



vol. 16 / 2023



The 7th International Conference on Science Technology

organized by
Faculty of Social Science and
Law Universitas Negeri Manado and
Consortium of International Conference
on Science and Technology

The Innovation Breakthrough in Digital and Disruptive Era

Heat Absorption On Walls With Red Brick Material

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Abstract. Merauke is one of the cities in the tropics, has a relatively high temperature. Currently, development in Merauke is quite rapid, so the need for materials, especially wall materials, is much needed. The material that is quite familiar for walls is red stone, however, in the last 2 years in Merauke, a new material for walls has been light stone. In this study, the material of the red stone wall is the main variable, the material is selected and measured to have the ability to absorb heat and emit heat. The methods used in this study were: making a wall prototype (test wall) with red stone material, research using a Thermometer Gun, measurements were taken from 6.00 – 20.00 WIT. The purpose of this study was to determine the effect of the sun's heat on the redstone walls which included: Peak temperature height and the difference between plastered and unplastered redstone walls, in addition to the thermal properties of the material. On the test wall that was not plastered, the temperature was quite high, reaching 46.1°C during the day, at measuring point A1 (west side) it was found at the end of the measurement (20.00 WIT) the temperature reached 30.7°C but on the reverse side of the measuring point B4, the temperature actually reached 32.2°C (the 2 measuring points were wall pairs without plastering). It was concluded that the measurement results on the west side had a higher temperature, because it was exposed to the sun's heat for a longer time, we can be sure that the heat temperature was reaching the inside side of the room. The walls the plastered test has a fairly high temperature, reaching 50.7°C during the day, the difference at the end of the measurement (20.00 WIT) between measuring point A4 and measuring point B1 is very low, namely; at measuring point A4 the temperature reaches 33.8°C while measuring point B1 reaches a temperature of 33.5°C.

Keywords: Climate change, heat absorption, red brick walls

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1 Introduction

Current climate change has a considerable impact on the surrounding environment, one of which is the occurrence of global warming which results in the current climate conditions and increasing air temperature. Thermal comfort is a condition felt by humans as a result of conditions in their environment. The climate in the environment will affect the shape and orientation of the building. Thermal comfort felt by the human body is influenced by air temperature, radiation temperature, air humidity, wind speed, and human activities.

To get the thermal comfort of the room in the right method used in the tropics, namely using cross-ventilation cooling with vegetation shade to provide coolness. The decrease in temperature in the room is influenced by conduction, convection, and radiation factors. The occurrence of heat transfer through the wall depends on the conductivity of the materials in the building. According to (SNI 2001) the comfortable temperature is $<27.1^{\circ}\text{C}$ and $> 20.5^{\circ}\text{C}$ with 40% -60% humidity and according to (MENKES 2002) the comfortable temperature for office buildings is 18°C - 28°C with 40% -60% humidity.

Wall material or building skin is a determining factor for thermal comfort and temperature reduction in buildings [2]. The process of thermal increase in this building occurs through the conductivity of wall materials that use certain types of materials so that heat or solar radiation does not directly enter the room but is conducted by the wall material which will enter the room. The high or low temperature or thermal in the room depends on the high or low conductivity of the material. One type of material used as a building wall is brick and lightweight brick. [8].

Red stone material is widely used in the city of Merauke, while lightweight brick has only entered Merauke Regency in the last 2 years. Where the temperature in Merauke Regency is relatively high, reaching 30°C (BMKG, 2019), so measurements are needed to find out how much influence the use of brick and lightweight brick materials has on building thermals so that the right solution can be determined for the use of building wall materials in the Merauke Regency area.

The use of house wall materials is still very diverse, ranging from red brick, light brick and adobe is still the people's choice. The amount of heat gained or lost in buildings is influenced by the building materials used, geometric factors, internal heat sources and environmental conditions are also influential [1]. While thermal comfort is influenced by various factors both from outside and from within the building itself, then the decrease in temperature is influenced by the processes of convection, conduction, and radiation [2].

2 Literature Review

2.1 Thermal comfort

Buildings designed and built to be shelter for humans require thermal comfort so that humans can carry out normal activities in their dwellings [5].

