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EFFECT OF GEOMETRY OF SHADING DEVICES ON QUANTITY OF INDOOR HEAT GAIN IN RESIDENTIAL BUILDINGS IN SOUTHEAST NIGERIA: A CASE STUDY OF OWERRI

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Abstract

The challenge of excessive heat gain in buildings has become a major source of concern, especially in residential buildings. This is because the build-up of heat within indoor spaces of residential buildings causes thermal discomfort for the occupants. The objective of the study was to examine different geometries of shading devices and their effect on the quantity of indoor heat gain in residential buildings with a view to developing design strategies to reduce heat gain in residential buildings. The research was designed as a field survey. Out of the 13 residential layouts within Owerri, five (5) homogenous layouts were chosen as a representative fraction because of similarity in environment and proximity to each other. Out of a total population size of 1570 shaded housing units, a 5% rule of thumb was applied to select a sample of 79 for the survey. Data was collected using observation schedule and data loggers. The variables in focus were interval variables; hence, Pearson's Product Moment Correlation Analysis tool was used to examine the significance of the relationship at 95% compliance. It was found that there was no significant relationship between the length of projection of the horizontal overhang (with integrated vertical fins) and average heat gain in residential buildings in Owerri, Nigeria. It is therefore recommended that the use of shading devices should be encouraged; education and awareness of appropriate principles for effective implementation of this shading instrument should be robustly conducted in the study area.

Keywords: Geometry, indoor heat gain, residential buildings, shading devices

INTRODUCTION

The challenge of excessive heat gain in buildings has become a major source of concern, especially when designing residential buildings. It has been stated that higher efficiency in the use of energy, largely contributes to the reduction of greenhouse gas emissions (Blazer, 2008). In other words, the problem of elevated levels of indoor heat gain in residential buildings is linked to increased temperature on a global scale. Measures commonly used to mitigate the discomfort due to indoor heat gain include air conditioning. The resulting by-products of air conditioners only exacerbate global warming, gradually increasing the need for even more air conditioning systems in residential buildings (James, 2002). There is therefore the need for new and sustainable ways of reducing indoor heat gain in residential buildings.

Architects and other designers in the building industry can match their designs with the ambient environment of their designs. Window openings are responsible for much of the heat gain within the building and, therefore, shading them properly offers an effective protection against heat gain (Dubois, 1997). Hawkes, McDonald and Steemers (2013) observed that window openings should be well shaded from solar radiation to reduce the ingress of radiation in warm-humid and hot seasons. Build-up of heat within indoor spaces of residential buildings generate thermal discomfort for the occupants. Incorporation of natural ventilation in the design, or the use of electric fans and air-conditioning systems are ways of mitigating the negative effects of indoor heat gain. The energy to operate these fans and air-conditioning equipment generally comes from fossil fuels. Their consumption partly militates against the attainment of sustainable architecture with the attendant adverse environmental effects, such as, the reduction of the ozone layer; increased atmospheric temperature and associated indoor heat gain in residential buildings (Union of Concerned Scientists, 2016).

Literature abounds on the effect of shading devices on indoor heat gain in residential buildings within warm-humid climatic regions (Toledo, 2007; Odim, 2008; Odim & Nwanguma, 2012) and little has been done to understand this phenomenon in residential buildings in Imo State. A cursory observation of parts of Owerri reveals that there is a lingering problem of poor passive design strategies for controlling heat gain in residential buildings in the study area.

Owerri, the capital of Imo State, Nigeria, (see Figure 1), occupies a land mass of about 11,420 square kilometres. It is situated in the southern part of Imo River Basin, an area that lies in the central part of the former Eastern Region of Nigeria. Imo State shares boundaries with Anambra State to the north, Rivers State to the South and Abia State to the east. Imo State has a high population density, with a population of over 11 million people (National Population Commission, 2006; onlinenigeria.com, 2003). The rivers, which crisscross the State are mainly the tributaries of Imo River; Imo River discharges into River Niger, which joins the Atlantic Ocean. The area has an abundance of clay minerals, gravel, sand, shale and lignite (Nwachukwu, Feng, & Alinnor, 2011).

