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Original Research Paper

Solar Geometry Factor in the Traditional Banjar "Bubungan Tinggi" House

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Abstract: The Banjar tribe in South Kalimantan has a traditional Bubungan Tinggi house, which is intended for nobles. This house is made of wood, in the form of a stilt with one roof angled upwards. This paper examines the solar geometry factor on the high ridge house, which is found on the pointed roof having a small geometric factor, so that the solar energy absorbed on the taper roof is small. This proves the local wisdom of the community in getting thermal comfort in their homes.

Keyword: Banjar Traditional House, Bubungan Tinggi, Solar Geometry Factor.

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1. Introduction

Each region has its own traditional house, adapting to the customs and environmental conditions in the area. The same is true in the area of South Kalimantan, where the majority are inhabited by the Banjarese. There are various forms of traditional Banjar houses, namely:

1. Bubungan Tinggi
2. Gajah Baliku
3. Gajah Manyusu
4. Balai Laki
5. Balai Bini
6. Palimasan
7. Anjung Surung
8. Tadah Alas
9. Lanting
10. Bangun Gudang
11. Palimbangan

Traditional houses made by ancient people, of course, have many considerations and philosophies, so they have various architectural forms. In this paper, we will study the thermal characteristics of one of the traditional Banjar houses, namely the high ridge ('Bubungan Tinggi') house as show in Figure 1 [1].

Figure 1. Wasaka Museum Banjarmasin, as one of High Ridge Building in Banjarmasin

The high ridge house is a palace house for the nobles of the Banjar tribe, which is inhabited by the King and his princes. The construction of this house is made of wood with a stilt shape, with a height of 1-2 meters above ground level. The main construction of the Banjar traditional house can be divided into several parts, namely:

1. The body of the building that extends straight ahead is the main building.
2. Buildings attached to the left and right are called Anjung.
3. The roof ridge that tapers high is called the high ridge.
4. The roof ridge that extends forward is called the Sindang Langit roof.
5. The roof ridge that extends backwards is called the Hambin Awan roof.
6. The body of the main building that extends forward is divided into tiered rooms

2. Literature Review

In assessing the thermal characteristics of a building, in this case a traditional high-rise house, the following parameters are required (see, Figure 2). Angle of a building, greatly affects the thermal characteristics of the building [2] [3] [4] [5].

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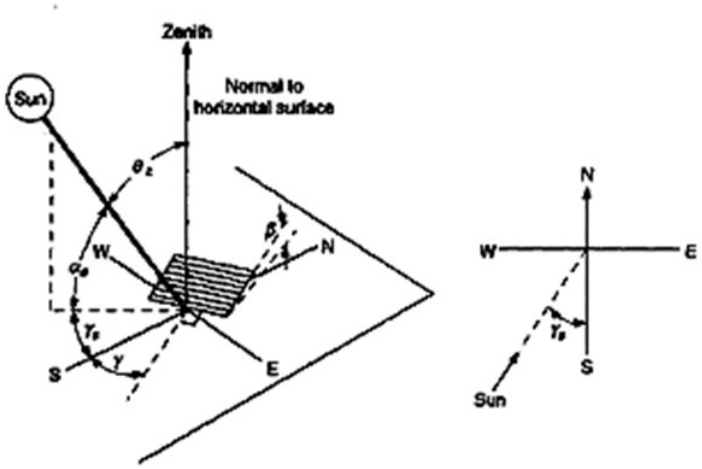

Figure 2. Solar Angle Parameters

- Declination angle

$$\delta = 23{,}4 \cdot \sin\left(360 \cdot \frac{284+n}{365}\right) \tag{1}$$

where,
n is the number of the day in one year (1 to 365).

- Solar beam angle

$$\begin{aligned}\cos\theta = {} & \sin\delta \cdot \sin\varphi \cdot \cos\beta - \quad \sin\delta \cdot \cos\varphi \cdot \sin\beta \cdot \cos\gamma + \\ & \cos\delta \cdot \cos\varphi \cdot \cos\beta \cdot \cos\omega + \quad \cos\delta \cdot \sin\varphi \cdot \sin\beta \cdot \cos\gamma \cdot \cos\omega + \\ & \cos\delta \cdot \sin\beta \cdot \sin\gamma \cdot \sin\omega\end{aligned} \tag{2}$$

$$\begin{aligned}\cos\theta_z = {} & \cos\varphi \cdot \cos\delta \cdot \cos\omega \\ & + \sin\varphi \cdot \sin\delta\end{aligned} \tag{3}$$

- Geometry Factor (*Rb*)

$$Rb = \frac{\cos\theta}{\cos\theta_z} \tag{4}$$

- Total solar Radiation absorbed by collector (I_T)

$$I_T = I_b \cdot R_b + I_d\left(\frac{1+\cos\beta}{2}\right) + I \cdot \rho_g\left(\frac{1-\cos\beta}{2}\right) \tag{5}$$

In Equation 5, it can be seen that the constant Rb is very important to determine whether the collector can work optimally in capturing direct solar radiation. The greater the constant Rb, the better the collector performance in capturing direct solar radiation.

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Over the past few years, mobile technologies have expanded and consolidated in term of recognition as devices employed in daily activities [3] [6]. This fast expansion has seen accumulated interest from varied fields within the benefits derived from the combination of those resources. The conception of mobile learning (m-Learning) has emerged within the educational field reaching to build the foremost out of mobile devices as learning tools [4] [7] [8].