The goal of any plan is to create maximum comfort for humans, for now, there is no objective benchmark for comfort [6]. Thermal comfort limits Mom and Wiesebron conducted research in Bandung (6°S), Indonesia and determined that thermal comfort limits were divided into 5 levels. Captions should be typed in 9-point Times. They should be centred above the tables and flush left beneath the figures.

Table 1. Mom's and Wiesebron's Thermal Comfort Limits.

No.	Levels	Effective Temperature Range (ET)
1.	Uncomfortably cold	$20,0^{\circ}\text{C} - 20,5^{\circ}\text{C}$
2.	Cool comfortable	$20,0^{\circ}\text{C} - 22,8^{\circ}\text{C}$
3.	Optimal comfort	$22,8^{\circ}\text{C} - 25,8^{\circ}\text{C}$
4.	Warm comfortable	$25,8^{\circ}\text{C} - 27,1^{\circ}\text{C}$
5.	Hot	$> 20,5^{\circ}\text{C}$

2.2 Building Materials

An architectural work that will be built in an area with temperatures that are not extreme in the sense that it is still close to human temperature requirements, as is the case in Indonesia's climate which has a humid tropical climate tends to use materials that are not thick. [7] The wall is a non-structural part that serves as a means of insulation between rooms and insulation between the inside of the building and the outside of the building. Judging from its function, walls are classified into three types, namely exterior walls, interior walls, and special walls.

Exterior walls, apart from being strong, must also be beautiful and weather-resistant to the surrounding area. Selection of the type of wall material for areas that are frequently hit by earthquakes, areas that often rain, or areas with high levels of heat, of course have material character requirements. If the exterior walls are usually permanent, on the interior walls there are also owners who want contemporary room dividers so they can be easily changed, for example by using partitions, removable dividers, or other types. Because it is located on the inside, the considerations in choosing materials tend to be adjusted to dominant tastes and slightly ignoring the weather resistance factor.

One of the studies conducted by Vladimir [8] explained that the selection of the type of wall material also affects the level of thermal comfort that occupants will feel indoors.

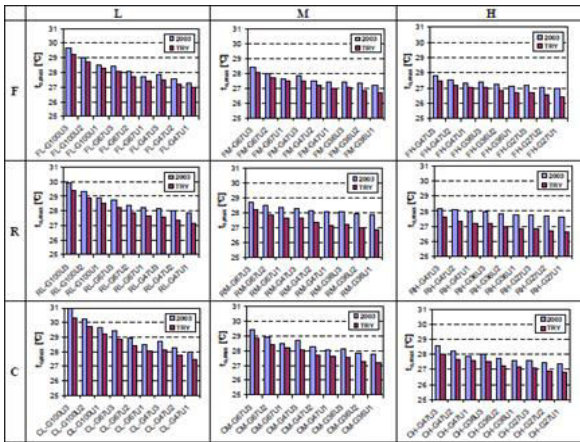


Fig. 1. Kasih nama Gambar in english.

Based on the graph of Vladimir's research results, he explained that the type of building envelope material, in this case the walls, has a significant influence on the level of thermal comfort in the room. How far the influence of the two materials on the indoor temperature needs to be known? Materials that are often used in the Merauke area are red bricks and light hebel bricks.

2.3 Thermal Properties

According to Rosenlund (2000), the material's ability to resist heat affecting buildings, called thermal properties, is:

- Density: has units of kg/m^3 , which is the ratio between weight and volume, density plays a big role for thermal properties, materials with light density have greater insulating power than materials with high density.
- Conductivity: has units of W/mK , is the material's ability to conduct heat. Materials that have low conductivity have good insulating power, whereas materials that have high conductivity are good heat conductors.
- Specific heat: has units of Wh/kgK , indicating the material has the ability to store a certain amount of energy. High specific heat means that the material has the ability to store a lot of heat (heat storage).

The combination of the three thermal properties of the material above produces what is called Time lag, which is: the maximum time used by the wall to remove heat from the outer surface of the wall to the inside of the wall. The title is set in bold 16-point Arial, justified. The first letter of the title should be capitalised with the rest in lower case. You should leave 22 mm of space above the title and 6 mm after the title.

