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AN APPRAISAL OF SHADING DEVICES IN INSTITUTIONAL BUILDINGS

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ABSTRACT

This study addresses user comfort and performance of shading devices systems in an institutional building. It also shows that the architect can improve the shading and thermal comfort of the building by way of proper building materials, effective landscape, types of sizes of fenestration among many other design considerations right from design state. Information and data were obtained from on the spot assessment. These assessments were basically field observations of physical characteristics and prevailing conditions carried out within study area. Also data was obtained from relevant literatures such as books and journals. Results reveal that a wide range of methods can be used in analysing the performance of shading devices in institutional buildings. It further shows that even without software, designers can put in place some measures and design considerations right from the preliminary design stage such as proper building orientation, choice of building materials, effective landscaping, types and sizes of the fenestrations among many other design consideration.

Keywords: Energy Saving Fenestrations, Shading Devices, User Comfort

INTRODUCTION

Buildings consume significant large amount of energy for cooling, heating, ventilation and lighting to create desirable thermal comfort conditions. In warm and tropical climates, excess solar gain may result to high energy consumption natural and passive cooling uses non-mechanical methods to maintain a comfortable indoor temperature natural cooling can be achieved by proper layout and resistance of the building materials, good landscape design, proper shading devices, over hangs, external surface finish (Gouri, 2001).

Most institutional buildings in Nigeria are designed and constructed without consideration of the climate and its effect on building system and material and most appropriate shading devices applicable to the building which will gives the desired thermal comfort to the occupants, save energy consumption and ultimately reduce greenhouse gas emission. There is no proper orientation of buildings and sometimes if the shading devices are fixed, they do not serve their primary functions. Furthermore, shading device slats used in the institutional buildings are usually made of non-transparent materials (mostly aluminium). In addition, institutional buildings in Nigeria are often designed and constructed without plant landscaping elements (such as trees, flower hedges and grasses) which can shade the building, provide green vegetation, improve the air quality of the environment and provide thermal comfort for the occupant (Lin, Matzarakis, Hwang, 2010).The shading device is not often used as part of a day lighting scheme, such as spaces that have a large distance from the window wall, to avoid the occurrence of glare. Existing shading devices are usually applied for protection from overheating in summer, for protection from glare and for providing privacy (Santos, Laustsen, and Svendsen, 2004). Shading devices are rarely used as solar collectors. The shading device, which is installed in the cavity of a double-skin façade, can absorb solar energy and transfer energy to the air in the cavity (Santos, Laustsen, and Svendsen,2004).

Studies maintain that direct sunlight for room lighting is difficult to be applied to all structures because its value of luminance is too high and its causes several problems such as overheating, uncomfortable visual environment and poor view performance. For these reasons, the utilization of shading devices is at the forefront again. Also, external shaping devices have been utilized extensively in residential and commercial buildings to control the amount of day light flowing into buildings. They are designed with the solar geometry in mind and their configurations are closely related to the sun's path. The various shading devices are available in different materials, sizes and shape and fixed at different positions in the building such as windows, buildings as part of the design while other moveable. Some are automated while other are manually operated. They are broadly classified into Internal shading devices (interior reflective screens, blinds and louvers), and external shading devices (awnings, building overhangs, canopies, light shelves, louvers, shading by textured surfaces, roof shading and roller shutters.

No particular shading device is 100% efficient as they all have their merits and demerits. The effectiveness of their performance depends on a number of factors such as the position they are placed, seasons and climatic conditions of the region. Highly glazed buildings are in advance worldwide, which means that solar control becomes a move and mere crucial issue both for comfort and energy performance of buildings. However the interrelation between a variety of device characteristics plus control options and building performance is often not known as heating, cooling, lighting and façade build a couple system, which is more or less influenced by automatic or user control. Operative boundary limits for a building are given by thermal and visual comfort requirements and of course by limits of the energy demand that have to be respected.

Impact of Solar Shading on Thermal Comfort

For body comfort, the most important factor which affects the absence of discomfort in an enclosed space is the correct combinations of air temperature, humidity, radiation from the surrounding surfaces and movement of the air and its freshness or stuffiness. Thermal comfort is a major issue in the indoor environment. The operative temperature is one of the main parameters that described thermal comfort. In common practice today, the operative temperature is measured and calculated for a location in the shade. Short wave radiation on the body due to the sun is not included. There a method is proposed to include direct solar radiation in the evaluation of thermal comfort.

Solar shading also has an impact of heating, cooling, lighting energy demand common venetian blind shading had strongly directional dependent optical properties. This means that solar and visual transmittance through a shaded façade depend significantly on the façade depend significantly on the façade orientation, the day time and the season in the year. In addition, shading is typically adjustable and or (removable, saying that control is an important issue that may crucially influence that energy performance of a building (Chia, (2004); Jian and Chengwen, (2011)).

