EFFECTS OF ROOF DESIGN ON AESTHETIC VALUE OF BUILDINGS IN THE TROPICS: A CASE STUDY OF AWKA METROPOLIS

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ABSTRACT

Roof is considerably the most exposed part of a building to the outside condition and the final topmost covering. Its designs aesthetically influences any building even the natural environment, which is perceived in the intangible experience it arouses when consciously engaged with. Roof designs, aside from their aesthetic and protective contents, are reasonably determined by the varying regional climatic environment. Despite this structural and aesthetic importance, the roof has received the least attention in the evaluation of buildings. This work therefore, is aimed at emphasizing the influence roofs have on the aesthetic value of residential buildings. Positing that, the common denominator apart from aesthetic value is the maintenance of comfortable temperature balance of interior spaces within the tropics. In carrying out the work, this study adopted the descriptive analysis method in its evaluation of various building components, construction techniques and geometric spatial configurations as the relate to the tropical climate, were studied and literatures reviewed to arrive at the conclusion that the value of any building is its roof. Hence, the study demands that appropriate roof design choices should be made since it does more than offer protection.

Key Words: Roof design; Aesthetic value; Building; Tropics

INTRODUCTION

The envelope of a building is critical and has both functional and aesthetic value. It shelters its occupants from the effects of the external environment by facilitating control of weather elements and maintaining warmth, dry, cool and safe indoor environment. An important part of any building envelope is the roof (CIB, 2003) because healthy buildings can only exist under well functioning roofs. The roof of a building is a key element of the building's design and one of its most important structural aspects (Architectural Record, 2007). It covers significant portion of the building's exterior surface area and is the part that is most exposed to the outside conditions. It comprises a complex component of the larger building system that exacts significant influence on the overall performance of the building. These influences could bother on the control of interior ambience, maintenance of users' comfort and protection of other components of the building. Roofs do more than serve a practical purpose of protecting a house and its occupants from outside elements. They can also add some additional space, make your home more energy efficient, and help bring in natural light. Roofs also play a major role in defining the overall look and style of a house (Slatton, 2014). Their performance can be measured based on the durability, strength, chemical, physical composition and appearance.

Characteristics of a roof are dependent upon the building's purpose, the availability of roofing materials and the climate and location of the building. For example, the pitch of a roof will be proportional to the extent and intense of precipitation it is expected to encounter. The roof is greatly affected by the general environment which causes its shape to

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vary from region to region. While some materials easily create malleable curved roofs, others are only amenable to rigidly geometric roofs forms. Also, grand public buildings call for bigger awe-inspiring roof styles, while residential homes favour humble functional roofs, even as aesthetic consideration is not missed. The functional response of the roof varies from warm climate to the cool climate. In cool wet climate, it performs the function of retaining and preventing the ingress of precipitation while in warm dry climate, the roof aims at reducing solar gain to promote cooling (Hyde, 2000). The Tropics is the part of the earth that has cooling as its main concern in buildings and the problem exacerbated by the heat gain of the roof, (Al-Obaidi et al, 2014). The roof acts as defense to climatic factors and these factors tactically affect roof's geometry, materiality, inclination and orientation. In designing roofs, balance between overall look and practicality is top consideration (Brinkley, 2012). Pitched, gabled, hipped and skillion roofs constitute the most frequently used in residential buildings, whether they are of organic flexible shapes or of rigid linear forms.

In some architectural epochs, the roof defined much of the architectural character or styles of building typology. It defined the style and contributed to the building's overall aesthetics. The hipped roofs of the Georgian Architecture, the Turrets of Queen Anne, the Mansard and the graceful slopes of the Shingle Style Bungalow designs are examples of the use of roofing as a major design feature (Sweetser, 2015). The choice of roof hinges on functionality but is also dependent upon stylistic factors seeking aesthetic delight. The roof is overwhelmingly a visual aesthetic element and serves as the defining and adorning element in a building design. Aesthetics is one of the major principles of architecture that students and professionals alike tend to worship in the valuation and validation of architectural products like residential buildings. Though aesthetics is only a consideration in valuation, it can also, no matter how plausible, be the on-the-spot summation of other valuation variables; which is to say that beauty is in the eyes of the beholder.