Figure 1: Map of Nigeria Showing Imo State (hatched)
Source: Department of Surveying and Geo-informatics, Nnamdi Azikiwe University, Awka, Anambra State (2016)

Owerri lies within latitudes 5°16′N and 5°33′N, and longitudes 6°50′E and 7°10′E, and is 159 meters above sea level (maps-streetview.com, 2011). It is situated in the warm-humid zone of the tropical rain forest belt of Nigeria. Derived savannah grassland interspersed with oil palm trees have replaced the greater part of the area's natural vegetation. It is characterised by two climatic seasons: the rainy season which occurs from April to October; and the dry season, which occurs from November to March. During the dry season, northeast wind blowing from the Mediterranean Sea crosses the Sahara Desert, bringing with it, harsh winds to the southern part of Nigeria. (Amadi, et al., 2012). During the dry season, humidity is usually low and clouds are absent. The monthly temperatures are generally high throughout the year. A mean annual temperature of 31°C is typical of the area (Ezeigbo, 1990). In addition, according to Ezeigbo (1990), the area experiences double maximum rainfall peaks in the months of July and September; a mean annual rainfall of 2152 mm characterizes the wet season. There is an 'August break' during this wet season, generally observed as a dry period in the last two weeks of August. This sometimes occurs in early September due to the vagaries of the weather. Whereas Imo State is made up of 21 local government (administrative) areas, Owerri, the area under study, comprises three (3) of these namely Owerri-Municipal; Owerri-North and Owerri-West (see Figure 2).

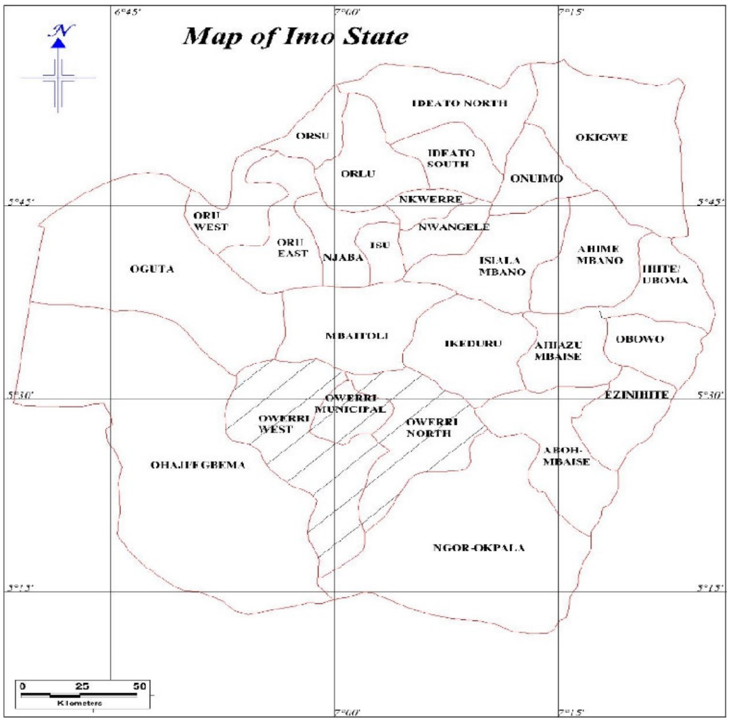

Figure 2: Administrative Map of Imo State, Showing Local Government Areas within Owerri

Source: Department of Surveying and Geo-informatics, Nnamdi Azikiwe University, Awka, Anambra State, 2016

This study is part of a wider research on the effect of shading devices on indoor heat gain in residential buildings in Owerri, Nigeria. It is aimed at investigating the effect of shading devices on indoor heat gain in residential buildings in Owerri, with a view to developing design strategies to reduce heat gain in residential buildings. As its objective, this study specifically sought to examine different geometries of shading devices and their effect on quantity of indoor heat gain in residential buildings. The null hypothesis proposed to guide the study was: The length of projection of horizontal overhang with integrated vertical fins (half height of window opening) has no significant effect on quantity of indoor heat gain in residential buildings.

LITERATURE REVIEW

In the review of literature, Blazer (2008) observed that, heat gain is more pronounced in urban areas due to a phenomenon known as the Urban Heat Island (UHI) effect. This is considered as one of the major problems in the 21st century posed to human beings as a result of urbanization and industrialization of human civilization. The large amount of heat generated from urban structures, as they consume and re-radiate solar radiations, and from the anthropogenic heat sources are the main causes of UHI. These two heat sources increase the temperatures of urban areas when compared with their surroundings. This phenomenon is known as Urban Heat Island Intensity (UHII). The problem is has been found to be worse in cities or metropolises with large population and extensive economic activities. The estimated three billion people living in the urban areas in the world are directly exposed to this problem, and it is expected that this would be significantly increased in the near future (Memon, Leung, & Chunho, 2008). It is noteworthy that Owerri is a growing urban centre.

The UHI phenomenon is a seemingly inevitable result of urban development with far-reaching consequences. With energy costs skyrocketing and the destruction of the environment at risk, urban planners and managers must do more to make the urban settings more environmentally friendly. Two well-known ways to combat the urban heat island effects were reported. First, the effect can be slightly negated by adding well-watered vegetation (i.e. urban afforestation) to the site; second, building materials and systems that reflect sunlight can be used, thus increasing the overall albedo (the ratio of the reflected light energy to the absorbed energy) of the urban area (Blazer, 2008).

