AN ASSIGNMENT

ON

THERMAL COMFORT AND THE USE OF VERANDAS IN RESIDENTIAL BUILDINGS IN AKURE.

Submitted by:

ALUKO ADEBOYE EBENEZER
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Course:

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Lecturer in Charge: Prof. Ogunsote

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Abstract

This paper presents the result of an investigation on verandas to achieve thermal comfort in residential houses. In this study the veranda is singled out as a significant building element to attain environmental comfort, a field study in three outlaying areas of the city of Akure was carried out. The results show that the front veranda and the back or side porch is still an important for domestic outdoor activities and receiving of fresh breeze. The population recognizes the veranda’s importance as a shading element and residential buildings in Akure has always incorporated this knowledge in to the design of their houses.

The use of Verandas to achieve Indoor thermal comfort in a residential building is essential for occupants’ well-being and productivity, thus providing for indoor thermal comfort and reducing energy use in buildings which is becoming increasingly difficult.

Human body response intelligently to different climate conditions by acclimatization and adaptation. The different thermal comfort behavior of human need for people in different climate condition and also for different season clearly shows that the design strategy for building must comply with the locality of the building.

Intelligent system may be used for the purpose of compliance to thermal comfort. This paper describes typical strategies to naturally improve comfort in a climate which is hot and humid without air conditioning.

Hot and humid city like Akure in Ondo State may requires air conditioning for residential buildings, the dependence for thermal comfort may be minimized or relatively reduced when good design is adopted.

Keywords: Thermal comfort; Residential buildings, Verandas

1.0 INTRODUCTION

In this study, the veranda is shown as one of the major building element to attain environmental comfort, the veranda can be shown to be a fairly constant element in the historical development of residential buildings in Akure, it provides transition from public to private spaces and shield the house from sun and rain, thus terrace or veranda improves thermal comfort of the house in hot and humid climates predominantly in Akure which is in the southwestern part of Nigeria. The veranda also provides shaded useful space for a number of domestic outdoor activities, it integrates the house with its garden and can also allow shielded observation of the street without ostensive involvement.
Veranda has been a building element incorporated into the indoor space of dwellings in Akure and its use for family activities has been on the increase, the importance given to the traditional transition space is thus an objective of study and three distinct investigations were undertaken in a strategic residential locations in Akure city.

The primary function of all buildings is to adapt to the prevailing climate and provide an internal and external environment that is comfortable and conducive to the occupants. However, in this era of climate change and global warming, providing comfort for the occupants of a building is quite challenging and very fundamental.

This is as a result of growing ranges of challenges now facing designers to provide buildings that will be fit and comfortable for the 21st century. Thermal comfort basically has to do with the temperature that the resident considers as comfortable to stay in. Indoor thermal comfort is achieved when occupants are able to pursue without any hindrance, activities for which the building is intended which is achieved through the use of verandas.

There are five parameters that are important in influencing the indoor thermal comfort of a building. The physical parameters which are the air temperature, air movement, and relative humidity and the external parameters which are the clothing and activity are known as the major factors in the issue.

**2.0 A BACKGROUND ON THE VARANDA**

The veranda can be called a house extension to the outdoors, veranda or porches are useful accommodation spaces in overheated climate. In the history of architecture, they appear in descriptions of indigenous building discovered by colombus but must have been part of vernacular architecture in many parts of the world. The loggia of Italian renaissance palaces is an important form of indoor-outdoor articulation, though an open colonnade. In the traditional Japanese house, veranda or engawa is an important outdoor-indoor transition space marked by the wooden flooring in contrast to the mats of the indoor room,
the relation to the garden is an important feature of the Japanese veranda highlighted by stone steps leading up to the terrace or veranda.

In more recent western architecture the veranda becomes prominent in the eighteen century, especially as an English military addition to house located in India and the Caribbean. The designed outdoor domestic space appears in the nineteenth century in the North American houses and is identified as an application of openness and a factor of comfort. Insect screening of the porch becomes popular feature of the house in southern part of United States. Thus detail is important in hot and humid climate especially for evening use or even for outdoor sleeping. In most parts of the world however, the veranda is not screened and probably only used in favorable conditions.

