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Review of Igbo Traditional Architecture and Thermal Comfort Features

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Abstract: Architects and stakeholders in the built environment have severally been urged and challenged by the public to come up with architecture that is tropically responsive. This call is based on the fact that tropical climate is challenging and ideal for energy economy and at advantage when compared to America and European situations, where architectural documentation existed. Tropical architecture in Nigerian before the import of colonialism was traditional and originated from the people. It was not designed to be mechanically supported rather it observed local climatic conditions and was considered effective. This is because the builders mastered the character of the prevailing climate around their locality. This paper reviewed Igbo traditional architecture and the architectural features that enhanced indoor thermal comfort. The paper recommend the adoption of those thermal potentials in modern designs to enable the achievement of energy efficient buildings.

Key words: Ventilation · Thermal comfort · Energy Efficiency and Traditional architecture

INTRODUCTION

It was the discovery of fire that originally gave rise to the coming together of men, to the deliberative assembly and to social intercourse. And so, as men kept coming together in greater numbers into one place, finding themselves naturally gifted beyond the other animals in not being obliged to walk with their faces to the ground, but upright and gazing upon the splendor of the starry firmament and also being able to do with ease whatever they chose with their hands and fingers, they began in that first assembly to construct shelters [1]. Some made them of green boughs, others dug caves on mountain sides and some, in the imitation of the nests of swallows and the way they built, made places of refuge out of mud and twigs. They were soon by observing the shelters of others and by adding new details to their own inceptions, they constructed better and better kinds of huts as time went on.

At first, men set up forked stakes connected by twigs and covered the walls with mud, covering them with reeds and leaves to keep out the rain and heat. Finding that such roofs could not stand the rain during storms, they built them with peaks daubed with mud, the roofs sloping and projecting so as to carry off the rain water. Traditional Igbo architecture doubtlessly followed similar development as recorded in history by Vitruvius in the ten books of architecture translated by [2].

Better stated, Traditional architecture in Igbo ethnic area is basically in earth, Earth is almost the most essential walling material in man's habitation since dawn of man, with nature setting the example. Termites built towers above ground and developed air circulation which predefined modern ventilation processes. [3], the potter wasp and the cousin the "mud mixed" wasp used their mandible to knead and model vaults that were perfectly rounded as if designed by architects [4]. [5] expresses shelter as a basic need for man and man's effort to shelter himself against the extremes of weather and climate is the ultimate aim of all human beings. Man's quest for shelter from the extremes of weather and climate is responsible for the peculiar house types and architecture dominant in Igbo region.

Literature Review

Igbo Traditional Architecture: [6], in a study of Nigerian traditional architecture, the Igbo-speaking areas puts architecture as neither a purely artistic nor an exclusively technical activity whose aim is to provide material frame for the major part of human life; for work and rest, for religious, social and artistic activities.

In order to achieve this end, the work of Architecture, the building must be strong to assume reliable shelter, it also must be well planned, to provide for comfortable use of the component parts. Finally, it must satisfy a demand always inherent in the human mind, for

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aesthetics satisfaction for that elusive, precious quality called beauty. [7] here agreed with the virtues of Architecture to include Utilitas, Firmitas, Venustats which is translated to structural stability, appropriate spatial accommodation and attractive appearance (beauty) [8] in Vitruvius, The ten books on Architecture.

Therefore, a building is not an end in itself, but rather a means to an end, which is to satisfy the material and spiritual needs of the people for which it is created. Architecture is the most firmly linked with human life and reflects its dynamics faithfully [9] Alozie further noted that architecture is derived by architects and no good architecture can originate without respect and love on the part of the society for which it is created - a society which is conscious and proud of its culture. Igbo traditional architecture is a product of proud consciousness of the people's culture, originating from ingenious builders, who were licensed as architects by mastering the climate and building material prevalent in the Igbo speaking area.