Aesthetic Values and its Ideological Foundation

The word “aesthetics” implies a wide variety of meanings. It suggests philosophical theories of beauty, ideas as basic as “style” and even concepts about personal experience (Douglass, 2008). It is the branch of philosophy that deals with the nature and expression of beauty (Architecture Student Chronicle, 2010). Aesthetics, according to Munro in the Britannica Encyclopedia (2015), "is broader in scope and deals not only with nature and value of the arts but also with those responses to natural object that find expression in the language of the beautiful and the ugly. The approaches to aesthetics are:

1. The study of the aesthetic concept or more specifically, the analysis of the “language of criticism”, in which particular judgments are singled out and their logic and justification displayed.
2. A philosophical study of certain states of mind – responses, attitudes, emotions – that are held to be involved in aesthetic experience.
3. The philosophical study of the aesthetic object. This approach reflects the view that the problems of aesthetics exist primarily because the world contains a special class of objects toward which we react selectively and which we describe in aesthetic terms."

Everything that is valuable is valuable in a variety of ways. Art objects often have sentimental value, historical value or financial value. Even a wilderness has both economic and recreational values as evident in Dubai have deployed its part of the Arabian Desert. In addition to these, great art works are said to be imbued or to possess a "distinctive sort of non-instrumental and non-utilitarian value that is of central concern when they are evaluated as art works" (Plato & Meskin, 2013). Aesthetic value, on the one hand, is the value of the aesthetic order as a whole, which cannot be explained in terms of constitutive elements of materiality, even if it depends on them. Aesthetic value incorporates visual elements like proportion, line and other formal qualities as auditory, tactile, olfactory, thermal, and even kinesthetic, in its mix (WBDG, 2014). This is why it is averred that the aesthetic value that a work of art possesses is also related to the kind of experience it evokes when directly engaged. It is said to be positive if it evokes such valued pleasures as beauty, elegance, gracefulness, harmony, proportion, unity, etc., and negative aesthetic value if it evokes such displeasures as ugliness, deformity or disgustingness. But, as has been observed earlier, important to note is that pleasure or displeasure underwriting aesthetic value is best thought of as directed at the object in question rather than being merely caused by it (Stecker, 1997). In the case of architecture, these underlying concepts may include branding, image-ability, ideas about community, and the importance of technology, (WBDG, 2014).

Architectural design values constitute some significance and influences, architects and designers are exposed to while making design decisions. Even if they are not always influenced by the same detailed value sets and intentions, because these value sets and intentions are defined by different Architectural Movements, Schools, as well as by individual architect's and designer's idiosyncrasies. The expansion of architectural design ideologies, thoughts, theories and vocabularies that took place during the last century created diversities of aesthetic realities that also, represent a kind of divergent aesthetic values. These aesthetic values and their diverse aesthetic expressions are to some degree a reflection of the development that has taken place in the art community as a philosophy behind a pleasing appearance.

Aesthetic value in residential architecture can include a simple act of improving physical appearance such as painting a house or weeding a garden. Discussions of aesthetics in architecture are often related to questions of style and elements such as harmony, diversity, symmetry, order, equilibrium and scale. Manning (1991) in his work on environmental aesthetic design, extended the meaning of aesthetics by arguing that objects of aesthetics value contain qualities of contemplated experiences which embody and express the emotions of the creator. For him “image” and “atmosphere” can and must be achieved by deliberate design actions since it is the “Image” that expresses the purpose, significance and status of an architectural object while “Atmospheres” can be expressed through such distinctive descriptors as happy-miserable; safe- dangerous; hard- soft; complex- simple; serious- humorous, etc (Kowaltowski, 1998).

Roof Designs and Categorization

A better understanding of roofs, their design and functional relevance require some review of studies on roof designs,

materials of construction that would be appropriate to reliability and climatic conditions, especially as they relate to the tropical environment. A roof, according to Whitney et al (1901), is defined as “part of a building envelope, both the covering on the uppermost part of a building or shelter which provides protection from animals and weather, notably rain, but also heat, wind and sunlight, and the framing or structure which supports the covering”. A well planned roof shape plays an important role in maintaining the building envelope which, in turn, will contribute to a building's livability, energy efficiency and resale value.