According to the (Oxford English Dictionary,) the word verandah originated in India where it is found in several native languages. However, it may have been an adaptation of the Portuguese or older Spanish varanda (baranda or barandilla in modern Spanish), again borrowed from Indian languages, referring to a railing, balustrade or balcony. The distinctive style of Indian architecture evolved from a hybrid of east and west. The veranda is one of the many new hybrid architectural elements. A veranda or verandah is a roofed opened gallery or porch. It is also described as an open pillared gallery, generally roofed, built around a central structure. It is often partly enclosed by a railing and frequently extends across the front and sides of the structure.

3.0 THE USE OF NATURAL VENTILATION

Natural ventilation is clearly a valuable tool for sustainable development as it relies only on natural air movement, and can save significant amounts of fossil fuel based energy by reducing the need for mechanical ventilation and air conditioning. Reducing electrical energy used for cooling contributes to the reduction of greenhouse gas emissions from the electrical generating plant providing the energy.

From the earliest times building designers have made use of naturally induced air movement to address two basic needs in buildings: the removal of foul air and moisture, and personal thermal comfort. Since the 1950s the use of
mechanical ventilation and, particularly, air conditioning has been adopted as a means of compensating for excess heat gains experienced in many modern lightweight and highly glazed buildings.

This increased use of mechanical services has provided building designers and clients with a great deal of freedom in terms of envelope design and internal flexibility. However, the cost has been much higher energy consumption and the introduction of centralized control systems, rather than user-based controls.

The need to reduce our consumption of energy and to give users more control over their immediate environments, are good reasons for designers now to reevaluate the role of natural ventilation in buildings and to become familiar with the basic principles involved. Air movement in and around buildings is a complex, three-dimensional phenomenon. At present the tools available to design for good natural ventilation are either inexact rules of thumb, or complicated wind tunnel or computer based modeling techniques.

3.1.1 The use of Verandas in Achieving Natural Ventilation and Shading

The real test for naturally ventilated Residential buildings is the provision of adequate cooling in hot weather. Under this condition it is necessary to have sufficient external wind pressure to create air movement within the building and, particularly, through the occupied zones.

Under hot, dry conditions, when the outside air temperature is well above the tolerable internal level, it may be necessary to shut off the external air altogether until the temperature drops to more acceptable levels. The need for having very high ceilings to store large volumes of air, and by using ceiling fans to provide personal cooling, a residential building with veranda achieves a natural cooling at this period due to the availability of fresh breeze that is available in an open space (veranda).
The other testing time for naturally ventilated buildings is in humid weather. The challenge then is to restrict incoming air to achieve the minimum necessary fresh air without causing cold draughts or excessive heat loss.

Even under calm weather conditions the difference in temperature between the building interior and outside air will usually create sufficient stack effect to draw in fresh air. The stack effect is brought about by warm air rising up to be exhausted through high level outlets and so drawing in colder, heavier air from outside.

4.0 THERMAL COMFORT IN BUILDINGS

Definition according to ISO 7730:
“That condition of mind which expresses satisfaction with the thermal environment” Building is a construction that protects people from the environmental conditions and provides a healthy and comfort indoor conditions with the possible use of systems

Why thermal comfort is important?

The essence of having the “right temperature” is one of the things people considered in a building with `air freshness' as an important requirement
Also the subjective feeling of the freshness of the air has been found to be closely related to temperature of the air

The achievement of thermal comfort is not always total due to the indoor environmental conditions –technical reasons and the thermal sensation usually changes over the time as it is subjective.

4.1.1 Thermal Balance of the Human Body

The body gets energy from digestion of food through metabolism, that is the processes involved in converting foodstuff into living matter and energy.

There are two types of metabolism:
Basal metabolism, which is the heat production of vegetative, automatic, processes involved in converting food stuff into living matter and energy and Muscular metabolism, which is the heat production of muscles while carrying out some work or activity.

The body is not very efficient in turning chemical energy into physical energy and about 80% of the energy produced must be dissipated in form of heat. Apart from basal and muscular metabolism, the body can gain heat by conduction, convection and radiation from the environment. The heat from the body can be lost through conduction, convection, radiation and evaporation.

In order to maintain a constant deep body temperature and thermal balance, the total heat gained must be equal to the total heat lost, there are mechanisms for controlling heat loss both inside and outside the body. These include sweating, shivering and breathing. Control is maintained externally by clothing, activity rate, posture and choice of location, physical built environment can also affect the thermal environment thereby contributing to the control of body temperature.

