The Assessment of Building Envelope Performance of Vernacular Architecture in Betawi House

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Abstract. Thermal comfort at house is very influential in the comfort of the occupants of the residence. Moreover, people living in tropical areas such as Indonesia country. At the present time many factors causing temperature changes of convenience, one of which is on the building materials used. Purpose of this study is to determine which factor most affects the comfort of the room temperature in the house. This study uses quantitative methods with the processing of temperature values were analyzed using a chart with a lot of surface measurement points roof, walls, windows, floors, and the room temperature. The results of this study are the factors that most influence on the temperature of the room is located on the sun's heat flow factor horizontal (outer wall, the inner wall, and window).

1. Introduction

Traditional buildings in different parts of the world, such as in dry climates and humid climates, have applied the principle of passive design in the design of the building as passive (1). In buildings in dry climates, many buildings are found with a good and thermally comfortable building solution (2). This is because traditional or vernacular architecture continues the previous tradition of design for centuries. (3 - 5).

Indonesia which is located in humid tropical climate area also has many examples related to building solutions to climate. Traditional architecture in Indonesia has different characteristics related to planning, material use and location (6**,** 7) . Large openings, long overhangs and local materials used in traditional constructions play an important role in optimizing ventilation rate and indoor thermal quality. (8).

One of the example of vernacular architecture is Betawi house. Betawi is the colonial name of Jakarta, Batavia (9). The Betawi race has its own custom house, and its particular shape is like a saddle roof and the form of a building of the seashore (10). Since most Betawi people live on the ground, their homes are not in the form of stilt houses. Many building components are made of wooden structures such as poles, walls, ceiling and floor (11), with roof tiles, zinc or aluminum. The front part of the house is an open terrace, at which four to six pillars are constructed in order to support the roof structure and the overhanging eaves that provide shading for the house. Additionally, there is wooden fence at the terrace. (12).

As occurred with other traditional houses, the Betawi house also changed to be modern. Tiled roofs, brick walls and glass windows are the hallmarks of several changes to Betawi houses. Modern housing has been criticized for its lack of response to the local environment. Recently, modern small / medium housing types in Indonesia have not followed the same design principles. Compared to their traditional counterparts, they are relative heavyweight construction; they often suffer from low levels of natural ventilation. (13).

This study examines the thermal performance of Betawi houses especially walls, windows, floors, ceilings and roofs exposed to solar radiation. In addition, the heat generated by heat transfer in the building element is also studied. The end of all this heat flow is the thermal environment of room such as air temperature, air humidity and all surface temperature that affect the comfort of its occupants.

2. Materials and Method

Locations used in this study is the Betawi-style house in the area of Setu Babakan Betawi Cultural Village, Jagakarsa south Jakarta.

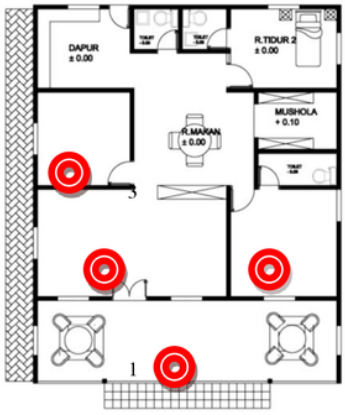

Figure 1. The location of the measurement

Figure 2. Front elevation of the Betawi house

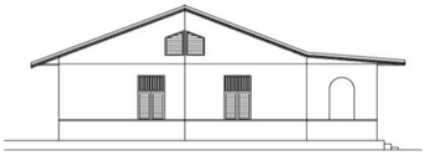

Figure 3. Side elevation of the Betawi house

This study uses a quantitative method, observation, and experimental. This study aims to determine what is the influence of the surface temperature to the temperature of the room inside and evaluate which factors that most influence the temperature in the room.

3. Results and Discussion

3.1. Analysis of the room temperature

Zone 1 space with a height up to 4 meters from floor to ceiling, expanses 3.1.2. Zone 1 space with a height up to 4 meters from floor to ceiling, expanses 4x7 space m². From the graph above it can be seen that the temperature of the roof has an average 32,42° C and the average temperature of the ceiling 1, namely 29.27 C while the average temperature of the room 1 is 29.86 C. On 08.00 a.m. to 10:00 a.m. at room temperature 1 is still in comfortable circumstances, but at 11:00 until 16:00 the temperature in the room one could say uncomfortable. Due to a comfortable temperature in tropical areas is 22.5 C to 29 C.

