Passive design techniques have shown to be quite successful and may significantly contribute to reducing building cooling loads. According to Tahmina (2009), there are concepts separated into planning factors and building envelopes that aid in guiding the passive design process in order to achieve energy efficiency in a design. They are as follows:

4.2.1 Aspects of Planning:

(a) Building Form

As a result, the building forms should be wide, outwardly orientated, and not compact. Figure 4 depicts the effect of building shapes on energy efficiency. The compactness of the building reduces the surface area of the building envelope, which reduces heat gain through the envelope.

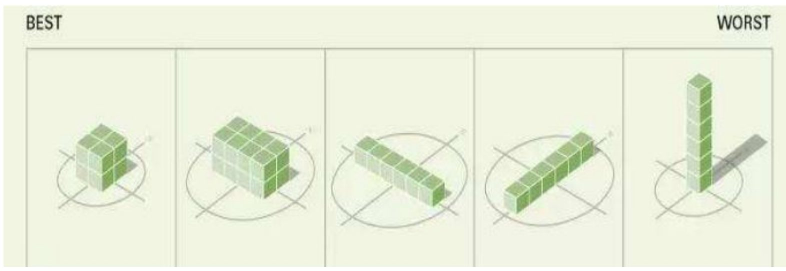

Fig. 4: Effect of building form on energy efficiency. (Source: Passive design toolkit, 2009)

(b) Building orientation

East and west-facing walls receive the most radiation, especially during hot weather. As a result, these barriers should typically be maintained as narrow as possible, with as few and small gaps as feasible. Figure 5 depicts the use of orientation to improve energy efficiency. In general, the best favored orientation is East and West facing.

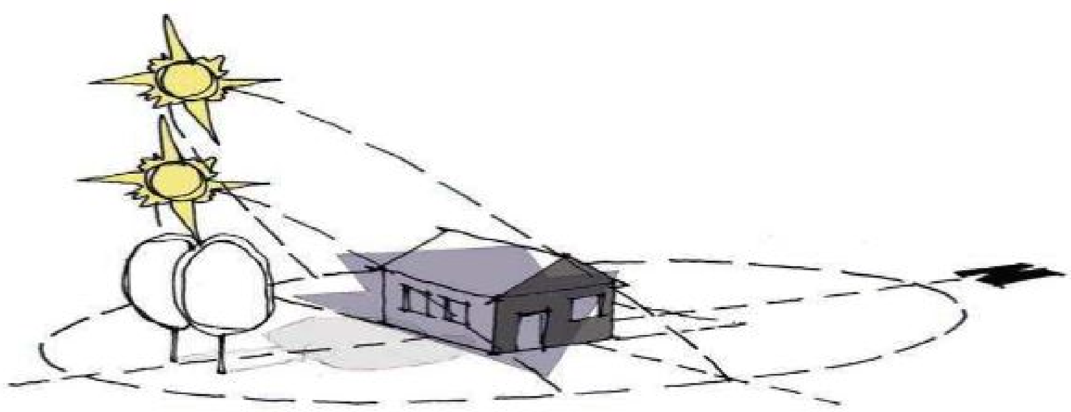

Fig. 5: Building orientation. (Source: Passive design toolkit, 2009)

(c) Spatial organization

According to Gut and Ackerknecht (1993), the organization of rooms is determined by their purpose as well as the time of day they are in use. According to Mowla (1985)'s research of spatial organization in Bangladesh, eastern facades in Dhaka get about 700 W/ m2 of morning light throughout the year. He recommends arranging rooms used later in the day on the east side, which is warm in the morning and cools off in the afternoon. According to Gut and Ackerknecht (1993), the organization of rooms is determined by their purpose as well as the time of day they are in use. According to Mowla (1985)'s research of spatial organization in Bangladesh, eastern facades in Dhaka get about 700 W/ m2 of morning light throughout the year. He recommends arranging rooms used later in the day on the east side, which is warm in the morning and cools off in the afternoon.

(d) Landscaping

Proper tree planting for energy savings finds that adequate tree planting can lower a house's cooling demands by 10% - 40%. They also point out that trees, which are better at shielding low morning and afternoon sun, can be used in conjunction with window overhangs.