Madhumathi, Radhakrishnan, and Priya (2014) posited that, the interface between the interior of the building and the outdoor environment, inclusive of the walls, roof and foundation, serves as thermal barrier and plays an important role in determining the amount of energy necessary to maintain a comfortable indoor environment relative to the outside environment. Minimizing heat transfer through the building envelope is crucial for reducing the need for cooling the indoor space. The primary function of building envelope is to control the solar heat loads. It is necessary to shield any windows from direct sun penetration and to reduce the heat transmitted through the sunlit walls and the roof. The east and west walls receive a good deal of radiation, but when the angle of incidence is small (early morning and late afternoon), the intensity of radiation is not at its maximum. The north and south walls receive comparatively little radiation and are much easier to shade with over-hanging eaves, verandas or trees and plantings (Tzempelikos, Athienitis, & Karava, 2007).

Al-Tamimi and Fadzil (2011) stated that building surfaces (such as windows, walls and roofs) exposed to the sun can admit heat from solar radiation, leading to an increase in the amount of energy needed for cooling purposes. To avoid the inflow of heat, whether direct or indirect, the surfaces on which the sun's rays fall must be protected. Emphasis must be given to shading devices because glazed windows are the main components which allow the penetration of incoming heat. A major conclusion, therefore, was that there was the need to implement, as appropriate, the optimum external shading devices required to reduce incoming heat and in turn reduce the risk of overheating, which substantially contributes to increased energy consumption. It becomes imperative therefore that external shading devices be examined to determine what works and how it will do so for every clime.

Similarly, the primary functions of exterior shadings are to reduce the thermal heat gain in a building as well as to control the levels of direct light. Bakhlah, Ismail, and Rahman (2008) concluded that exterior devices are generally more effective in decreasing heat build-up because they block, absorb or reflect solar heat before it gets into interior spaces. To keep unwanted solar heat out, it is either a device is attached to the building skin or is an extension of the skin itself. Exterior shading devices include awnings, louvres, shutters, rolling shutters and shades as well as solar screens. Adjustable shading is particularly useful for east- and west-facing windows. Horizontal shading devices (i.e. overhangs) are usually placed horizontally in front of the window, in various ways. Their shape, type, depth, and height all differ, depending on the sun conditions. A window overhang is usually a horizontal surface that juts out over a window opening to shade it from the sun. This is desirable to reduce glare or solar heat gain during warm and hot seasons. Exterior vertical, as well as egg-crate solar shading devices, are primarily useful for east and west exposures. The egg-crate solar shading device is a combination of vertical and horizontal shading elements; they are more commonly used in warm and hot climatic regions because of their high shading efficiencies. The horizontal elements control ground glare from reflected solar rays. The device works well on walls especially those with extensively glazed windows (usc.edu, 2016).

Shading devices and their geometries

Ogunsote and Procnal-Ogunsote (2012) has identified types of sun-shading devices: the vertical, horizontal, egg-crate devices, and other variants of these basic three. It further noted that, vertical shading devices consist of pilasters, louvre blades, or projecting fins in a vertical position, while horizontal shading devices are usually in the form of canopies, long verandas, movable louvre blades or roof overhangs. The effectiveness of vertical fins is determined by the horizontal shading angle (δ in Figure 3). Their performance as shading devices is better when the projection of the fins is longer. In addition, they have been found to be most effective when placed on eastern and western elevations. On the other hand, horizontal fins are most appropriate for northern and southern elevations. The combinations of vertical and horizontal devices form egg-crate devices. The effectiveness of the egg-crate type is determined by both the horizontal and vertical shadow angles that result (δ and ε in Figure 3 and Figure 5, respectively). They are usually in the form of grill blocks or decorative screens (Ogunsote & Procnal-Ogunsote, 2012). See Figure 3, Figure 4 and Figure 5.

