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An Examination of the Thermal Transfer Rate in Rice Husk Ash Brick and Sand Crete Brick (A Means of Reducing Buildings' Indoor High Temperature in Girei, Adamawa State, Nigeria)

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Abstract: **There is a need to proffer solution to the relatively high temperature being experienced in various residential buildings, especially in the tropics. The kind of building material being used are of paramount importance when considering how to reduce heat passage from the ambient into the indoors of the residences. This research considered brick material among other building material. Therefore, there was an examination of thermal heat transfer rate comparison between rice husk ash brick and the popular sand crete brick. To achieve this, a 9 inches (230mm) Rice Husk Ash Block was produced (50% of cement content of the normal 100% cement block was replaced with RHA) and compared to the popular full cement 9 inches (230mm) block. Thermal Measurements were taken at the heights of 3.5cm and 23cm. At 3.5cm height, RHA brick has maximum temperature of 26^{0}C while full cement block has 44^{0}C. The minimum values at 3.5cm were 3^{0}C for RHA block and 13^{0}C full cement block. At 23cm above the burning side of the block, the mean temperature of RHA and full cement blocks was 1.3333 and 4.6667 and the maximum value were 3 and 10^{0}C. Paired sample test showed there is significant difference between the RHA and Full cement block.**

Keywords: **Rice Husk Ash Brick; Cement Block; Temperature.**

1. INTRODUCTION

Comfort is a major factor in the construction of building. How comfortable the building occupants are suggests how accurate and fast they can function. Moreover, it also tells how operative one can be. Buildings are essentially modifiers of micro climate; a space isolated from environmental temperature and humidity fluctuations, sheltered from prevailing winds and precipitation, and with enhancement of natural lights (Olanipekun, 2002).

According to Ajibola (2001), the attainment of high level of comfort in building (residential and public) depends on the amount of the solar radiation excluded from the interior space. The aim should therefore be to avoid solar radiation as much as possible and to allow for illumination, without this, much money will be invested on the use of active energy for air-conditioning, ventilation and illumination in order to attain high level of thermal and visual comfort in buildings. The use of active energy should be minimized by the designer. The thermal performance of buildings is considered one of the most criteria of successful building design. It aims to provide the most comfortable environment for occupants and thus minimizing the energy demand for cooling and heating requirements.

The task of maintaining thermal comfort in residential buildings is a complex problem. There is debate as to the relative influence of external and internal temperatures on mortality, but both appear to be significant and housing conditions are a contributory factor to the high excess mortality (Wilkinson *et.al*, 2001).

Having the right temperature is one of the things people considered most important in a building. Incidentally, architects and builders place great attention on some concepts while the importance of convective-conductive heat transfer depends mainly on the type of the construction and on its tightness against the air flow. The aim of this research is to examine the thermal heat transfer rate in Rice Husk Ash brick and sand crete brick as a means of reducing indoors heat.

2. STUDY AREA

Girei is located between latitude 9^0 11 and 9^0 39 North and Longitude 12^0 21 and 12^0 49 east. Girei is situated within Girei local government. The local government is boarded by Song Local government area in the North, Furore Local Government area in the east, while River Benue acts as a physical boundary between the local government area, and Yola North and Demsa local government areas (Adebayo, 1999).

Girei LGA experiences dry an wet seasons with temperature and humidity varying with seasons. Girei local government area falls under the Sudan Savannah type of vegetation and it experiences distinct dry and wet seasons with temperature and humidity varying with seasons. (Saka *et.al*, 2013).

The wet or rainy season fall between April and November, which is characterized by single maxima in August. Seventy percent of the total rainfall in the area happens to fall within four months of May –August. The area has an average of 62 rainy days while average amount of rainfall recorded in the area is 972mm. The dry season which is the harmattan period is between Decembers to March.

Temperature in Girei is relatively high all year round. The temperature of Girei ranges from 27-40° C. The coldest months which are December and January are of the average temperature 15°C, while the hottest period within the area being April and May with an average temperature of 34°C. It has an average minimum temperature of 20.5^0C and maximum temperature of up to 40^0C (Adebayo, 1999).

The monthly global solar radiation are not uniform throughout. The peak of radiation being the month of March, April, May and June. The least value of global solar radiation is in January, this could be explained in terms of peak of cold harmattan season. The wet season is basically during the months of August and September (Medugu and Yakubu, 2011).

3. METHODS

3.1 Methods of Data Collection:

RHA was used to form a 9 inches block for thermal performance comparison to the popular 9 inches cement hollow block. The major reasons for using RH are because of the compressive strength *of* the block (It can serve as a good binder), cost of Materials (Availability), insulation Properties (The pore spaces within the material doesn't allow for air flow) and resistance to water. One major reason for using this material is its availability. Rice is one of the major staple crops in Nigeria grown on over 1.5 million hectares of land. Its production in the country rose from 2.4 million metric tonnes in 1994, to 3.9 million metric tonnes in 2005 (FAO, 2003; CBN, 2006). In Adamawa State, rice is grown virtually in all parts of the state (Adebayo & Onu, 1999).

3.2 Preparation of RHA:

The Rice Husk was obtained from Rice Millers at Girei Market, Girei Local Government, Adamawa State, Nigeria. The rice husk was burnt to ash on the 5^{th} November, 2014, under temperature of 124^0C for 1 hour. An Iron Pot was placed on a burning stove and a thermometer dimple (-10 to 360^0C) which was obtained from the Department of Chemistry, Modibbo Adama University of Technology, Yola was used to take the measurements. The thermometer was placed on the pot in order to measure the temperature yielded by the pot after fifteen (15) minutes of burning (which gave 124^0C), this was later measured about 30 minutes after pouring the Rice Husk and it gave the same temperature measurement (124^0C). The RH was being stirred at regular intervals. At 1hr, the RH was already burnt to ash.