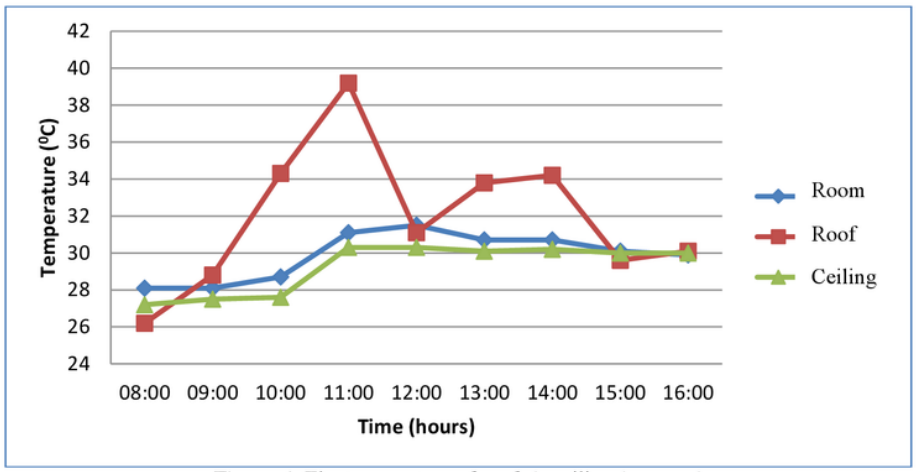

Figure 4. The temperature of roof 1, ceiling 1, room 1

Zone 2 space with a height of up to 4 meters, has spacious rooms 3,5x3,5 m². On 3.1.3. Zone 2 space with a height of up to 4 meters, has spacious rooms 3,5x3,5 m². On This graph shows that the roof surface temperature reaches an average 32,42°C and the mean temperature limit 2 reached 29.65 C while the average temperature chamber 2 reached 29.67 C. At 08.00 to 10.00 at room temperature 2 very comfortable. But at 11.00 to 16.00 at room temperature 2 can be said to be uncomfortable

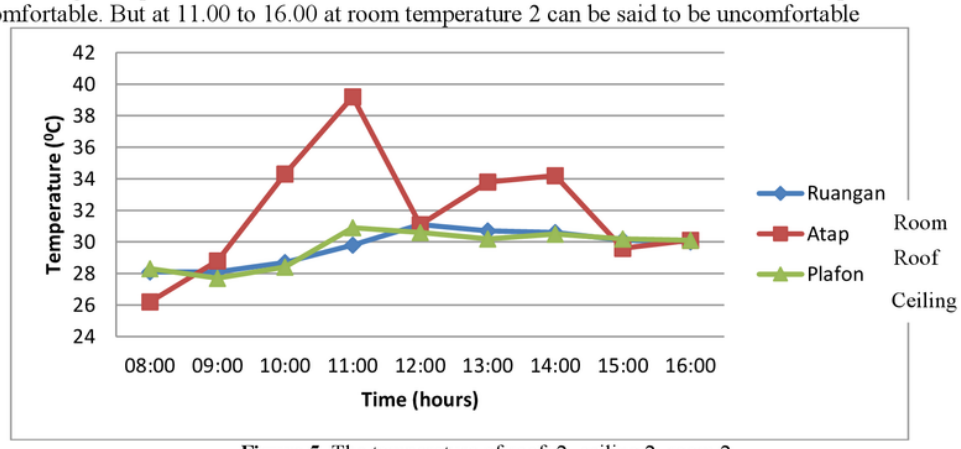

Figure 5. The temperature of roof 2, ceiling 2, room 2

Zone 3 space with a height of up to 4 meters, has spacious rooms 4x4 m². This graph shows that the average temperature of the roof surface is 32,42°C and the average temperature of the ceiling 3, namely 29.22 C while the average temperature of 29.9 C. Room 3 At 08.00 to 10.00 at room temperature 3 pretty comfortable. But at 11.00 to 16.00 at room temperature 3 can be said to be uncomfortable.