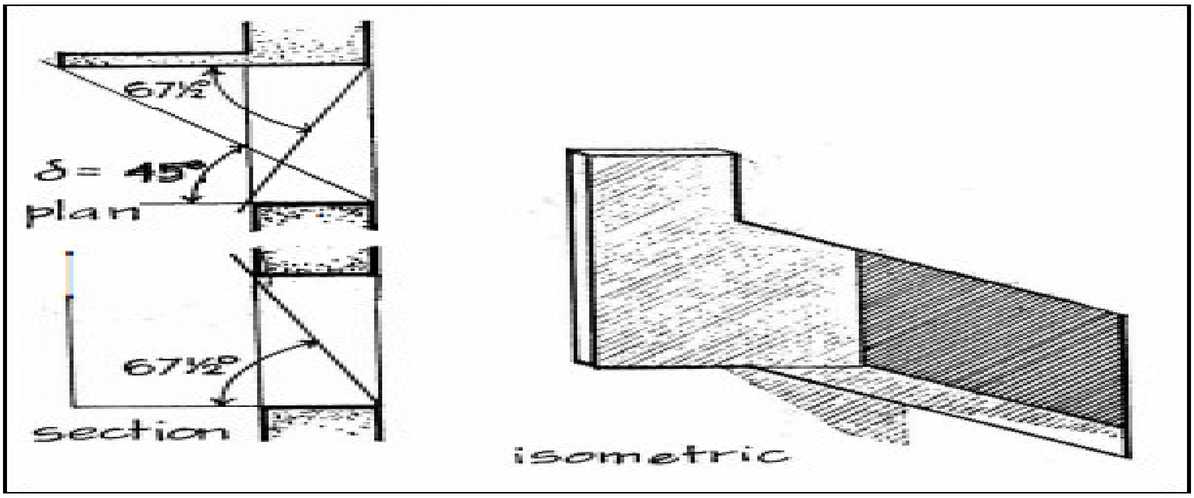

Figure 3: Section and Isometric view of Vertical Shading Device

Source: (Ogunsote & Procnal-Ogunsote, 2012)

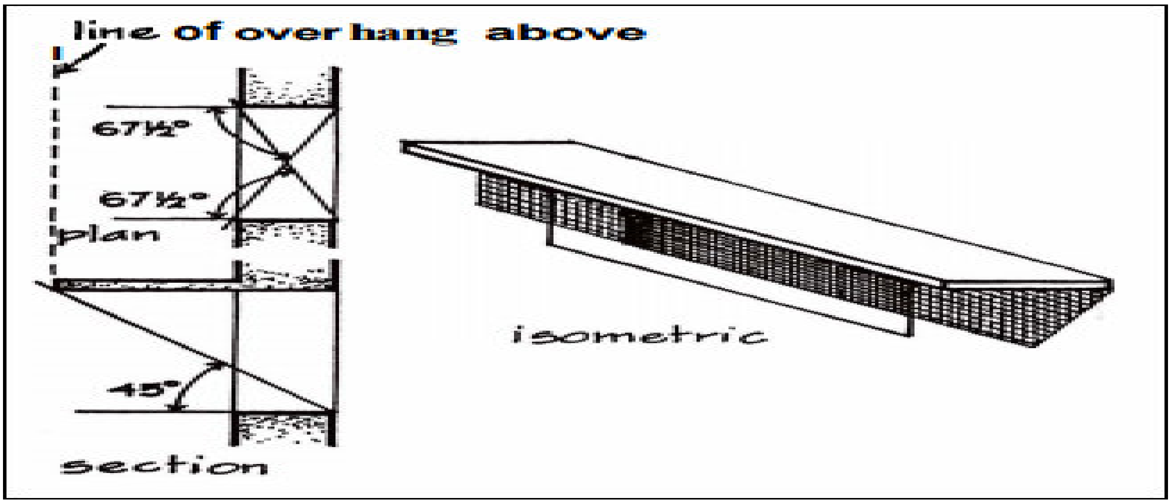

Figure 4: Section and Isometric view of Horizontal Shading Device
Source: (Ogunsote & Procnal-Ogunsote, 2012)

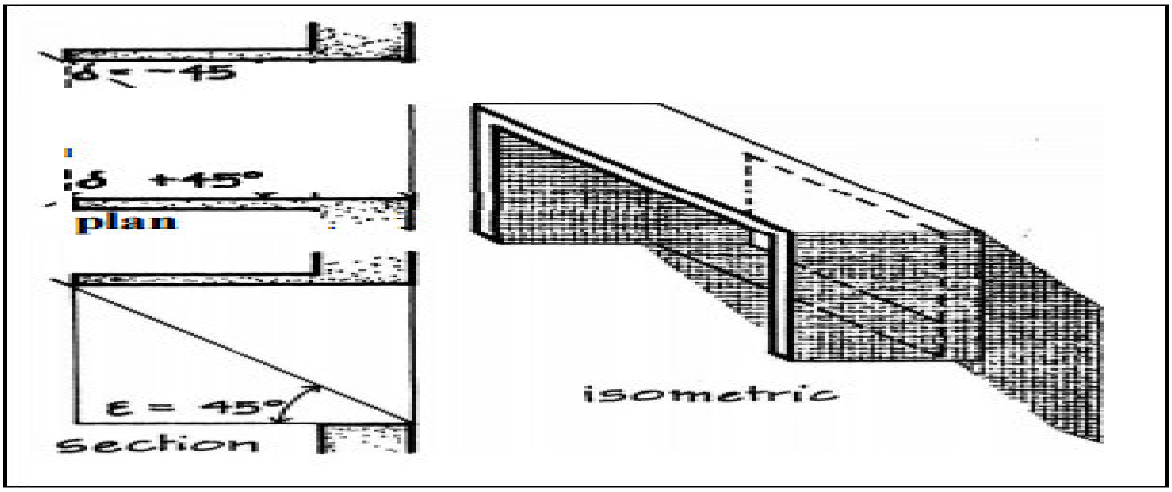

Figure 5: Section and Isometric view of Egg-crate Shading Device
Source: (Ogunsote & Procnal-Ogunsote, 2012)