The major factors which affects thermal comfort as earlier stated the air temperature, the mean radiant temperature, air velocity, the relative humidity, the intrinsic clothing and the level of activities as earlier stated above, though apart from these major factors, there are several others that may have an effect on the sensation of comfort, these include age, sex, acclimatization, body shape and health.

There are thermal indices which are index that enables us to measure the effects of factors that affect thermal comfort but any assignment of thermal comfort for practical design purpose must take cognizance of all the six variables simultaneously i.e a scale that will combine the effects of all these factors, such a scale is called the thermal index or comfort scale e.g the standard effective temperature, effective temperature, the corrected effective temperature. Etc. (Ogunsote & Prucnal-Ogunsote 2003)
5.0 BUILDING TRADITION / VERNACULAR ARCHITECTURE OF AKURE

Akintoye (1971) identify the beginning of the nineteenth century as “an era of intense tumultuous and for reaching changes in the history of the Yoruba of south western Nigeria”. This marked changes in the socio-cultural and economic structure is brought about by external factors such intensified trade with Europe, spread of Christianity and western Education.

Akure is among some of Yoruba town that came under the influence of western culture through Education, colonization and spread of Christianity. (Akintoye,1971; Osasona, 2002; Olotuah, 1997).

The Vernacular architecture of Akure is expressed in forms that have roots in traditional architecture and are also derived from the culture influence of Brazil and a limited European influence. While deeply concerned with their local traditions the local craftsmen derived inspiration from these foreign examples. The external modes dominated more and more the choice of materials and techniques as well as the decorations, the size and relationship of the rooms and the formal organization of the dwellings.

The European (British) influence was through the colonial administrators houses constructed mostly from imported materials and through the missionaries who usually built their mission houses and established churches. It had an impact on the choice of materials, extended roof overhung the size and type of the windows and the general aesthetics.
In Akure, the veranda appears early in colonial times as part of the rural house, the origin of Akure colonial urban houses in the medieval European (British) urban house which has generous verandah. A utilitarian veranda as an extension to the front of the house and to the kitchen is common in the back of the house.

In most houses the social rooms were elevated and the front entrance was often proceeded by a wide veranda, this space served as observation post and extension of the formal living room, although it was not necessary directly physically linked to the receiving room but to central corridor.

Veranda also served as an extension of indoor space for many domestic activities integrated to the new urban side garden. Houses may have several verandas in various forms, balconies, terraces or front and back porches. The simple house also may have front and back veranda to observe city life and a back porch for services activities, drying, washing and cooking. Akure residential architecture continues to be influenced by European stylistic development.

These influences reach the design of the modernistic house in Akure, the veranda is more of an aesthetic feature than a utilitarian or comfort detail of the house and once more designed to provide shaded outdoor space linked to the social activities of the house.
5.1 Akure City Profile

Akure is the capital city of Ondo state, which is one of the thirty six states of Nigeria. While the 1991 census put the population of Akure at 324,000, the current population of the city is put at 495,000 people. It is projected that by 2015, Akure will be inhabited by about 1.8 million people.

The projected figure is expected to result from the impact of industrial growth. The state has recently been classified as an oil-producing state while Akure has been classified as a Millennium Development City. All these factors are expected to greatly influence the population growth of the city.

5.2 Akure Ecosystem and Climatic Condition

Akure is located in southwestern Nigeria the climatic condition of Akure follows the pattern of southwestern Nigeria where the climate is influenced mainly by the rain-bearing southwest monsoon winds from the ocean and the dry northwest winds from the Sahara Desert.

High temperatures and high humidity also characterize the climate. There are two distinct seasons, the rainy and dry seasons. The rainy season lasts for about seven months [April to October]. The rainfall is about 1524mm per year. The atmospheric temperature ranges between 28oC and 31oC and a mean annual relative humidity of about 80 per cent.

The climate is characterized by high humidity and hot discomfort for eleven or more months in the year. This makes provision of permanent ventilation essential; the monthly rainfall exceeds 200mm for three or more months making adequate drainage necessary.

There is no need for thermal storage as a high diurnal temperature range of more than 10 degree coupled with low humidity is not experienced for more than one month in the year. The maximum monthly temperature never falls below the comfort limit, thus no special precautions need be taken against cold discomfort (Ogunsote and Pruncnal – Ogunsote, 2002b, 2002c).
5.3 The Climate of Akure

The thermal comfort and the use of verandas in residential buildings in Akure require a good understanding of the climatic conditions and thermal stress (comfort conditions) in Akure. From the data available, Akure enjoys a moderate tropical climate with maximum temperature rarely rising above 33°C and minimum temperatures rarely falling below 20°C.

