2%, the maximum was 79.7%, the minimum was 67%, and the daily range was 12.7%, with a large range of variation. During the test, the highest air temperature in the main room occurred between 14:30 and 16:00, with a maximum temperature of 5.3°C, and the lowest temperature was reached at night, with a minimum temperature of 1.7°C, an average temperature of 3.3°C, and a daily range of 3.5°C, with a small range of variation. The overall trend of the relative humidity of the main room air is similar to that of the outdoor relative humidity, with an average value of 68.2%. The highest relative humidity is 72.8%, the lowest is 63.1%, and the daily range is 8.7%, with a large fluctuation range.

ISSN: 2710-0588

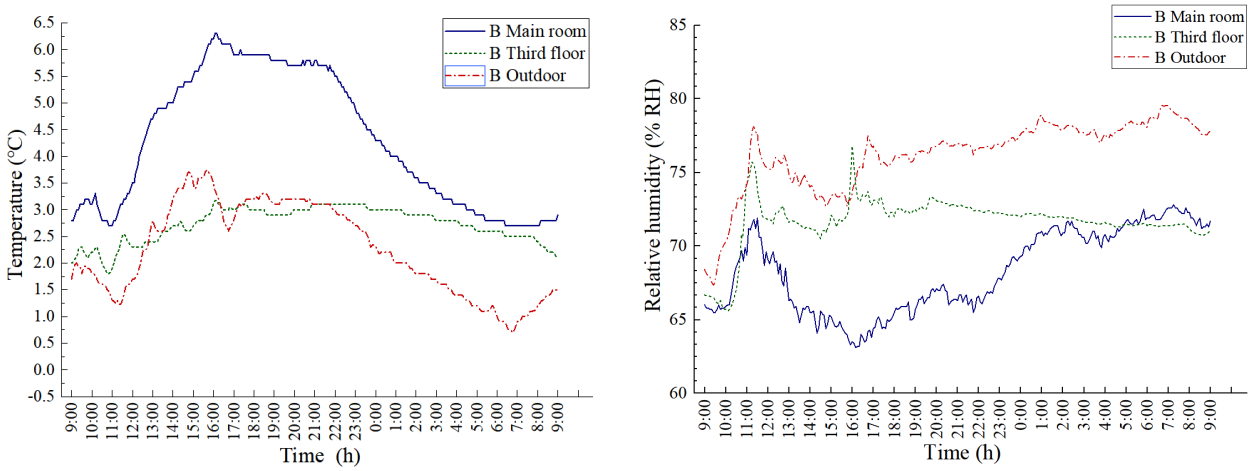

Figure 7. Winter measured data of House B

4. Conclusion

Combined with the analysis of the test results above, there are two main advantages of the stilt houses in this area. One is that the stilt houses have good heat insulation in summer and the indoor temperature and humidity are pleasant. According to the survey, this is because the stilt houses mainly use wooden frames, and there are many vents on the gables and roofs, which makes the internal space system conducive to air circulation. Its unique ventilation system discharges excessive humidity in the air and improves the comfort of the human body indoors. The other is that the indoor temperature remains stable in winter with small fluctuations. This is because the construction method of the stilt houses is that because there are many mountains and abundant water systems in the Langde area[3], most of the stilt houses face the water with their backs to the mountains. The unique spatial structure with the back house embedded in the mountain and the front house overhead keeps the indoor temperature better in winter.

Acknowledgements

Key Project of National Social Science Fund

References

[1] Yong Xia: *The Research of Buyi Villages and Building in Guizhou*(MS.,Chongqing University, China 2012), p.38.

[2] Shilin Jia and Hong Wang: *Research on thermal environment characteristics and construction strategy of traditional dwellings in karst areas in central Guizhou Province*(MS.,Guizhou University, China 2018), p.150.

[3] Zhenxu Zhou and Sijia Cheng:A Study on the Morphology and Survival Rationality of Ethnic Buyi Settlements in Baishui Valley, Guizhou Province. Architectural Journal.Vol.10(2018)No.3, p.101-106.