3 Research Method

This research is experimental and Action Research in nature, the activities carried out are making test objects in the form of walls with red brick masonry with 1/2 brick masonry, 1/4 brick masonry and light brick masonry.

Research Stages are divided into 3 (three) stages, including:

- Make a prototype test wall with red brick material, 1 prototype red brick test wall with 1/2 brick masonry, measured on both sides (east side and west side)
- Measuring the thermal of the test wall, Each test object (test wall) is measured from 7.00 WIT to 20.00 WIT, measured on the east and west sides and each side is measured 6 points.
- Analysis of measuring the absorption of heat and emitting heat from each side, on each side divided by 2, namely; 1/2 plastered and 1/2 unplastered sides and the data is shown in graphical form.

Measurement of heat on the wall using a thermometer gun, measuring distance ± 30 cm from the wall. Measurements were carried out for 6 days.

4 Results and Discussion

Two test walls were made, namely a test wall with red stone material, and a test wall with light stone wall material. The test wall will be measured on the east and west sides, with 6 measuring points on each side, with a measuring point height of 35 cm, 60 cm and 90 cm from the floor. On 1 side the test wall is divided into 2 measuring points, namely; One side is plastered and the other side is not plastered. The goal is to determine the absorption of solar heat between plastered and non-plastered walls.



Fig. 2. Pair of Red Stone Walls.

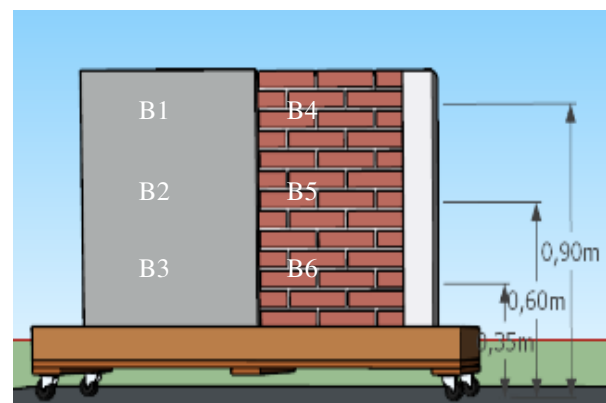


Fig. 3. Height and placement of the measuring point, the wall on the east side.

Table 2. Summary of heat measurements of red stone walls at Measurement Points A1, A2 and A3, the East side and the wall is not plastered.

NO	Time	Measurement Points		
		A1	A2	A3
1	06.00	27,6	28,4	28,4
2	07.00	27,8	28,2	28,5
3	08.00	28,8	29,3	29,4
4	09.00	32,0	32,9	32,6
5	10.00	33,5	35,1	34,2
6	11.00	32,2	32,1	32,1
7	12.00	37,9	40,4	40,6
8	13.00	41,5	45,2	44,7
9	14.00	44,0	46,6	47,3
10	15.00	46,1	49,1	47,1
11	16.00	45,8	49,1	49,1
12	17.00	40,4	43,6	43,6
13	18.00	34,9	35,9	36,5
14	19.00	32,1	33,3	33,3
15	20.00	30,7	32,1	31,7

Table 3. Summary of heat measurements of red stone walls at Measurement Points B4, B5 and B6, West side and plastered walls.

NO	Time	Measurement Points		
		B4	B5	B6
1	06.00	28,1	28,8	28,8
2	07.00	28,5	28,9	29,1
3	08.00	30,6	31,0	31,1
4	09.00	34,3	34,8	34,8
5	10.00	35,6	36,3	36,4
6	11.00	32,1	32,1	32,1
7	12.00	37,9	38,9	38,8
8	13.00	38,7	39,7	38,9
9	14.00	39,5	40,7	40,1
10	15.00	40,0	40,2	40,8
11	16.00	39,3	40,5	40,7
12	17.00	36,5	37,9	38,0
13	18.00	33,6	35,6	35,4
14	19.00	31,5	32,5	32,3
15	20.00	32,2	31,3	31,3

From the measurement results between measuring points A1 (west side) and B4 (east side) the two walls were not plastered, it was obtained at 06.00 WIT- 11.00 WIT measuring point A1 had a lower temperature, but the temperature increased at 12.00 - 16.00 WIT, this increase was due to the orientation of the sun starting to head west, then the temperature decreased from 17.00 WIT-20.00 WIT, this decrease

was due to the wall starting to change temperature because the sun began to sink and the air in even the days tend to be cold.