Relative humidity is also moderate with maximum relative humidity rarely rising above 86% and minimum relative humidity rarely falling below 40%. There are some forms of precipitation throughout the year, even though there are distinct wet and dry seasons. There is usually more than six hours of sunshine, even during the raining season.

Table 1: Average Climatic Conditions in Akure (1983-2004)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Mean Monthly Maximum Temp(0c)</td>
<td>32.1</td>
<td>31.6</td>
<td>29.0</td>
<td>29.0</td>
<td>28.2</td>
<td>29.1</td>
<td>30.4</td>
<td>32.2</td>
<td>31.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Monthly Minimum Temp(0c)</td>
<td></td>
<td>20.0</td>
<td>21.7</td>
<td>22.0</td>
<td>21.1</td>
<td>20.8</td>
<td>20.2</td>
<td>20.1</td>
<td>20.2</td>
<td>20.6</td>
<td>21.2</td>
<td></td>
</tr>
<tr>
<td>Mean Daily Maximum Relative Humidity (%)</td>
<td></td>
<td>66.3</td>
<td>65.1</td>
<td>75.9</td>
<td>78.4</td>
<td>79.6</td>
<td></td>
<td></td>
<td></td>
<td>79.2</td>
<td>75.2</td>
<td>70.7</td>
</tr>
<tr>
<td>Mean Daily Minimum Relative Humidity (%)</td>
<td>43.6</td>
<td>40.0</td>
<td>48.2</td>
<td>54.0</td>
<td>56.5</td>
<td>59.1</td>
<td>62.8</td>
<td>64.1</td>
<td>61.4</td>
<td>60.3</td>
<td>50.0</td>
<td>43.2</td>
</tr>
<tr>
<td>Precipitation (mm)</td>
<td>10.9</td>
<td>33.5</td>
<td>65.6</td>
<td>79.1</td>
<td>154.4</td>
<td>169.5</td>
<td>209.9</td>
<td>245.7</td>
<td>178.8</td>
<td>180.3</td>
<td>49.0</td>
<td>34.1</td>
</tr>
<tr>
<td>Hour of Sunshine</td>
<td>7.9</td>
<td>8.1</td>
<td>7.4</td>
<td>8.4</td>
<td>8.1</td>
<td>7.5</td>
<td>6.9</td>
<td>6.3</td>
<td>7.6</td>
<td>7.6</td>
<td>8.0</td>
<td>7.6</td>
</tr>
<tr>
<td>Mean Wind Velocity (m/s)</td>
<td>0.9</td>
<td>1.1</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.1</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>
5.4 COMFORT CONDITIONS IN AKURE

Studies conducted by Ogunsote & Prucnal-Ogunsote (2003) indicate that the comfort limits and method proposed by Evans (1980) are the most effective for the determination of thermal stress for the Nigerian Climate. This method uses the air temperature and the relative humidity to establish the thermal stress. See Table 2.

Table 2: Comfort limits proposed by Evans

<table>
<thead>
<tr>
<th>Relative humidity (%)</th>
<th>Day comfort limits (0c)</th>
<th>Night comfort limits (0c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 30</td>
<td>29.5 – 32.5</td>
<td>27.5 – 29.5</td>
</tr>
<tr>
<td>30 - 50</td>
<td>28.5 – 30.5</td>
<td>26.5 – 29</td>
</tr>
<tr>
<td>50 - 70</td>
<td>27.5 – 29.5</td>
<td>26 – 28.5</td>
</tr>
<tr>
<td>70 - 100</td>
<td>26 - 29</td>
<td>25.5 - 28</td>
</tr>
</tbody>
</table>

Source: Evans (1980).

These limits were used to determine the comfort conditions (thermal stress) in Akure. The day thermal stress was obtained by comparing the mean monthly maximum temperature with the day comfort limit using the mean monthly minimum relative humidity. Note that the maximum temperature is used with the minimum relative humidity because both readings are taken in the early afternoon. The night thermal stress is obtained by comparing the mean monthly minimum temperature with the night comfort limits sing the mean monthly maximum relative humidity.

The thermal stress is categorized as shown in table 3:
The Climatic data, comfort limits proposed by Evans and this categorization were used to determine the thermal stress in Akure as shown in Table 4.