Plate 1: Traditional thatched roof.
(Source: www.google.com)

The earliest constructed roofs by humans were thatched roofs made of straw, leaves, branches, or reeds that were usually set at a slope, or pitch, so that rain drops could easily drain off. Conical thatched roofs are good examples of this type and are still used. Roofs are constructed in a wide variety of forms: flat, pitched, vaulted, domed, or in combinations dictated by technical, economic, or aesthetic considerations (Britannica, 2015) and usages which vary from region to region or from one builder to another.

Flat roof
As the name implies, is a low-pitched style of roof that are usually found in buildings located in regions with low precipitation.



Plate 2: Flat/ low pitched roof.
(Source: field study 2015)

Pitched roof
'Pitched' describes the angle of the roof that compares the horizontal run and the vertical rise and has sections or slope which angle exceeds 10 degrees. It can be mono-pitched, as in lean-to, skillion, shed roofs; multi-pitched as in gable, hip, mansard, e.t.c.



Plate 3: Pitched roof.
(Source: Field study 2015)

Vaulted roofs
They are parallel series of arches used to form a roof. The most common form being cylindrical or barrel vaults.



Plate 4: Vaulted roof
(Source: www.google.com)

Domes are hemispherical structures that also serve as roofs.



Plate 5: Domed roof *(Source: www.google.com*

Functional Requirements
At the design stage, a roof type is usually considered in perspective of the building type, climate, cost, available materials and technology. All roofing system performs essentially the same weather protective functions that also include: protecting the building's interior from outside inclement weather conditions by ensuring strength, stability, fire safety; maintaining water-proofing effects; safe easy accessibility for inspection and maintenance; security and aesthetics, (Donald et al, 1999).

Roof Coverings and Constituent parts
Roof coverings or sheets are materials designed to shield from wetness or precipitation. They come in different forms, sizes, dimensions and colours in form of shingles, panels, tiles, slates, shakes and sheets made of metals, plastics, aluminium, burnt clay, wood, cement, asbestos and allied composite synthetic materials like fibers, etc. It must be noted that roofing sheets or coverings have their unique designs and that such designs are based on configuration of corrugation, texture, weight, color and span. Each of these variables is also subject to variations in details. For instance, the corrugation of a roofing sheet can determine the strength or sturdiness of the sheet; the deeper the corrugation the stronger and more rigid. Again, the self weight of a roof covering determines the nature of the roof structural members upon which the covering will rest. The color and texture of a roof covering are very significant echoes of the aesthetic impression of not only the roof, but also of the entire building that bears the covering as a crown.

Though it has been pointed out that the nature of the roof covering determines the nature of the underlying roof structure, most conventional roofs consist of wall plates, rafters, collar ties, and struts, purlins, ceiling joists and a ridge board and cap. There exist variations of these roof members in terms of spacing, joining, placement, depth and material. They can be made of such materials as timber, steel, or a combination of two or more materials.

Rafter are part of a roof structural system, sometimes similar to joists, but inclined rising from the eave to the ridge forming the pitch of the roof and made

rigid by the combination of the overlaying purlins placed and nailed/bolted transversely to the rafters.

Collars are horizontal timber ties attached at each ends of opposite spars in a pitched roof, fixed at any height between the wall plate and half way up the roof to prevent roof spread and failure. It is a means of ensuring the rigidity and stability of the rafters and the cross tie beams.

Other component parts of the roof include:

The Valley is formed by the intersection of two roof surfaces and having an external angle less than 180 degrees. The wood member at the intersection is called the valley rafter and the feet of the short spars are nailed to the valley rafter.

Eaves means lowest edge of the roof and projected atleast 600mm beyond the external wall plane and trimmed off with the **Fascia board** which is an external horizontal wooden board attached to the ends of rafters.

Verge is the edge of a roof which runs from eaves to the ridge at a gable.

Ridge is the line of high points of meeting of two pitched planes running opposite or adjacent to each other (MacDonald, 2015).

The Tropics and Case Study Area

The tropical zone is defined as the area of land and water lying between the Tropic of Cancer, 23.38^{0}N, and the Tropic of Capricon, 23.45^{0}N (Edmonds and Greenup, 2002). Occupying approximately 40% of the earth's surface, the Tropics are home to almost half of the world's population. There are variations in climate within the Tropics. While some are hot humid; the rest are desert-like characterized as hot dry climate (Baish, 1987).