Calculation of sizes for overhangs and fins

Designguide (2016) stated that one of the methods to ensure minimal build-up of heat gain within residential buildings is to use shading devices whose parameters have been correctly sized. It summarized the steps for sizing the overhangs and fins as follows:

i. Select critical months and times of shading for each façade. September - noon was suggested for south windows; September - 10 am, for east windows; and September - 3 pm is recommended for west windows. Concurring with this, Alshamrani and Mujeebu (2016) averred that the north façade does not present much problem, concerning shading.

ii. Find the solar altitude and azimuth for the target month and hour (See Figure 6).

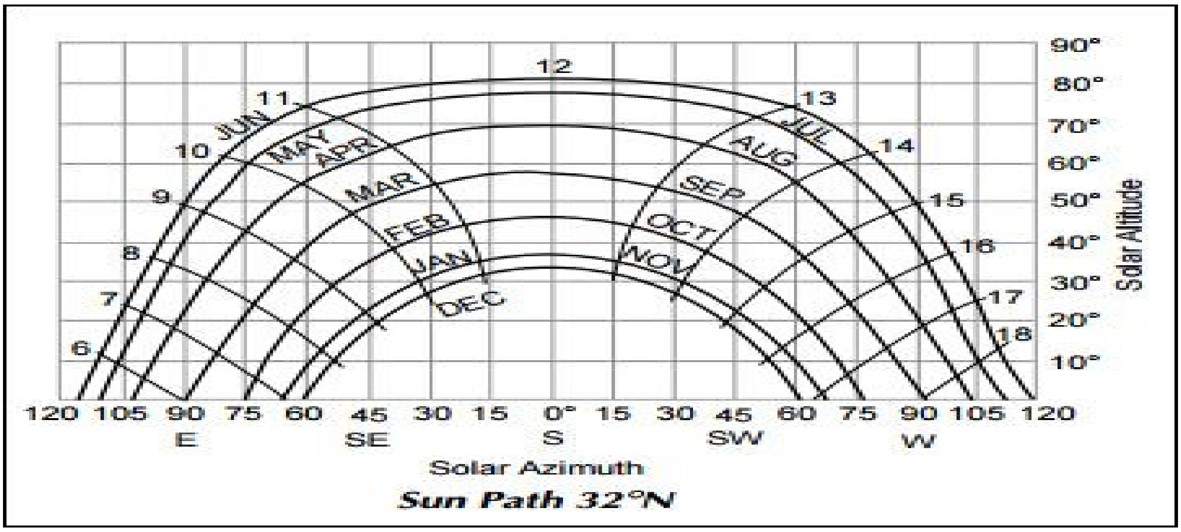

Figure 6: Example of Solar Azimuth Chart
Source: Designguide, 2016

iii. Apply the relevant formulae (equations 1 and 2) to obtain the size of the overhang and fin respectively. The results are a minimum starting point.

For an overhang: $h = \frac{D \times \tan(solar\ altitude)}{\cos(solar\ azimuth - window\ azimuth)}$ (1)

For a fin: $w = D \times \tan(\text{solar azimuth-window azimuth})$ (2)

The relevant parameters are described in Figure 7.