Buildings provide a shield from the sun and wind, store heat and increase the temperature outside. They can also create winds and reflect the sun's rays. Buildings constitute fixed screens for their surrounding area. Their role can be positive if protected from the sun is sought. This is the case for traditional Mediterranean town, in which the narrowness of the streets and the height of the buildings considerably reduce direct radiation and provide welcome shade. This role can be negative if the neighbouring buildings mask the sun when solar gain is desired. In the case of a passive solar design, it is important to gauge the impact of this masking effect the nature of a building's surface also influence the microclimate by retaining heat. In an urban setting average temperature are a few degrees higher than average temperature in the open country side (Liérbardand De Herde, 2005).

Building on the land also prevents water from percolating under the ground. Finally, buildings can create paradoxes. They reduce average wind speed at the same time as forcing winds to go around them, thus increasing turbulence. Tall buildings are particularly well known for generating violent gusts at their bases (foot)(Saito, Ishihara, Katayama(1991);Takakura, Kitade, Goto (2000);Santamouris (2007); Srivanit, Hokao, (2013)). The use of reflective materials (glazing) can also influence a building's effective exposure to the sun. A north facing building equipped with large clear glazed windows to make the most of natural light can find itself in a south facing position if the building is built opposite and fitted with reflective glazing specifically to protect it from the sun(Saito, Ishihara, Katayama(1991);Takakura, Kitade, Goto (2000);Santamouris (2007); Srivanit, Hokao, (2013)).

Climatic factors affect user comfort and they can also impair the materials. In the tropics, for example, factors such as intense solar radiation, high humidity and condensation, dust and sandstorms and the salt content of the air affect building materials. For walling materials the comfort implication of heat storage capacity, where they are needed, are secondary to those of privacy, stability, protection and security against house breaking. As a result of this, sandcrete block walling and thin mud walls adobe or wattle and daub is commonly used in various climatic zones. Roofing materials also absorb 65% of solar radiation which increase to 80% with age or when dirty. Similarly asbestos cement roofing sheets absorb as high as 61% at heat, which increase to 83% when old and dirty. Generally, the problem is not what is thermally desirable and efficient, but what is readily available and economically affordable to the people (Wilmers F (1991); Zhang, Lv, Pan (2013);Zhang, XieGd, Gao and , Yang (2014); Venhari,Tenpierik, and Hakak, 2017).

The Influence of Landscape and Vegetation on the Micro Climate

The landscape influences temperature variations, the amount of sunshine as well as cloud phenomena and wind systems. Landscape impacts temperature as much by variations induced by the irradiation of slopes during the day (depending on their orientation and steepness of slope) as by its influence on wind systems. Slopes exposed to the wind are colder than sheltered ones and if the landscape protects some places, it over exposes others. Vegetation provides seasonal shade for buildings, screens them from the wind, cools the air through water loss and filters dust in the atmosphere. Vegetation differs from other elements owing to its potentially seasonal aspect (deciduous plants and due to the fact that its effectiveness depends on the growth of individuals plants. Furthermore, it only offers partial protection. It filters rather than stop the sun. it plants are used to provide shade, the should be deciduous varieties in order to exploit solar gains in the winter season and to progressively shield glazed areas when the spring starts climbing or trailing plants may be used, and those with dense foliage are the best choice in order to provide maximum protection in summer, but with small branches in order to reduce shade to a minimum amount of shade corresponding to almost 50% of the amount in summer.

Trees are also able to filter or retain dust, and to absorb or produce water vapour. A hectare of forest can produce nearly 5,000 tonnes of water per year. With photosynthesis, trees renew the air b producing oxygen. In heavily wooded regions, trees renew the air by producing oxygen; intercepting 60 to 90% at solar radiation, thus preventing an increased in ground temperature. This phenomenon may be permanent or seasonal depending on weather deciduous or evergreen varieties are involved. Conversely, trees reduce night – time radiation backup into the air: the foliage constitutes a 'canopy' for the ground at the foot of the trees and its radiant temperature is greater than that of the sky. The drop in temperature at night is therefore reduced. Moreover, only small variations in ground temperature are observed in wooded regions. A 3.5℃ difference in average temperature can also be observed between a town centre and districts alongside a green belt vary from 50 to 100 meters in width. Horizontal convention from the cold zones (vegetation) towards the warmer zones (neighbouring buildings) enables this cooling effect. Due to this, relative humidity increases by 5%. Finally, vegetation provides protection from strong winds. Hedges, rows of trees, climbing plants all serve to break up the airflow: wind speed is reduced and heat loss from buildings through convection diminishes(Upmanis, Eliasson, Lindqvist, (1998);Vailshery, Jaganmohan, Nagendra, (2013).