3.3 Production of RHA Block:

The production was done on the 6^{th} of November, 2014, at Eltom Ventures Block Industry along Army Barracks Road, Jimeta, Adamawa, Nigeria. According to their daily mixing, about 52 blocks can be produced out of a 50kg bag of cement. Therefore, to make a block, approximately 1kg of cement can be used. In this research, half (50%) of the 1kg content of cement was substituted with RHA in order to compare the performance to the normal 100% cement block. There was therefore a need to measure out 0.5kg of cement to be complemented with a corresponding quantity of RHA. RHA is a lightweight material. Therefore, scaling it in kilogram will not give the quantity to be used. The 0.5kg was poured into a 4litre keg; the height covered by the cement in the keg was measured using a centimeter graduated ruler which measured 4cm of the keg's height. The same quantity (4cm) of RHA was also measured in order to give the ratio 0.5:0.5. Moreover, 10kg of river sand was measured on the scale, so that RHA and Sand formed the aggregate that was bind and compacted down by ordinary Portland cement (Ashaka cement) which was used as a binder for our aggregate mix (RHA and River Sand). Finally, 2250ml of water was also used to effect the mixing.

3.4 Heating the RHA Block and 100% Cement Block:

The varying temperatures of RHA block and the 100% cement block were measured at two different points above the origin (the surface of block directly facing the fire). They were measured at the heights of 3.5 cm and 23 cm respectively. 3.5cm above the origin is the lower surface of the blocks' hollow (inside the hollow) while 23cm above the origin is the other outer surface of the block (outside the hollow)

4. RESULT AND CONCLUSION

The difference between the ambient temperature and the blocks was determined. The more the blocks' temperature moves higher than the ambient temperature, the greater the influence of the artificial heat source. This will show direct thermal influence of the artificial heat source on the temperatures of the blocks aside the ambient temperature. This is shown in Table 1.

Table 2 shows the mean, maximum and minimum values of the two blocks at 3.5 cm above the burning surface after getting the block-ambient temperature difference. The mean temperature values of Rice Husk Ash and the Full Cement Block are 22.0833 and 34.7500 giving 12.667 mean difference. With these mean difference, it can be clearly seen that RHA block performed better than full cement block. Also, the maximum temperature values for RHA block was 26 while that of full cement block was 44. The maximum temperature of the two compared further establishes the fact that RHA block performed better than the full cement block. Another point to establish the better performance of RHA block than the full cement block was the minimum temperature value, which was 3 for RHA block while that of full cement block was 13 respectively. Table 2 shows also the thermal results at 23cm above the burning side of the blocks. The mean temperature values of RHA Block and the Full Cement Block are 1.3333 and 4.6667, the maximum values are 3 and 10 while the minimum values are 0 and 0 respectively. It can be clearly seen that the minimum value of 100% cement block is relatively higher than the RHA block. The mean differences between Rice Husk Ash Block and Full Cement Block are also shown in Table 2.

Moreover, paired samples test was used to show the significance of the blocks' thermal transfer rate difference at 3.5cm and 23cm heights. The Sig. (2-tailed) column in Table 2 shows there is a significant difference between the two blocks at 3.5cm and 23cm heights, since the P values 0.00 and 0.001 are much lesser than 0.05

Table 1: The Summary of Thermal Data Collected on RHA Block, Cement Block and Ambient (^{0}C)

	RHA Block					100% Cement Block				
Minutes Intervals	**3.5cm height**	**23cm height**	**Ambient**	**Difference (3.5cm)**	**Difference (23cm)**	**3.5cm Height**	**23cm Height**	**Ambient**	**Difference (3.5cm)**	**Difference (23cm)**
2:05pm	41	38	38	3	0	49	36	36	13	0
2:15pm	59	38	38	21	0	58	36	36	22	0
2:25pm	59	39	39	20	0	64	37	36	28	1
2:35pm	59	39	39	20	0	66	38	36	30	2
2:45pm	62	40	38	24	2	72	38	36	36	2
2:55pm	63	41	39	24	2	74	40	36	38	4
3:05pm	64	41	39	25	2	76	42	37	39	5
3:15pm	64	41	38	26	3	77	44	36	41	8
3:25pm	66	43	41	25	2	78	44	34	44	10
3:35pm	66	43	41	25	2	78	44	36	42	8
3:45pm	66	43	40	26	3	78	45	36	42	9
3:55pm	66	43	40	26	3	78	45	36	42	9

Table 2: Results of RHA Block and 100% Cement Block at 3.5 cm Height above the Burning Surface (^{0}C)

	RHA Block (3.5cm)	RHA Block (23cm)	100% Cement Block (3.5cm)	100% Cement Block (23cm)	Paired at 3.5cm (RHA and100% Cement Block)	Paired at 23cm (RHA and100% Cement Block)
Mean	22.0833	1.3333	34.75	4.6667		
Mean Difference					12.66667	3.33333
Minimum	3	0	13	0		
Maximum	26	3	44	10		
T					8.979	4.212
Sig. (2 tailed)					0.000	0.001

The use of RHA blocks in the tropics will be suitable for the comfort of the occupants in the dry hot season as the heat transfer is largely delayed compared to the popular100% cement block. This work shows that the 50% substitute of RHA with Cement gave a better thermal result compared to 100% cement block.

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