The characteristics of architectural design in Nigeria were determined by the natural conditions of a given area, most of all by the climate and the building materials available. This particular assertion determines Igbo traditional architecture. This paper reviewed thermal comfort features in Igbo traditional architecture with an aim to determine how their buildings provided acceptable indoor thermal conditions.

Nature of Igbo Traditional Architecture: Igbo traditional architecture is one that has great varieties in design of compounds and in buildings, this was a natural consequence of the diversity of the materials used for walls and roof construction. The Igbo traditional architecture start from the Igbo village and progressed to the compounds, buildings and building materials [10].

Igbo Village: Water was one of the determinants to the location of the Igbo village as is the case in many other ethnic settlements. There were no predesigned plans for the villages. They evolved as a result of local conditions. The winding streets and lanes were usually erected according to the choice of each family at a distance from and quite independent of the neighborhood.

Communal life was carried out in public grounds such as markets and public spaces (ilo) which were often open or in a landscape of tall trees that provided shade. These trees added to the scenic value of the villages [11]. Families or lineages in particular had their own meeting places in buildings of their socio-religious character (Obu).

Igbo Compounds: The five main dimensions and sub dimensions of Igbo-land developed a variety of compound designs consequent upon the general plan of the village, which in turn depended mainly on socio-cultural factors, but also on geographical ones. The buildings has rectangular outline; and frequently possessed ingenious structural devices and practically always incorporated a harmonious spatial composition and decoration. The compounds, to whatever extent they varied in shape formed as a rule formed distinct entities, each sheltering a whole family group. A boundary wall with a single main entrance, which was strongly built and although not really fortified, yet in certain examples contained some defensive contrivances. Quite often, there was another back door to the compound, used in case of necessity or as an escape route. Accordingly [12], strongly affirmed that there exist much in Igbo architecture to inspire the creation of modern Nigerian design.

Igbo Buildings: The variety of design of compounds, was a natural consequence of diversity of the materials used for wall and roof construction and for decoration as a typical Igbo traditional building has a rectangular plan without windows and verandahs in front of the house. The buildings were erected with forked post to carry the roofs. Igbo traditional buildings was one of the diverse architectural design believed to be born out of human creative spirit, the proud imperative of the builder to express his own traditional approach, to solve, in compliance with the material and spiritual environment, the building problems presented to him by his family and society [13].

Apart from the dwellings, other common features of Igbo architecture were massive compound gates; meeting houses (for families, patrilineages and secret societies); shrines and defensive walls. Generally Igbo architecture embraced convenience rather than ornament. The wall was made of red earth, tempered, which when dry is as hard as brick. The buildings are arranged in the compound in hierarchy of responsibility and founded on a large square piece of land, which is surrounded by fence or enclosed on a mud wall. Within this area, arranged in order of importance are social buildings to accommodate the family and the domestic servants. In the middle the big building belonging to the master, consisting of two apartments, the day where his guests are hosted and the night where he sleeps. Alongside, or behind this house is the house of his wives, young children and his yam barn. The male siblings, cousins and adult malechildren are

allowed to have their building on both flanks copying similar rectangular forms as the masters. The domestic servants and animals are housed behind these buildings too. The buildings were bungalows, built of wood or stakes driven into the ground, crossed with wattles and neatly plastered within and without. The roof is thatched with mats, made from leaves of raffia palm.

Igbo Building Materials: Loam, the product of processing building earth varies considerably in quality in Igbo-land, from the best which is red, claylike and viscous to greyish soil which is not strong enough to be used without an inner reinforcement of wattle. The earth is usually made into a pudding with water. When the density and plasticity of the mixture is attained and the desired mass obtained, the walls are then erected [14].