From this analysis, human comfort conditions in akure are satisfactory and there are no extreme of cold or hot discomfort. Hot discomfort in the day is often followed by cold or very cold discomfort in the night, thereby giving room for
amelioration of thermal stress through the use of building materials with high thermal capacity and long time lag.

This analysis however does not take many Variables, such as the globe temperature and wind speed, into consideration. There is need for a more detailed and accurate estimation of the thermal stress and also a specification of the thermal capacity and time lag of recommended building material that will be required to maintain the environmental variables within the comfort limit (Adedeji Y.M.D)

5.5 Relevant of Verandas to Akure Residential Vernacular Architecture

In the past years greater importance has been given to natural conditioning of spaces through the concept of bioclimatic architecture and its importance, attention is shown to the use of veranda.

It is no longer only seen as a functional element in design, the veranda is recognized as an important transition of indoor-outdoor space and a space for social contact and contemplation of nature.

The veranda is also an important extension of the house protecting walls and opening from the sun and rain, it provides shaded air cushion for the most exposed facades of a house.

it reduces the indoor heat gain through shading and avoid the hot-house effect. Windows are protected by the long overhang of a veranda which allows the window to be kept open during rain storms so that the indoor rooms may profit from cooling effect of rain

The veranda is singled out as a significant building element to attain environmental comfort for the type of climate present in the Akure city region of Ondo State Nigeria, and has been shown to be a fairly constant element in the historical development of the Akure residential buildings.
It has been a utilitarian extension to the kitchen common in the back of the house and provides transition from public to private spaces and shields the house from sun and rain.

Veranda integration in the Akure residential buildings with its garden allowed shielded observation of the street without ostensive involvement. The terrace improves thermal comfort of the houses been in hot and humid climates.

As stated in Givoni (1998), the outdoor climate in hot and humid regions is more pleasant than the indoors. Furthermore, many functions have to be carried our outdoors. In this respect, outdoor areas protected from rain and sun has been very useful.

In relevance to ventilation and especially cross-ventilation is important, in hot and humid climates like Akure to attain thermal comfort. Veranda helps to obtain adequate air currents to mitigate heat gains in indoor spaces and cool the building envelop and also used as outdoor sleeping area to receive fresh breeze.

6.0 Methodology

A field study was conducted in three outlying area of Akure city :Ijapo Housing Estate, Oba Ile Housing Estate and Alagbaka Housing Estate all in Akure. The sample is defined as appreciated percentage of the total number of buildings in these areas in terms of design character as they all exist under the same climatic condition and influence of Akure.

Field study 1
Field study 2

COME AND WORSHIP WITH US AT
THE NEW COVENANT BAPTIST CHURCH
PLOT 8, ROAD A2, OBASHILE HOUSING ESTATE, AKURE.

WEEKLY PROGRAMME:
SUNDAY—9:00AM–10:00AM SUNDAY SCHOOL
WORSHIP SERVICE—10:00AM–12:30PM
TUESDAY—5:00PM–7:00PM BIBLE STUDY
THURSDAY—6:00PM–7:00PM MIRACLE HOUR

"CHRIST IN US THE HOPE OF GLORY" COL. 1:27
6.1 Results

Results show that virtually every residential buildings in these locations in Akure has the design character of veranda, terrace, balconies either at the ground floor or at the upper floors positioned at the approach, side or back view of the buildings serving the purposes as mentioned above in achieving the thermal comfort as experienced by the residence.

In most cases the verandas are built as part of the building while some are an extension or projection of roof and the position of the veranda are thus very much related to the form of the roof. Also the positioning and dimensions or proportions in size of the verandas varies from one building to another.

7.0 CONCLUSION

The study conducted to investigate details of the veranda in residential buildings in Akure to achieve thermal comfort shows that front veranda, back and side porches are still an important element for outdoor activities and the population recognizes the verandas importance as a shading device element.

Veranda as a transition space and as a climate-mitigating element in a region with hot and humid weather will continuously be part of the residential building design and construction in achieving thermal comfort.
This study also showed that the use of veranda has huge influence on lighting and thermal condition of residential buildings as regards the climatic condition of Akure and the use of veranda to achieve thermal comfort will always be relevant in Akure and southwestern zone of Nigeria generally.

8.0 REFERENCES

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Thermal comfort in buildings located in regions of hot and humid climate of Brazil. Wagner Augusto Andreasi and Roberto Lamberts.