The educational application of those technologies promotes communication and students' autonomous learning, and it brings the teaching -learning method out of the schoolroom, therefore enabling learning anytime, anywhere [9] [10]. This breaks the barriers between formal and informal education, tight the event of latest method ways that contribute to gap up the faculties to the outside world, making bonds between colleges and families and between academics and students which permit teachers to guide the students' learning method within and outdoors the schoolroom [11] [12].

3. Methodology

To be able to determine the thermal characteristics of the high ridge house, it is necessary to measure the dimensions and angles of the high ridge house [13]. This was carried out at the Wasaka Banjarmasin museum, which has the form of a high ridge house. From the known dimensions, the value of the geometry factor can be calculated in a period of 1 year. As is known, due to the tilt of the earth's rotation at 23.5°, there is an apparent movement of the sun towards the earth (Figure 3).

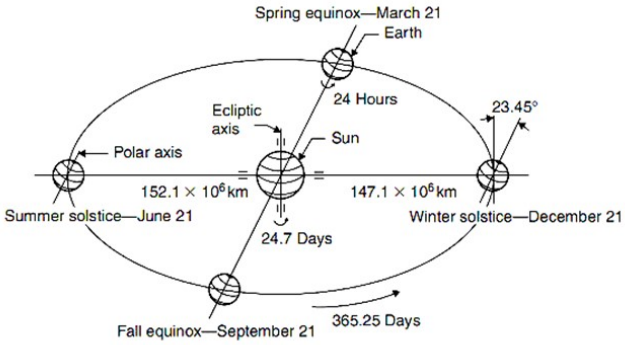

Figure 3. Solar Equinox and Solstice

4. Result and Discussion

In measuring the dimensions of the high ridge house in Banjarmasin, the following results were obtained (Figure 4) in mm units, where this house faces the southeast (Figure 5).

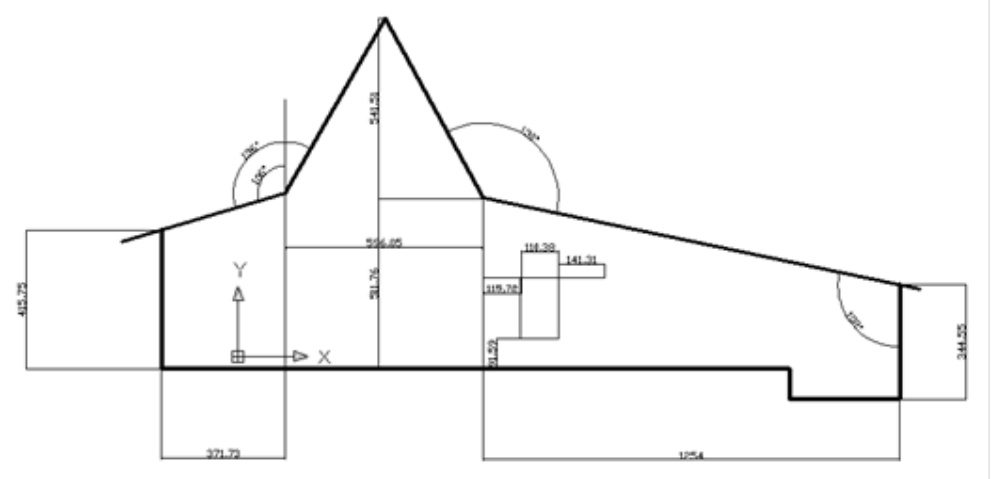

Figure 4. Dimensions of High Ridge House

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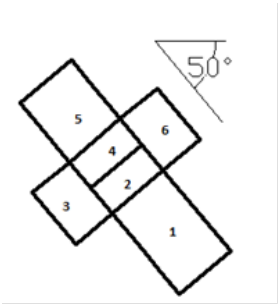

Figure 5. Direction and Roof Numbering of High Ridge House

Table 1 shows the slope and direction of each high-rise roof, while Table 2 shows the geometry factor calculations result.

Table 1. Roof's Slope and Direction

Roof number	**1**	**2**	**3**	**4**	**5**	**6**
Roof slope (β)	30	80	30	80	16	16
Roof direction (γ)	-40 East	-40 East	40 west	130 west	130 west	-130 East

Table 2. Geometry Factor of High Ridge House

	Roof number					
Date	1	2	3	4	5	6
21-Mar-21	0,84	0,13	0,84	0,2	0,96	0,96
21-Jun-21	0,67	-0,2	0,67	0,48	1,04	1,04
21-Sep-21	0,84	0,13	0,84	0,2	0,96	0,96
21-Des-21	1	0,45	1	-6,1	0,89	0,89

Based on the data in Table 2, it can be seen that the roofs of number 2 and 4 which are the high ridges of the banjar house have a small geometric factor. A small Rb value means that roofs number 2 and 4, which are upright, absorb very little solar radiation, so that the roof has a lower temperature than other roofs which are more flat [14] [15].

The results of the calculations in Table 2 show that the traditional high-rise house building, apart from being a building that has a high philosophy (because it is intended for Banjar nobility), also contains the value of local wisdom in terms of its thermal characteristics.

5. Conclusion

The traditional Banjar high ridge house is a house dedicated to the nobles of the Banjar tribe in South Kalimantan, which has a sharp upward angle. Based on the calculation of the solar geometry factor, the roof with an acute angle has a maximum geometry factor of 0.48, far below the other roof geometry factors which have a maximum value of 1.04. This shows the local wisdom of the Banjar people to get thermal comfort in their homes.

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