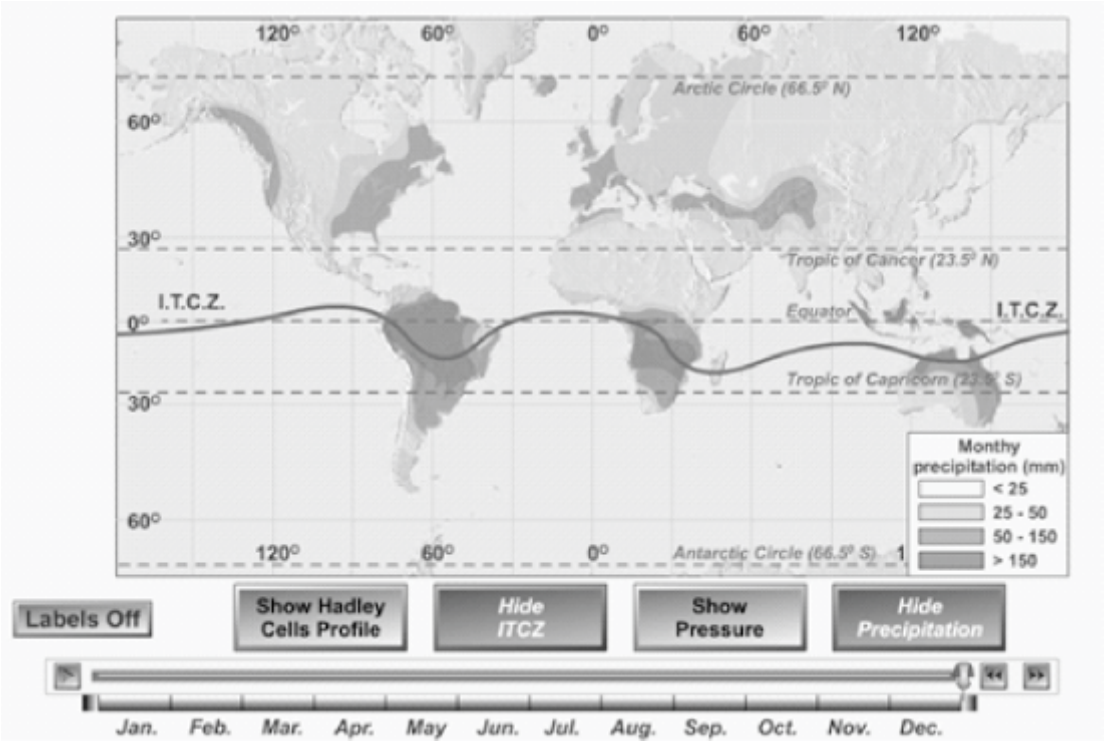


Fig 1: Tropical Zones *(Source: thebritishgeographer.weebly.com)*

Apart from the general prevailing climatic conditions in these tropical environments, local conditions, sometimes, differ substantially depending on the topography, altitude and other surrounding features which could be natural or human-made (Ossen et al., 2008). Hence, the Tropical and Subtropical regions can be divided into different climatic zones which, according to Gut & Ackerknecht (1993), include the Hot Arid zone; the desert and semi desert climate, the hot dry maritime climate, the Warm Humid zone; the equatorial climate and warm humid island climate and the Temperate zone; the Monsoon climate and the Tropical upland zone. They further averred that four main climatic factors that affect human comfort and also relevant to building construction are temperature, humidity, air movement, solar radiation.