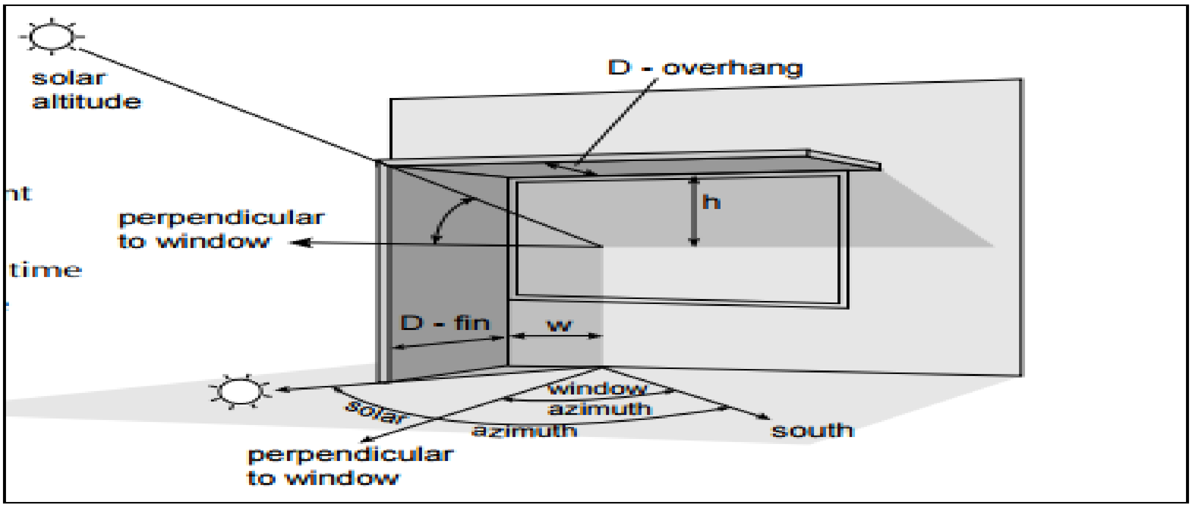

Figure 7: Showing proper sizing of overhangs and fins in residential buildings
Source: (Designguide, 2016)

For total shade at the target month and hour, h is set to height of window from sill to head, the value of D, the required overhang depth, is computed. For the partial shade, h is set to acceptable height of shadow (perhaps 2/3 of window height); Value for D, the required overhang depth is then computed; For a fin, the value of w is computed using equation 2.

Computation of Heat Gain

To calculate heat gain in the buildings, the Stefan-Boltzmann Equation (brighthubengineering.com, 2009) was applied. This follows Bozman's law which stated that the total radiant heat energy emitted from a surface is proportional to the fourth power of its absolute temperature (Encyclopædia Britannica, 2009). This heat energy is given by the following Stefan-Boltzmann Equation:

$P = e\sigma AT^4$, where: P = Power radiated (Watts); e = emissivity (no units); σ = Stefan Boltzmann constant ($5.67\times10^{-8} Wm^{-2}K^{-4}$); A = Surface area ($m^2$); T = Temperature (Kelvin)

This formula gives the relationship between heat gain and the independent variables: emissivity, surface area, and temperature. Emissivity is a measure of how well a surface emits thermal energy. It has no units. It is also described as the fraction of energy being emitted relative to that emitted by a thermally black surface (a black body). A black body with an emissivity value of 1 is regarded as a perfect emitter of heat energy. A material would be considered a perfect thermal mirror if it has an emissivity value of 0, i.e., it does not absorb any heat energy and so cannot emit any (ThermoWorks, 2016). The surface area, A in square metres ($m^{2)}$, represents the total area of the surface materials enclosing the indoor space being investigated. The temperature, T in Kelvin (K), represents the air temperature of the indoor space of the residential building being studied. Examples of some common surface materials with their emissivity values are given in Table 1.

Table 1: Common Substances Emissivity Table

S/No.	SURFACE MATERIAL	EMISSIVITY COEFFICIENT (Ɛ)
1.	Aluminium, Painted	0.27-0.67
2.	Asbestos, Board	0.96
3.	Asbestos, Paper	0.93-0.945
4.	Asphalt	0.93
5.	Iron	0.95
6.	Black Enamel Paint	0.80
7.	Brass, Rolled Plate	0.06
8.	Brick, Red Rough	0.93
9.	Brick, Fireclay	0.75
10.	Concrete, Tiles	0.63
11.	Cotton, Cloth	0.77
12.	Copper, Electroplated	0.03
13.	Copper, Polished	0.023-0.052
14.	Copper Nickel Alloy, Polished	0.059
15.	Glass, Smooth	0.92-0.94
16.	Granite	0.45
17.	Limestone	0.90-0.93
18.	Sand	0.76
19.	Sandstone	0.59
20.	Tile	0.97
21.	Wood Oak, Planed	0.885
22.	Wrought Iron	0.94

Source: ThermoWorks (2016)

METHODOLOGY

This study was part of a wider research on the effect of shading devices on indoor heat gain in residential buildings in Owerri, Imo State, Nigeria. The research design was survey design. A multi-stage random sampling method was applied in the selection of the sample. The universe for the study consisted of the 13 residential layouts within the study area (See Table 2). The buildings to be sampled were shaded buildings i.e., buildings with some form of shading device designed or installed.