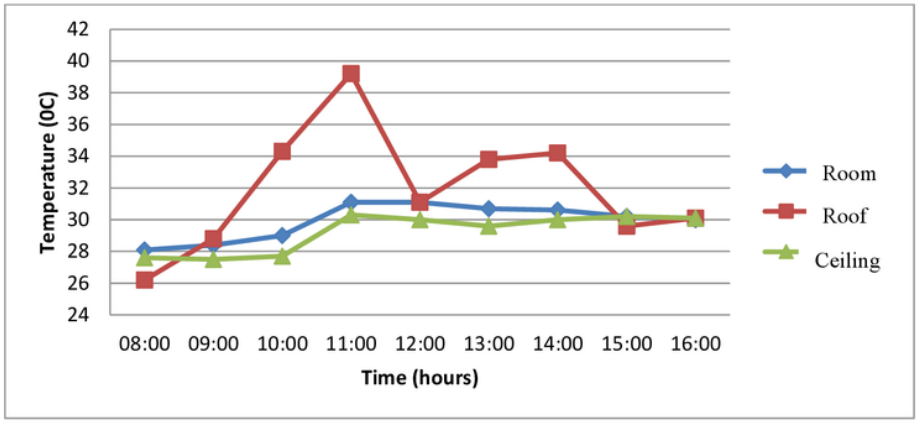

Figure 6. Graph of roof temperature 3, ceiling 3, room 3

The third graph from the data above shows that the temperature of the room almost all uncomfortable if at an average yield that is in Room 1 (29.86 C), room 2 (29.67 C), and a third (29.9 C).

3.2. Analysis of the temperature in the room

On this chart the average surface temperature of the outer wall that is 29.1 C. When viewed from the outer wall surface area is 4x4 m² with a window in the middle of the length of 1.15 meters and a height 1.10 meters have an average temperature of 27.57 C. The average temperature in the wall surface, namely 28.14 C while the average temperature of the room 1 is 29.86 C.

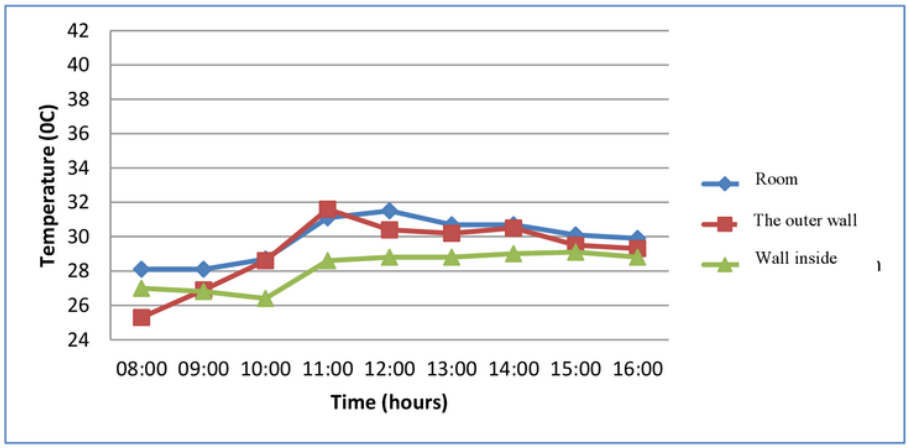

Figure 7. Graph of outer wall temperature 1, wall 1, room 1

This graph shows the temperature of the outer wall has an average of 25.94 C. The surface area of the wall 2 is 3,5x4 meters. There is a window in the same area and has an average temperature of 29.82 C. The average temperature in the wall surface temperature was a window in the same area and has an average temperature of 29.82 C. The average temperature in the wall surface temperature was 28.63 C while the second chamber is 29.67 C. In this second wall window in the open condition.

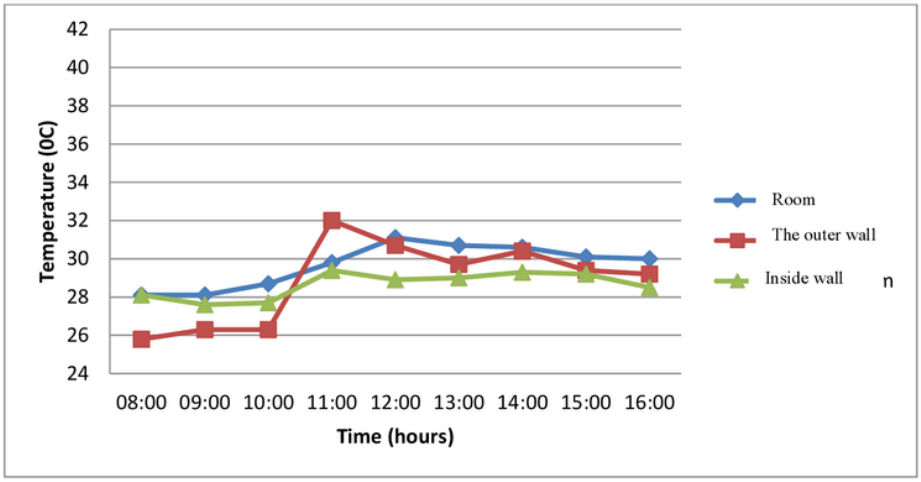

Figure 8. Graph of outer wall temperature 2, wall 2, room 2

On the east side of the house also d planted by palm trees which also serves as a heat barrier direct sunlight and also as a shade. On the east side of the building also contained within a 1.2 meter eaves that serves as a barrier east incoming sunlight gets the east of the building.