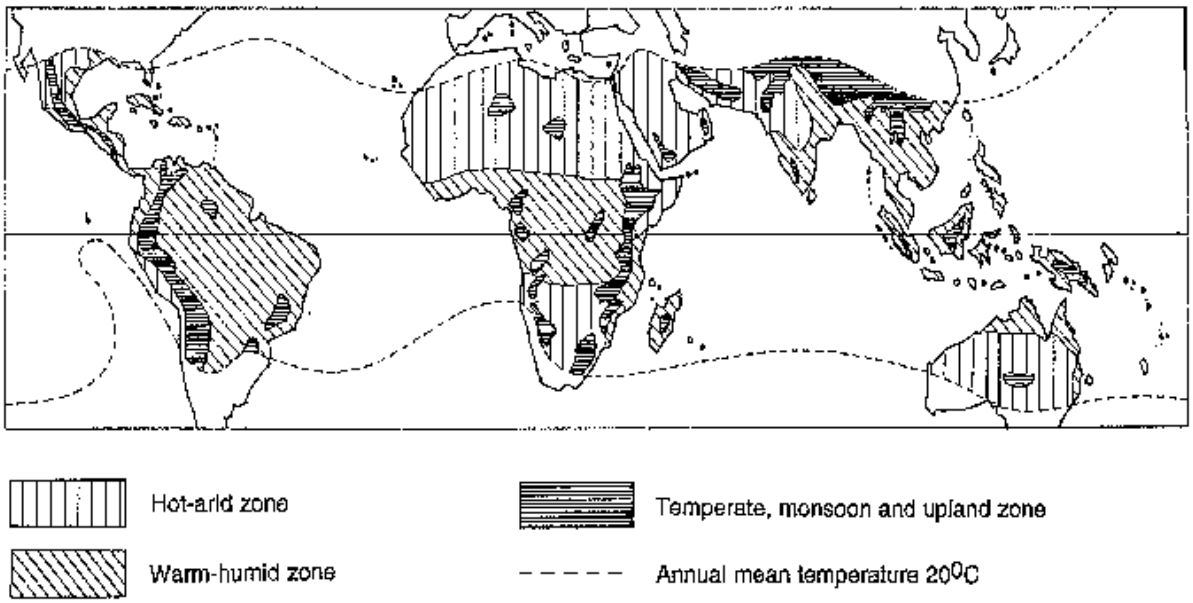


Fig 2: Tropical Climatic Zones *(Source: Gut & Ackerknecht, 1993)*

Elaborating further, Gut & Ackerknecht (1993) in Ossen et al (2008), stated that the main points to consider while engaging in a design of tropical responsive buildings include: minimizing daytime heat gains and maximizing night-time heat losses in hot seasons; minimizing internal heat gains in hot seasons; selecting sites according to micro-climatic criteria; optimizing building structures in terms of thermal storage and time lag; controlling solar radiation; regulating air circulation.

Awka is the capital of Anambra State, in the South Eastern part of Nigeria, with a population of 1,130,020 inhabitants (NPC, 2006).The inhabitants of Awka are mainly Igbos, although there are other ethnic groups who constitute a small percentage of the population.



Fig 3: Map of Nigeria showing the location of Anambra state



Fig 4: Map of Anambra showing Awka
Source: (Wikipedia, *the free encyclopedia*)

The city is located in the centre of the densely populated Igbo heartland and is among the earliest settlements in Igboland and at the centre of the Nri civilization, the cradle of Igbo civilization, which produced the earliest documented bronze works in Sub-Saharan Africa around 800 AD (Wikipedia, the free encyclopedia).

Awka lies geographically between latitude 6.22^{0}N and longitude 7.07^{0}E (Iloeje, 2001). It lies within the flood plain of Udi escarpment and is drained into the River Niger by the Omambara River and its tributaries (Iloeje, 2001). It has distinct wet and dry seasons which include eight months of rainfall (April - October), with an annual rainfall range of 2000 – 3000mm and a dry season which lasts from November to March, with a dry Harmattan wind blowing for about four to six weeks between December and January or into February. The Daily Temperature range of about 22.3^{0}C– 32.1^{0}C and Relative Humidity range of about 68% – 79% (Onyido et al, 2014) are predominant.

The South East zone of Nigeria, according to Osefoh et al (2014), lies within the warm humid zone of the tropics and experiences the sun as one of its most abundant resources. The climates in Awka and the South East zone of Nigeria, characteristic of such Tropical climates, present challenges of excessive heat and high humidity, thereby affecting thermal comfort of building occupants in these areas. Humidity and heat are consequences of precipitation and solar radiation both constituting direct actors on roof of buildings. This is why design of roofs is very important in the Tropics if the comfort of buildings' occupants must be assured.