Table 2: List of Residential Layouts in Owerri

SN	LIST OF RESIDENTIAL LAYOUTS IN OWERRI
1.	Akwakuma Layout
2.	Aladinma Housing Estate Layout
3.	Aladinma Northern Extension Layout
4.	Amakohia Layout
5.	Emmanuel College Layout
6.	Government Station Layout
7.	Ikenegbu Layout
8.	Ikenegbu Extension Layout
9.	Irete Layout
10.	New Market Layout
11.	Orji Layout
12.	Orlu Road Secretariat Layout
13.	Works Layout

Source: Fieldwork, 2018

The layouts were considered to be homogenous because they were all located in proximity to each other within the study area, so were thus experiencing similar climatic conditions. It was also considered that a proportion of five out of thirteen was sufficiently representative of the universe of residential layouts. At the first stage of the sampling, therefore, five residential layouts were chosen by balloting. These were Akwakuma layout, Aladinma Housing layout, Amakohia layout, Ikenegbu layout and Works layout. The study population consisted of all shaded residential buildings within these randomly selected residential layouts in the study area. The total number of housing units within these five layouts was 1570 (See Table 3).

Table 3: Distribution of buildings among the Layouts

S/N	LAYOUT	NUMBER OF BUILDINGS IN LAYOUTS	PERCENTAGE OF TOTAL
1	Akwakuma	211	13%
2.	Aladinma	344	22%
3.	Amakohia	230	15%
4.	Ikenegbu	435	28%
5.	Works	350	22%
	TOTAL	**1570**	**100%**

Source: Fieldwork, 2018

Using the rule-of-thumb method suggested by Gay (1987), as cited in Yount (2006), 5% of 1570 = 78.5 (approximately 79) was obtained as sample size. Random sampling was again applied in the selection of which housing units that would be surveyed. In each street, after the first house, every twentieth house would be targeted. In addition, these study buildings were chosen from the layouts following the factor of willingness by the occupants to be surveyed. The distribution across the layouts, based on their percentage contribution to the total population is shown in Table 4.

Table 4: Population Distribution of Sample Size among the Layouts

NAME OF SAMPLED LAYOUT	NUMBER OF HOUSING UNITS IN EACH SAMPLED LAYOUTS	PERCENTAGE OF TOTAL
Akwakuma	11	13%
Aladinma	17	22%
Amakohia	12	15%
Ikenegbu	22	28%
Works	17	22%
TOTAL	**79**	**100%**

Source: Fieldwork, 2018

The main research instruments were observation schedule, which was used to collate data on the variables being studied, and data loggers used to gather temperature and other data during the survey. The temperature data obtained was then used to compute heat gain values, the vital dependent variable in the study.

RESULTS AND DISCUSSION

As stated, the objective of this study was to examine different geometries of shading devices and their effect on quantity of indoor heat gain in residential buildings. The lengths of the horizontal overhangs and height of integrated fins were in focus. Data was therefore gathered on the occurrence of shading devices whose geometry consisted of horizontal overhang projections with integrated vertical fins. Furthermore, the material of the shading devices under discussion was reinforced concrete. Analysis of the data showed the following:

i. *Analysis of projection lengths of horizontal overhang of shading devices with integrated vertical fins (half height of window opening)*

Analysis of data gathered showed that majority of the shaded residential buildings in the sample had no shading devices whose geometry consisted of horizontal overhang projections with integrated vertical fins (half height of window opening). Less than one tenth of the sample had horizontal projections of 0.15m – 0.45m length, in this category. This is shown in Table 5.

Table 5: Occurrence of projection lengths of horizontal overhang with integrated vertical fins (half height of window opening)

VALUE LABEL	VALID PERCENT	CUMULATIVE PERCENT
None	92.9	92.9
0 - 0.15m	0.0	0.0
0.15-0.45m	7.1	100.0
Above 0.45m	0.0	100.0
TOTAL	**100.0**	

Source: Fieldwork, 2018

ii. *Analysis of projection lengths of horizontal overhang of shading devices with integrated vertical fins (full height of window opening)*

Analysis of data showed that under this variable, about half of the buildings studied had no projection of horizontal overhang. About one fifth had horizontal projections of 0.15m – 0.45m length; a smaller proportion had projections of less than 0.15m length. In addition, less than one tenth (7%) of the buildings had horizontal projections of above 0.45m length. This is shown in Table 6.

Table 6: Occurrence of projection lengths of horizontal overhang with integrated vertical fins (full height of window opening)

VALUE LABEL	VALID PERCENT	CUMULATIVE PERCENT
None	57.2	57.2
Projection below 0.15m	14.3	71.5
0.15-0.45m	21.4	92.9
Above 0.45m	7.1	100.0
TOTAL	**100.0**	

Source: Fieldwork, 2018

iii. *Heat Gain in sampled buildings*

In continuation of the stated objective, daily temperature readings were obtained in the sampled residential buildings using data loggers. Heat gain values (for the study period: one year) were then calculated. The results showed similarities in outcomes for all the buildings. This is shown in Table 7.