Summarily, the use of solar shading devices effectively include reducing glare, reducing overheating, eliminating direct insulation, increasing a window's insulation properties, ensuring occupants privacy or closing off a room., preventing fading of curtain fabrics and decorating windows, walls and roofs.

METHODOLOGY

Data for the study were obtained using both primary and the secondary sources. Primary data were basically from field observation of the physical characteristics and the prevailing conditions carried out within the study area There are six basic parameter s for evaluating shading device performance, namely orientation of building, types of shading device used, types and sizes of the fenestrations, finishing materials, wall materials and effective landscaping. The main campus of University of Jos is located along Bauchi Road in Jos North Local Government Area.

Plate i: Aerial view of Main Campus, University of Jos

Source: Google Earth (2018)

RESULTS AND DISCUSSION

The floor layout of the Multi-Purpose Auditorium is adequately oriented. This is vital as correct site orientation of buildings for thermal efficiency must consider solar radiation and the resultant heat load, direction and force of the wind, and the topography of the site. Shading devices is one of the major elements is building which determines the thermal comfort of the occupants. The Multi-Purpose Auditorium was designed with consideration for shading device. The shading devices utilised are vertical fins and egg – crate screen wall (plates ii to vii) for aesthetics and structural stability. The type of shading device used, egg – crate screen wall is the most effective type for institutional buildings, providing both horizontal and vertical shading at the same time. As a result of this, there is adequate protection from the sun rays for the users of the theatre especially at certain times of the day.

Plate iv shows the fenestration which has a major effect on thermal and visual conditions in perimeter areas of large buildings, like the Multi-Purpose Auditorium, creating a complex challenge in managing time varying lighting, heating cooling and air supply requirements. Performance is a concern in terms of individual perimeter spaces and whole building energy use. The choice of type of material used for the fenestration is very important in any building. This is because some of the materials used for glazing do not reflect back the sun rays hitting there surface but allow it to pass through.

Finishing Materials Wall

Thermal mass is a term used to describe the ability of building materials to store heat (thermal storage capacity). The basic characteristic of materials with thermal mass is their ability to absorb heat, store it and at a later time release it. The use of facing brick on sandcrete block enables adding thermal mass within the insulated building envelope and helps reduce the extremes in temperature experienced inside the home, making the average internal temperature more moderate year round and the home more comfortable to live in.The wall material used in constructing the Multi-Purpose Auditorium is basically hollow sandcrete blocks and reinforced concrete. The both have a high thermal conductivity (high thermal mass). They trap in heat during the day and give it out to the environment when the temperature is reduced.

Effective Landscaping

Landscaping involves the enhancement of the appearance of land, especially around buildings by altering its contours and planting trees, shrubs and flowers. The landscaping of Multi-Purpose Auditorium helps in improving the air quality around a building and ultimately enhancing the thermal comfort of the occupants.

Plate ii: Shading devices Multipurpose Auditorium, University of Jos

Plate iii: University of Jos Auditorium

Plate iv: Windows: Multipurpose Auditorium, University of Jos

Plate v:: Interior Shading; University of Jos Auditorium

Plate vi: Windows: Multipurpose Auditorium, University of Jos

Plate vii:: Interior Shading; University of Jos Auditorium

CONCLUSION

From the research carried out, the findings shows that a wide range of methods can be used in analysing the performance of shading devices in institutional buildings. It further shows that even without software, designers can put in place some measures and design considerations right from the preliminary design stage such as proper building orientation, choice of building materials, effective landscaping, types and sizes of the fenestrations among many other design consideration.

RECOMMENDATIONS

The following recommendations can help designers in putting in place the most effective shading device systems in buildings which will improve the thermal comfort of the occupants of the building and the environment.

1. Architects and other designers should always consider the prevailing climatic conditions of an area before the commencement of the design.
2. There should be proper orientation of building on the site to suit the anticipated function of the building.
3. Materials and sizes of all the fenestration to be used for should be extensively explored taking cognizance of the prevailing weather and climate of that region.
4. Building materials (for walls and floors) ad finishes should be carefully selected to avoid the use of those with high thermal mass (conductivity) in place and period of the year which are not suitable. Materials to be used should be those that maximize the thermal comfort of the occupants all year round.
5. Effective landscaping of building should always be done especially with plant materials such as trees, flowers/hedges and grasses cool the environment and improve the air quality of the environment.
6. Architects should strive to design buildings that are sustainable and highly environmentally friendly irrespective of the type of building or its location.

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