Tropical Roof Design

A near overhead solar radiation during the hottest hours of the day causes roofs to bear the brunt of intense heat (Plumbe, 1987). Hence, thermal performance of roofs in the Tropics is one important factor for achieving indoor comfort for buildings designed for natural ventilation. Warm-humid climates induce heat surpluses in buildings thereby, requiring that roofs play the complex role of reducing such surpluses during the day and promoting cooling at nights. Climate matching roof design strategies, applicable to domestic scale, like high pitches and large overhangs to protect the walls and openings from direct radiation and precipitation are recommended (Gut & Ackerknecht, 1993). Also, design specification should include low thermal capacity and high reflectivity lightweight materials like light-coloured metallic surfaces. On the other hand, according to Duchein (1988), roofs made of aluminum, zinc, copper or stainless steel, have the disadvantage of being very effective heat conductors, as well as being prone to corrosion occasion by contacts with sulphur dioxide. Hyde (2000) suggested that reflective foils should be used to laminate the roof's undersurface (50mm - 75 mm below the covering in order to provide air space to further improve performance), that use of roof lights be minimized while Parasols are employed to maximize ventilation. Flat roofs are prone to leakage due to intense and extensive precipitation in the tropics and are not encouraged (Plumbe, 1987).

Roof Effects and Aesthetic Value

Aside from the primary purpose of roofs being to protect buildings, with minimum maintenance, in all weather, another consideration is appearance. In the past architects were obsessed with just the functionality of roofs while thinking less of



Plate 6: Gable roof *(Source: Field study 2015)*



Plate 7: Hipped roof
(Source: Field study 2015)



Plate 8:
Combination of the hip and gable roof styles *(Source: Field study 2015)*



Plate 9:
Combination of the hip, gable and skillion roof styles
(Source: Field study 2015)

Deep eaves and large overhangs are other aspect of roof designs with aesthetic implication. An eave and the shadow it creates visually soften the intersection between walls and the roof. Arrays of roof shapes, textures and colours can also create myriads of architectural aesthetic effects. For instance, flexibility of metals allows for the creation of architectural effects where different colours can be used with textures to have marble-effect or where the roof can be roll-capped to give the appearance of a standing seam (Facilitiesnet, 2010). Again, reflectivity is another factor of roof aesthetics. Reflectivity is the fraction of total incident solar radiation reflected by a surface. The selection of roofs with high solar reflectance, besides representing one of the most significant energy-saving options available to builders in tropical climates, is also important in the presentation of roof colors and textures and management of glares.
Below is the Laboratory Measured Solar Reflectance of Utilized Roofing Materials by Parker et al (2000).

Table 1: Laboratory Measurement of Solar Reflectance of Roofing Materials

Specimen	% Solar Reflectance
Dark gray shingle (RGS, RSL)	8.2
White shingle (RWS)	24.0
Terra Cotta barrel tile (RTB)	34.6
White barrel tile (RWB)	74.2
Flat white tile (RWF)	77.3
White metal (painted)* (RWM)	66.2

Conclusion

Roof is a very important part of any building, whether residential or commercial. It represents a complex component of the larger building system, and is the part that is most exposed to the exterior conditions. Roofs impact significantly on the overall performance of the building, by reducing solar gain of a building and promoting cooling. The roofs thermal performance is one of the most important factors for achieving indoor thermal comfort in tropical houses designed for natural cross ventilation. In view of thermally controlling the indoor conditions of the residences in the tropics, the roof equally imparts much of the architectural characters that influence visual appearances of buildings, vis-a-vis, their aesthetic values. This is even more poignant in the Tropics where the effects of solar radiation are dominant. Though architects and building developers had in the past paid less attention to the aesthetics of roof design, there is now a growing awareness and consideration of roof aesthetics because they contribute to a building's long term perspective, stability, durability and comfortability. Roofs are also part of style definition. When designing new buildings or retrofitting existing ones in the Tropics, appropriate roof design choices should be made since roofs do more than offer protection. The roof is an aesthetic element and according to Poriau (1986) and Loewry (1979), “the aesthetic value of architecture is equivalent to the extent to which this architecture gives rise to a multitude and complexity of interpretations engendered by architectural metaphors” and these are “most advanced, yet acceptable”. The value of a building is significantly its roof.

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