Table 7: Heat Gain values in ascending order of magnitude for the sampled buildings

S/No	NO. OF UNITS WITH SIMILAR RESULTS	HEAT GAIN (WATTS)
1	6	0.000018732
2	6	0.000026129
3	6	0.000068445
4	6	0.000150254
5	6	0.000176659
6	6	0.000239636
7	6	0.000246741
8	6	0.000425754
9	6	0.000515072
10	5	0.000523343
11	5	0.000686456
12	5	0.000897548
13	5	0.001000245
14	5	0.001673204

Source: Fieldwork (2019)

Test of Hypothesis

Having examined the relevant variables individually, the guiding hypothesis for the study was statistically tested. This was done to test the relationship between the length of projection of horizontal overhang (with integrated vertical fins) and average heat gain in residential buildings in the study area. The variables in focus are interval variables, hence, Pearson's Product Moment Correlation Analysis tool was used to examine the significance of the relationship. The result of the analysis showed a Pearson's Product Moment correlation coefficient value of 0.145 and a significance value point of 0.620, which was greater than ρ = 0.05. At 95% compliance, it means, therefore, that the relationship is strong, but it is not significant. The null hypothesis was therefore accepted which is that '*there* is *no significant relationship between the length of projection of the horizontal overhang (with integrated vertical fins, half height of window opening) and Average heat gain in residential buildings in Owerri, Nigeria'.* The result is shown in Table 8.

Table 8: Pearson's product moment correlation analysis result of relationship between the projection of horizontal overhang with integrated vertical fins (half height of window opening) and average heat gain in the sampled buildings

		Average heat gain
Length of projection of the horizontal overhang with integrated vertical fins (half height of window opening)	Pearson's Correlation	-0.145
	Sig. (2-tailed)	0.620
	N	14

Source: Fieldwork, 2018

Another associated correlational analysis was conducted to further examine the phenomenon. This involved horizontal overhang with integrated vertical fins (full-height of window opening). Similarly, the the result of the analysis showed a Pearson's correlation coefficient value of 0.191 with a significance value point of 0.513. This, again, implied a high, positive relationship existed between the two variables. However, the significance value of 0.513 showed that it was not significant at 95% compliance. It means, therefore, that the relationship was strong, but not significant. The null hypothesis was therefore accepted, i.e.

'*there is no significant relationship between the length of projection of the horizontal overhang with integrated vertical fins (full height of window opening) and Average heat gain in residential buildings in Owerri, Nigeria'*. The results are shown in Table 9.

Table 9: Pearson's product moment correlation analysis result of relationship between the projection of horizontal overhang with integrated vertical fins (full height of window opening) and average heat gain in the sampled buildings

		Average heat gain
Horizontal overhang with integrated vertical fins full height of window opening.	Pearson Correlation	.191
	Sig. (2-tailed)	.513
	N	14

Source: Fieldwork, 2018

From the foregoing, it can be observed that the majority of the housing units did not have shading devices whose geometry comprised of horizontal overhang projections with integrated vertical fins. It can also be seen from the results of the analyses that where this existed, it did not significantly affect average heat gain in the buildings. It is intuitive that, where these have been installed, all the advantages expected of shading devices (including reduction in heat gain) would be expected (Dubois, 1997; Hawkes, McDonald, & Steemers, 2013). It is, therefore, possible that other attenuating factors intervened to give this result. It is also possible that this passive design strategy has not been applied appropriately. This view then makes it imperative that the guidance described by Ogunsote and Procnal-Ogunsote (2012), with regard to rules of choice and placement as well as that by Designguide (2016), with regard to calculation of sizes and angles of placement of shading devices, be carefully observed.

CONCLUSION AND RECOMMENDATION

In architectural design, achievement of indoor thermal comfort within residential buildings in warm-humid climatic regions such as Owerri has largely been associated with the quantity of heat admitted into the indoor spaces. The intensity of solar radiation across the external envelope of residential buildings affects indoor heat gain. To ameliorate the resulting discomfort, occupants tend to use unsustainable means such as air conditioning to mollify the effect of the influx of heat. Following from this, different geometries of shading devices and their effect on quantity of indoor heat gain in residential buildings were examined. It can be concluded from the results that there was no significant relationship between the two variables. This appeared counter-intuitive. However, examination of literature revealed that this could be as a result of inappropriate application of this passive design strategy. It is therefore recommended that, following established science, to increase its adoption, the use of shading devices should be encouraged; education and awareness of appropriate principles for effective implementation of this shading instrument should be robustly conducted in the study area. Corroborated studies indicate that if these are done, there would likely be a reduction in heat gain in residential buildings in the area. The result would be a reduction in energy usage, reduction in the cost of house maintenance and ultimately a reduction in the contribution of housing to climate change.

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