3.3. Zone 3 facing west

In this graph shows the average temperature of the surface of the outer western wall that is 28.5 C. The surface area of the wall 3 is 4x4m² and there is a window of the same size with an average temperature of 28.8 C. The average temperature in the wall surface at 27 , 65 C while the average temperature reaches room 3 27 , 65 C while the average temperature reaches room 3 29.9 C

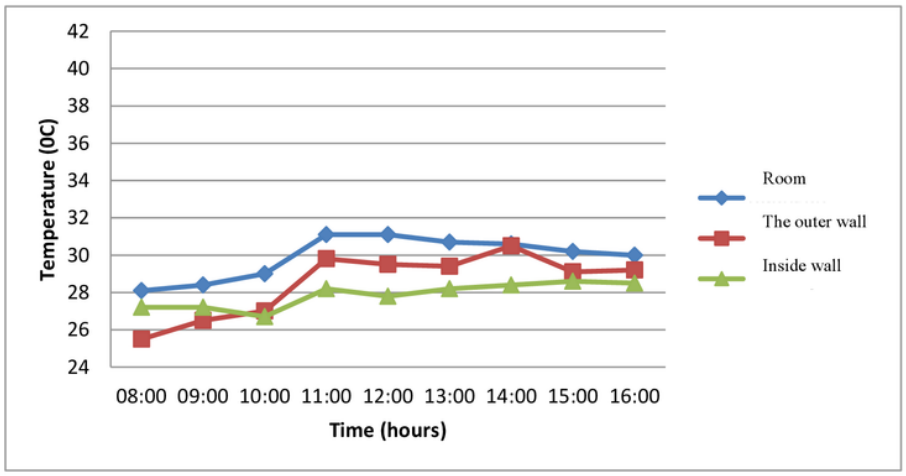

Figure 9. Graph of wall temperature outside 3, wall in 3, room 3

On the west wall adjacent to the boundary wall of the neighboring land. Allows the west wall receives the reflected radiation from the neighboring wall within only 2 meters of the west wall. And on the west wall there are trees as the eastern part, which can reduce solar heat radiation.

Judging from the picture above that the average room temperature is not lower than the ceiling surface temperature. The room temperature tends to be hotter than the surface temperature of the ceiling which should be hot because it is located just below the roof. Therefore the heat flow vertically not affect the air temperature in the room.