Timbers: The Igbos are located in the rain forest which in abound is excellent hardwoods. Valuable mahogany is used for making planks. Iroko and Ukpi both hardwoods serve to make beams and post in buildings, the mangrove is another hardwood which is termite resistant. The areas outside the forest are often heavily farmed and it is mostly there that many kinds of palm trees grow. Of the various species of palm tree, practically every plant is used for building purposes: timber, fronds and fibers. Bamboo, which grows in clusters of up to hundred stems and reaches up to 15 meters in height and 12 centimeters in diameter are available in almost all parts of Igbo countryside. They are used mostly for roof construction. They are split when sufficiently thick. Various lianas and creepers provide binding materials [15].

Walls: The structure of Igbo walls depend on the quality of the building earth available in the area. Two different techniques are employed in building the walls. They are either erected in thick solid layers of processed loam, or made using wattle and daub method.

Roof Thatching Mats: There are predominantly two kinds of roof covers, the mat from raffia palm fronds and the grass. The choice determines the construction techniques.

Floors: Floors were raised to 50 centimetres above ground level both in rooms and verandahs. The height was necessary to prevent the interior from flooding during torrential tropical rains. Floors were usually made of good red building earth and sometimes polished in charcoal for aesthetic and cooling effects.

Thermal Comfort Studies: Heat Movement in Buildings: Over the years, several definitions for thermal comfort have been given by various researchers. [16] defined thermal comfort as a state in which there are no driving impulses to correct the environment by behaviour. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) defined thermal comfort as the condition of the mind in which satisfaction is expressed with the thermal environment or as the express satisfaction within the thermal environment, in which 80% of the sedentary or slightly active persons find their environment thermally acceptable [17, 18], later provided one of the simplest definitions of thermal comfort and defined it operationally as the range of climatic conditions considered comfortable and acceptable to humans. This implied an absence of two basic sensations of discomfort: a thermal sensation of heat and a sensation of skin wettedness.

From all the definitions, thermal comfort is achievable when temperature is under control and when at least 80 % of the sedentary or slightly active persons find their environment thermally acceptable [19, 20] underlines three variables that affect thermal comfort. These are environmental, personal and contributing factors. Thus, six parameters are necessary for thermal comfort assessment and calculations. These are: air temperatures, relative humidity, mean radiant temperature (which is equal to the air temperature), air velocity, metabolic rate and clothing insulation [11]. In most thermal comfort studies, temperature have been indicated as the most important parameter since it is temperature that actually determines how occupants feel within spaces. Most authors have confirmed this assertion. Air temperature is often taken as the main design parameter for thermal comfort, hence it is essential for occupants? well-being, productivity and efficiency [10].

[4] believes heat transfer is the basic mechanism of environmental effects on buildings and occupant's thermal behavior and that the most significant heat input into a building is through solar radiation, Both noted that in warm and humid climates, the solar radiation penetrates through the openings and that solar heat gain over the building envelopes during the day causes overheating in the building.

[12], claimed that the amount of diffused solar radiation in tropical region is very high because of high content of water vapour in the air and the cloud cover in the sky, this excessive solar radiation affects the indoor thermal environment through direct radiation and absorption properties of materials. Solar radiation enter

through buildings openings such as windows to heat up the internal surfaces. Absorption by building facades through conduction also transfer heat into interior spaces thus increase the indoor temperature [6].

Ventilation Studies: [6, 7] stated that ventilation is the replacement of used inside air by outside air and it has three major functions: supply of fresh air, body cooling and structural cooling or heating. Air movement through buildings can be induced by the stack effect, wind pressure or mechanical means such as fans, evaporative coolers, air-conditioners and heaters. The factors that affect air flow through buildings are external features and factors, number and size of openings and opening components. Air flow around buildings is determined by the shape, height, orientation and planning of building. Ventilation is predicated by mathematical formulae or with the aid of models. Minimum ventilation standards provide for supply of fresh air, body cooling and structural cooling.