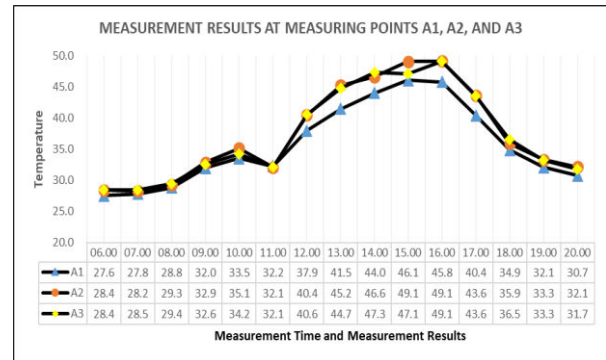


Fig. 4. Graph of temperature differences at measuring points A1 (West side) and B4 (East side) of an unplastered wall.

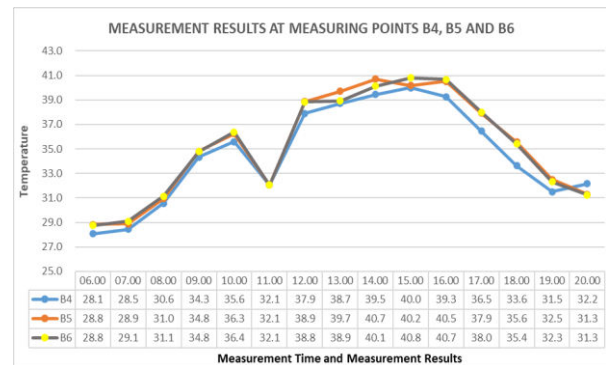


Fig. 5. Measurement chart at measuring points A4, A5 and A6 on the West side with plastered walls.

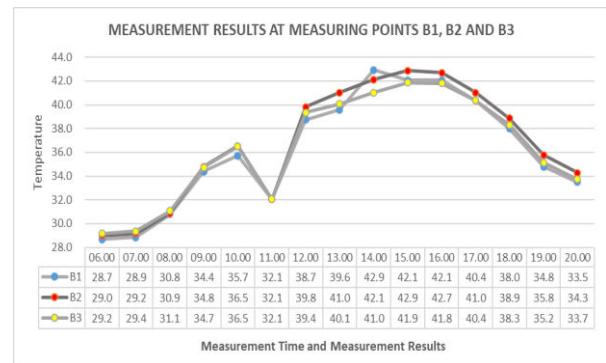


Fig. 6. Measurement chart on measuring points B1, B2 and B3 on the East side with plastered walls.

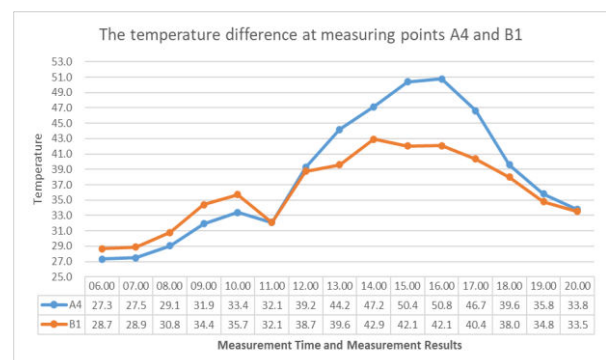


Fig. 7. Measurement Grafik perbedaan suhu pada titik ukur A4 (sisi Barat) dan B1 (sisi Timur) dinding yang dipleseter.

At measuring point B4, the temperature also increases from 12.00 WIT – 16.00 WIT, after which it decreases until 19.00 WIT, but the temperature increases higher than measuring point A1, this could be due to the heat from A1 spreading on the side of measuring point B4.

It can be illustrated if the measurement point A1 is the wall of the broad part of the building and the measurement point B4 is the inner wall of the building. Heat from A1 propagates to B4, which means that the heat temperature that is already in B4 can increase from this process, moreover the cross ventilation in the room is not good, so the air flow inside is not smooth.