Fig 6: Rockhurst University, Kansas City, Missouri, makes good use of climbers and trees to limit heat penetration into the structure. (Ogunsote,Prucnal-Ogunsote,Adegbie, 2005)

4.2.2 Building Envelope:

(a) Construction material

In Nigeria's hot-humid climatic zone, the choice of building material is critical for ensuring maximum comfort. The thermal qualities of materials that influence the rate of heat flow in and around the structure, and hence the thermal state and comfort of the inhabitants, include the following: -

- Thermal conductivity: A material's capacity to conduct heat.
- Thermal Stability: A material's ability to keep its basic physical and mechanical properties, as well as its interior structure, when heated.
- Thermal Resistance: A material's capacity to resist heat flow.
- Heat Capacity: A material's capacity to absorb heat when its temperature is raised.

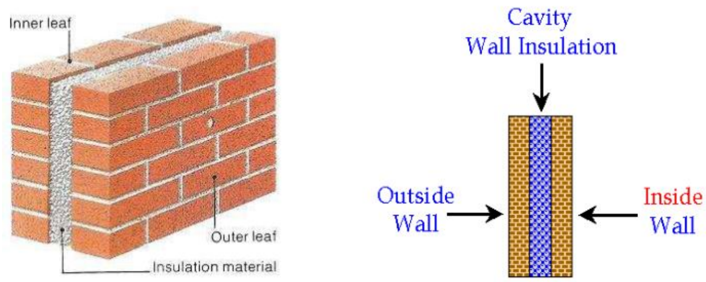

Fig. 7: Insulated brick cavity walls absorb heat thereby cooling the interior
(Source: www.smarthousingmanual.com, 2002).

The proper utilization of thermal mass throughout a structure may make a significant difference in comfort and cooling costs (Chris, 2008). This is seen in Fig. 7 with insulated brick cavity walls. Buildings in the tropics made of high thermal mass materials should be effectively shaded to prevent heat gain and inside insulated to limit heat transmission.

(b) Natural ventilation

The circulation of fresh air to replace heated air is referred to as ventilation. According to Watson and Labs (1983), ventilation serves three purposes in the construction industry. It is used to: (a) meet the inhabitants' desire for fresh air; (b) increase the rate of evaporative and sensible heat loss from the body; and (c) chill the building interior by exchanging heated indoor air for colder outside air. Cross-ventilation can also be employed to promote quicker cooling and improved ventilation, according to Givoni (1998).

"The following two forces can provide natural ventilation:

- Temperature differential between the outside and the inside of the structure
- Wind flow against the building

(c) Day lighting

Day-lighting helps to minimize the requirement for electric lighting while still contributing to bright and productive interior spaces. The amount of natural day-lighting in a room or structure is determined by the kind, size, and location of windows. Consider the sun's direction and seasonal fluctuations, the best quantity of day-light, glare reduction, and the heat gains and losses connected with the choice of windows and frames. Sunlight tubes are another means of bringing natural light into a building's interior. Sunlight tubes catch sunlight from the rooftop or outside walls, divert it down a highly reflecting shaft, and then distribute an abundance of pure day-light throughout the interior area using cutting-edge design and technology. Figure 8 depicts the utilization of sunlight tubes.

5. Conclusion

Energy efficiency, as a result of its principles and features associated to the Passive approach, suggests the employment of simple approaches and strategies that will easily generate balanced and comfortable structures. The research study is based on the premise that the energy efficiency principle may be utilized to give means that are likely to lead to discoveries in the execution of future designs and constructions employing the aforementioned passive means using design methodologies, building techniques, and material use. The adoption of such is obtained from a collection of theoretical materials that have been compiled and accessible; case studies used as inference give light on the potential inclusion of the researched problem statement. It is expected that energy-efficient solutions would be used in the design of shopping malls and other structures.

Passive design solutions have the ability to increase building energy efficiency. According to the findings of this study, lighting and ventilation are highly essential since they are primary aspects that impact the comfort of building users. A considerable proportion of users believe ventilation has the biggest influence on comfort and would want to have control over these factors. Passive design methods should be used from the beginning of a building's design process. Solar glazing and shading systems also limit solar heat gain and can enable appropriate natural light into rooms in buildings, while natural ventilation helps reduce the continual usage of artificial ventilation. These passive design solutions, when correctly implemented, may significantly increase energy efficiency in residential buildings while simultaneously lowering energy usage. Buildings should be built to offer appropriate natural lighting and ventilation while providing building users control over these variables.

This study is expected to give a model for the later implementation of Energy Efficient design principles employing passive approaches in the construction of a shopping mall or any other public structure.

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