Basic Concepts in Ventilation: Ventilation which has been defined as the replacement of used inside air by outside air, may consist of cross ventilation which is ventilation achieved by placing openings in opposite walls or an enclosure or natural ventilation is ventilation achieved without mechanical aids, but by stack effect and pressure. Comfort cooling is the use of air movement or body cooling [13]. Air movement refers to the circulation of air within a space and is not necessarily associated with ventilation. Infiltration is uncontrolled air flow into or through a building especially via gaps in doors and windows. Ventilation is measured in air changes per hour.

Thermal Comfort Features in Igbo Traditional Architecture: The following features were unconsciously but effectively applied by Igbo builders to achieve indoor thermal comfort in their buildings, ventilation, lightning, orientation, landscaping and building materials.

Ventilation: Ventilation is the replacement of used air by outside air and it has three major functions: supply of fresh air, body cooling and structural cooling or heating [5]. Cross Ventilation is ventilation achieved by placing openings in opposite walls or enclosure, while natural ventilation is ventilation achieved without mechanical aids, but by stack effect and pressure [8].

Igbo traditional builders were able to use ventilation process to achieve the following injection of fresh air into their buildings, body cooling and structural cooling of the three work together in harmony to provide acceptable indoor thermal environment. This was possible through the use of openings, windows, doors and gaps between the roof and the wall which serve as high level openings. Larger windows are allowed on the wind ward side and in the exit, smaller units are used. This made it possible for larger quantity of air to come in and due to the smaller openings, struggle to escape, thus bring about cooling. Igbo builders had primary knowledge of Cross ventilation and Natural Ventilation, hence they applied both to achieve comfort. Another feature that enhanced ventilation in Igbo traditional buildings was the courtyard. Igbo traditional settlement, allowed for patrilineal system where people linked by one father or grandfather live together in very large compounds. Buildings are erected leaving very big open space in the middle (courtyard). The courtyard helps in air circulation.

Lighting: Maximizing natural light in building can lead to significant energy saving [17]. Natural light access can be obtained through Skylights, Atria, Light Shelves, Clerestory, Windows and Light Tubes.

Natural Light is an effective dynamic tool for expressing the quality of living space. Whether used to diffuse illumination of the museum gallery or as a dramatic and variable figure within an enclosed space. The formal and architecture intensions of daylight (natural light) should be directly associated with evaluation of quality. Natural light plays a central role in the design of a visual environment.

The architecture, people and objects are all made visible by lighting. Natural light influences our well-being, the aesthetic effect and the mood of the room or area. Our perception of architecture will be influenced by natural light. Natural light defines zones and boundaries. It also expands and accentuates a living space. Natural light creates links and delineates one area from another [6].

Igbo pioneer traditional builders, though without formal western education were able to illuminate their interiors, creating delineation in spaces and linking spaces together. They were able to define interior boundaries, created accentuations and expanded living spaces. Light in Igbo traditional building was through openings in form of windows and doors and sky lights.

Igbo traditional buildings is not complex, that is to say that it hardly exceed four bedrooms. This makes it easy to introduce natural light. Natural light is still very essential in today's Igbo traditional buildings interiors, as It limits the use of artificial light which heats up the interior.

Orientation: Unconsciously and without tutelage, pioneer Igbo traditional builders understood the need to shade their walls from the sun as they craftily avoided openings in the west. Their buildings were built in a pattern around courtyards which could not avoid the West in some situations. In such cases, economic trees were extensively planted in the west to help shade the buildings, filter the air and increase air circulation. Orientation was effectively applied in Igbo traditional buildings, which enabled them to achieve acceptable indoor thermal comfort.

Building Materials: Igbo traditional architecture, parade building materials which had been discussed in the buildup pages of this paper. Listed below are materials that define the architecture and possess thermal comfort potentials which enabled the building's thermal performance. The materials are principally thatch and mud.