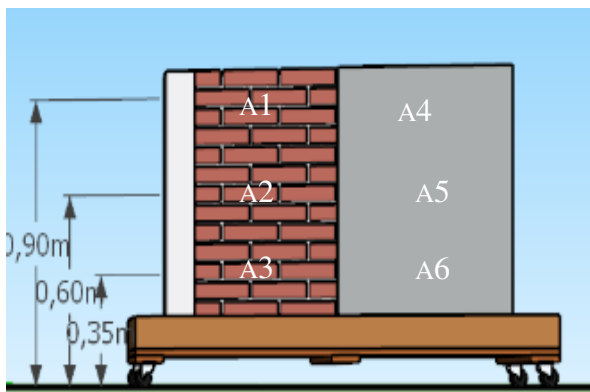


Fig. 4. Height and placement of measuring points, the wall on the west side.

Table 4. Summary of heat measurements of red stone walls at Measurement Points A4, A5 and A6, the East side and the wall is not plastered.

NO	Time	Measurement Points		
		A4	A5	A6
1	06.00	27,3	28,5	28,4
2	07.00	27,5	26,4	27,7
3	08.00	29,1	29,0	29,0
4	09.00	31,9	32,0	32,4
5	10.00	33,4	34,6	35,0
6	11.00	32,1	32,1	32,1
7	12.00	39,2	41,6	42,0
8	13.00	44,2	47,5	47,3
9	14.00	47,2	50,5	50,9
10	15.00	50,4	53,9	53,0
11	16.00	50,8	53,2	54,1
12	17.00	46,7	48,3	48,4
13	18.00	39,6	40,7	40,6
14	19.00	35,8	36,7	36,1
15	20.00	33,8	34,7	34,6

The results of temperature measurements at measuring point A4 on the west side which was plastered, the temperature increased from 12.00 WIT -16.00 WIT

with the highest temperature of 50.8°C, while at measuring point B1 (east side) the temperature was 42.1°C

Table 5. Summary of heat measurements of red stone walls at Measurement Points B1, B2 and B3, West side and walls not plastered.

NO	Time	Measurement Points		
		B1	B2	B3
1	06.00	28,7	29,0	29,2
2	07.00	28,9	29,2	29,4
3	08.00	30,8	30,9	31,1
4	09.00	34,4	34,8	34,7
5	10.00	35,7	36,5	36,5
6	11.00	32,1	32,1	32,1
7	12.00	38,7	39,8	39,4
8	13.00	39,6	41,0	40,1
9	14.00	42,9	42,1	41,0
10	15.00	42,1	42,9	41,9
11	16.00	42,1	42,7	41,8
12	17.00	40,4	41,0	40,4
13	18.00	38,0	38,9	38,3
14	19.00	34,8	35,8	35,2
15	20.00	33,5	34,5	33,7

5 Conclusions

From the results of the above research several conclusions can be drawn, including:

1. The test wall that was not plastered had a fairly high temperature, reaching 46.1°C during the day, at measuring point A1 (west side) it was found at the end of the measurement (20.00 WIT) the temperature reached 30.7°C but on the opposite side of measuring point B4, the temperature actually reached 32.2°C (the 2 measuring points are wall pairs without plastering). It can be concluded that the measurement results on the west side are higher in temperature, due to longer exposure to the sun's heat, you can be sure that the heat is rebated on the indoor side.
2. On the plastered test wall, the temperature is quite high, reaching 50.7°C during the day, the difference at the end of the measurement (20.00 WIT) between measuring point A4 and measuring point B1 is very low, namely; at measuring point A4 the temperature reached 33.8°C while measuring point B1 reached a temperature of 33.5°C. in their final form, ready for reproduction, pasted in the appropriate place in the text. Try to ensure that the size of the text in your figures is approximately the same size as the main text (10 point). Try to ensure that lines are no thinner than 0.25 point.

6 Acknowledgements

Acknowledgements given Kemenristekdikti which has provided grants PPT SIMLITABMAS UNMUS 2023 to the researcher, the University Musamus, especially LPPM which has provided support for the study as well as to other parties who participated during the study, contributed to the publication of the article. Thanks are also given to the Department Architecture, Universitas Musamus Merauke, which has been providing support to research activities.

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