A. Vertical Aspect

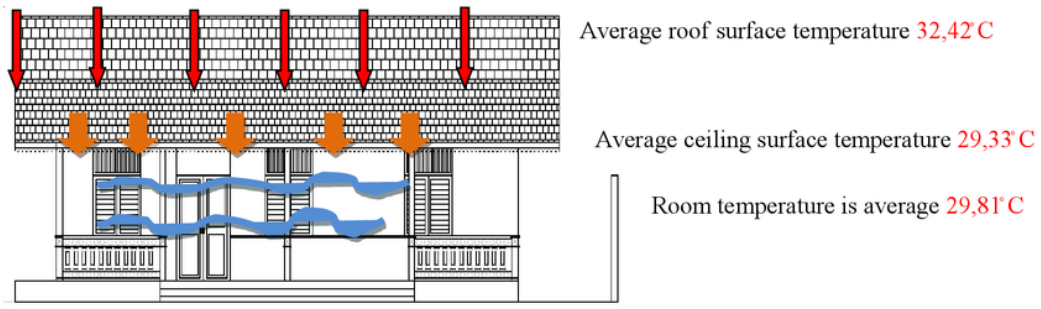

Figure 10. Vertical Aspect

B. Horizontal Aspect

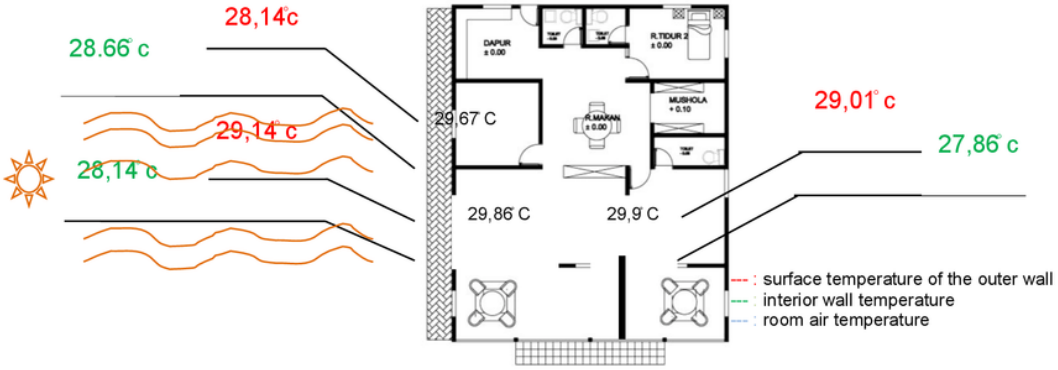

Figure 11. Horizontal Aspect

The influence of the orientation of the sun coming through the outer wall surface temperatures are forwarded to the wall surface in making the room air temperature to be increased. Resulting from heat radiation factor and also openings in the open window.

4. Conclusions and recommendations

In the data already in the analysis that the room belonged to the father of modern Betawi house Suroni different temperature cycles solar orientation from morning to evening. Comfortable indoor temperature in homes ranged from 08.00 to 10.00 with average temperatures: 28.32 C. And temperatures are not comfortable room ranges from 11.00 up to 16.00 with an average temperature of the room is 30.55 C.

In the first room (living room) an average temperature of 29.86 C in a state that the windows were covered with ceiling surface temperature 29.2 C, the temperature of the wall surface is 28.14 C, and the temperature of the window surface that is 31,08° C. temperature 29.2 C, the temperature of the wall

surface is 28.14 C, and the temperature of the window surface that is 31,08° C. Possible room 1 the room air temperature 1 influenced by radiation from the surface temperature of the wood at the closed window. On the condition of the room sealed window one does not get the air flow so that the temperature in the room gets hot.

In room 2 (the child's bedroom) average temperature is 29.67 C in an open window with the window surface temperature is 29.83 C, ceiling surface temperature is 29.65 C, and the temperature of the inner wall surface that is 28.63 C . It is possible that the second room air temperature influenced by the radiation window with a high temperature compared with the temperature in the ceiling or wall. But on the condition of an open window in the room air temperature is slightly decreased compared to the first room with the window closed condition, caused by the flow of air into the room.

In the third room (master bedroom) the average temperature is 29.9 C in an enclosed window with the window surface temperature is 27.68 C, ceiling surface temperature is 29.6 C, and the temperature of the inner wall surface that is 27.86 C. It is possible 3 room temperature is highest among the other room because diperngaruhi surface that is 27.86 C. It is possible 3 room temperature is highest among the other room because diperngaruhi factors and conditions ceiling windows closed so the lack of air flow into the room 3..

4.1. Conclusion

In this study indicate that the surface temperature outside the building is very influential 1. In this study indicate that the surface temperature outside the building is very influential to room temperature inside. Judging from the heat transfer flow from the outer surface of the building toward the surface of the building which resulted in an increase of the room temperature caused by heat radiation surfaces in buildings. Openings in the window also affects the temperature of the room. Due to the air flow into the room so that the hot air inside the room can be piped out of the room. The most hot surface that is on the roof because the roof surface is the most widespread and is above that direct solar heat gain.

The factors that most having an effect on modern Betawi house indoor temperature is a factor 2. The factors that most having an effect on modern Betawi house indoor temperature is a factor horizontal, ie heat flow factor flows horizontally as outer walls, windows, and walls inside. Heat received by the wall can be increased by the use of wooden windows (warm) .Suhu average window reached 29.53 C while the vertical factors (temperature limit) is 29,33° C. Because at the bottom of the roof is covered by aluminum foil which is to reduce heat into and also have vents in the eastern part gin-gin so as to facilitate heat flow can exit through the vents.

4.2. Recommendations

Preferably part around the house by trees, in order to reduce heat and also as a shade.

At the gin-gin west as well ventilated as in the east so that the hot air flow can exit channeled through the vents.

Openings in the window is very influential especially against the passage of air ventilation in the room, so the room can merunun hot air temperature

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