Thatch: Natural thatch roofing, has been used for centuries, but it is far from a thing of the past. Today, this type of eco-friendly roofing material is still found atop countless buildings around the world, in both tropical and temperate climates. Thatching is the craft of building roofs with dry vegetation such as straw, water reeds, sedge, (Cladium Mariscus), rushes, heather or palm branches. Thatch uses renewable local materials requiring minimal or zero energy input in production and cost less than most other types of roofing.

Thatch is a natural insulator and air pockets within straw thatch insulate a building in both warm and cold weather. Thatched roof ensures that a building is cool in summer and warm in winter. Thatch's natural thermal efficiency also helps to keep the interior comfortable (http://www.amazuluinc.com/2017/11/21/).

[17], in investigating thermal qualities of thatch as roofing material in Abakiliki, Ebonyi State Nigeria, found out that the indoor environment of a thatch building registered a low temperature of 20°C in the morning hours as compared to 26°C registered in same morning by a corrugated metal sheets roof building. It further reported that while the temperature of the thatched building remained relatively moderate, that of corrugated metal sheets was high throughout.

Thatch is popular in Igbo traditional architecture due its availability, cost and manageability, thatch have over years of undocumented history provided thermal efficiency in interior environments of Igbos traditional buildings.

Mud: Mud remains an iconic walling material in the development of the Igbo settlement and housing. Mud has been used as the main material from time immemorial in different forms such as mud blocks, mud walls and mud plaster. It is a fact that the world's first tall buildings were in mud. The Ziggurats, in (3000-2000 BC), the great walls of China in 206 BC remain great works in mud [4, 5] remarked that the biggest building in the world in mud brick was in Mali in 1907. Mud is good thermal insulating material in itself. Due to its excellent thermal regulating property.

Mud can be used either in form of building blocks or can be applied directly to construct walls. The prevailing common techniques of mud wall construction are

- Cob Technique
- Rammed Earth Technique
- Wattle and Daub Technique
- Compressed Earth and SMB [8]

Cob is lump of rounded mass. Cob is a traditional building technique using hand formed lumps of earth mixed with sand and straw [10], observed that cob is easy and inexpensive to build. Rammed earth is clay soil compacted into a formwork, this has been replaced in recent age by stabilized mud. Wattle and daub consists of bamboo framework with mud filling [12].

Mud is used also for fencing in Igbo settlements. Mud has a number of properties which makes it a perfectly suitable material for construction. Mud construction is used to achieve thermal comfort at a low cost and are constructed without mechanical means [5, 8] holds further that mud slurry is most economic insulation material an opinion strongly shared by [15] in their comparative study of the thermal performance of mud and brick houses in Bangladesh. Both concluded that mud as a building envelope keep the interior of the hut cooler in summer than outside and warmer than outside in the winter when compared with brick.

Traditional Igbo architecture is predominantly mud, hence [7, 8], fill the gap in literature in unveiling the thermal comfort potentials of mud as walling material in Igbo traditional buildings.

RECOMMENDATIONS AND CONCLUSION

The paper discussed Igbo traditional architecture. It delved into the traditional values of villages and compound planning, building forms materials and finally reviewed architectural features that enabled the ancient architecture of the people to thermally serve them long before the invention of electricity. It must be underscored that the builders of this architecture possessed no primary western education and had no documentation on passive design. Their teacher was nature.

The paper agree with Vitruvius assertion of architects studying the prevailing climate in any location they find themselves. It recommended that the traditional architecture in any locality is dependent on its climate and should effectively be used to provide thermally functional buildings. It called on contemporary architects and developers of modern human habitation to emulate these passive potentials as used by the nature tutored builders of Igbo Traditional Architectural and improve on them for the comfort of their clients and the population who depend on their product for comfort.

In conclusion it acknowledged that adoption and modernization of these architectural features will facilitate the remodeling of our environment to one of comfort and reduce cooling cost which is the predominant means of energy consumption in tropical environment. It believes that the long term practice of this will enable the attainment of green and sustainable environment.

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