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ENHANCEMENT OF COMFORT IN BUILT ENVIRONMENT: A REVIEW

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ABSTRACT

The primary purpose of building design is the creation of a built environment which is conducive to the well being of the occupants. Comfort can be defined as a state of mind that is satisfied with the terms of the environment. Heat gain through window is major problem for achieving thermal comfort in built environment. This can be achieved either by proper window orientation, choosing proper glazing material or proper window aspect ratio. Aspect ratio is the ratio of the width to the height. Thermal comfort in residential and office buildings received the greatest attention and has a goal to develop a 'comfort zone' or the temperature range in which most of the people feel comfortable. The thermal and visual performance of a building depends upon various building parameters. Thermal property of window glazing is an important parameter for controlling built environment. In the present paper the review for achieving indoor comfort of the built environment has been studied considering the energy conservation.

Keywords: Aspect Ratio, Glass Window, Thermal Comfort, Visual Comfort.

I. INTRODUCTION

Well planned and concerted actions are required for future buildings with a view to develop energy conserving buildings. The buildings which would need minimum of light, minimum of heating/cooling, would depend substantially on natural resources (light and ventilation), and would use materials which would lead to saving of energy and electricity. Window in a typical building accounts for more heat gain than any other building component. Thermal performance of building depends on several parameters such as climatic condition, building location and orientation, size and location of window, shading devices and thermal properties of glazing material. The impact of glazing on thermal comfort of built environment is a mixed performance of all above factors. Western part of India lies in hot climatic zone. Glass windows admit excess solar radiation in building that in turn contributes to increase in cooling load. Institutional and commercial buildings usually have large amount of glass windows installed as the building envelopes. These windows serve as physical and visual connection to outsiders, as well as make the appearance of buildings look more aesthetic. This results in to increased requirement for mechanical cooling in buildings.

II. LITERATURE REVIEW

One of the main characteristics of a building is its thermal indoor climate. The indoor climate should optimally support the activities of the people within the building. Even though several dynamic models exist, the model of Fanger was mainly used in the construction industry as it was convenient in practice. It is a steady state model applicable to situations such as office work. Fanger postulates that a person can be considered dissatisfied if he or she gives a score of -2 or +2 to the thermal indoor climate. Because of physiological variances, different people assess the climate in different ways. This leads, in a particular (calculated) predicted mean vote (PMV), to a wide distribution of individual climate assessment [1].

The above model combines six conventional indexes (air temperature, mean radiant temperature, water vapor pressure, air velocity, occupant's clothing insulation, and metabolic rate) to predict occupant's thermal sensation in a controlled climate chamber [2]. Thermal indoor environment affects a person's comfort condition. Maria L. [3] computed the mean radiant temperature of people in thermal moderate indoor environment in the presence of solar radiation. The effects produced on the amount of solar radiation entering rooms in the presence of shadowing devices were also analyzed. Mean radiant temperature for a non-parallelepiped room equipped with a south window was evaluated. The model facilitated analyzed the thermal behaviour of buildings for the thermal comfort evaluation methods.

Solar radiation entering in to a building can be effectively controlled by orienting the building and locating the windows in proper direction. Orientation of the building generally used to refer to solar orientation which is the facing of building with respect to solar access. Although any building will have different orientations for its different sides, the orientation can refer to a particular room, or to the most important facade of the building. The building orientation can have an impact on heating, lighting and cooling costs.

For most regions, optimum facade orientation is typically south. South-facing glass is relatively easy to shade with an overhang during the summer to minimize solar heat gain. Light shelves also can work well with the higher sun in the southern exposure. North-facing glass receives good daylight but relatively little direct isolation, so heat gain is less of a concern. East and west window orientations and horizontal orientation (skylights) results in more undesired heat gain in the summer than winter. East and west sun glare is also more difficult to control for occupant's comfort because of low sun angles in early morning and late afternoon.

The impact of building orientation on solar heat gain reduction fluctuates with the climate conditions and form of the building. For example, climates that regularly have overcast skies or low levels of direct solar radiation (averaging less than 1,000 W/m^2) may not see an impact from shifting the building orientation. Additionally, surface area ratios play a large part in the effectiveness of the optimal orientation strategy. Buildings that are only one or two stories tall and have the majority of the surface area on the roof will have similar amounts of solar heat gain regardless of orientation. Square buildings that have similar amounts of vertical surface area on all elevations will also fail to see an impact from changes in orientation [4].

A careful choice of orientation and size of window provides more thermal comfort especially in hot climate. Further, properly oriented windows minimize the dependency on artificial lighting. Incident solar radiation on the glass window enters as transmittance and absorptance. The transmitted radiation becomes instantaneous room heat gain while the absorbed radiation in the glass window becomes the delayed heat gain. In hot climate,

for most of the glass window without film (clear and tinted glass) values of predicted percentage of dissatisfied (PPD) due to solar radiation effect were larger than the values of PPD due to surface temperature effect [5].
Sufficient illumination inside the building is also a major parameter in occupants comfort in built environment. Illumination primarily depends on building orientation, types of windows and type of glass [6]. Reduction in heat gain through reflecting glass increases need for internal lighting [7].
Selection of efficient glazing for window depends on several parameters. The coefficient of heat gain due to incident solar radiation is an important index for ranking glass window. The performance of glass facades has an impact upon energy consumption and indoor environment comfort. In a study carried out in Taiwan an actual lobby in a tourist service center was used for parametric analysis. It was found that thermal comfort in the investigated lobby was not only affected by long-wave radiation from isothermal surfaces but also by beam and diffuse solar radiation falling on the human body. The impact of eight different types of glazing, four different glazing areas and five different types of overhang on occupants' thermal comfort were investigated in terms of the occurrence of discomfort and severity of overheating. Study demonstrated that the glazing type, window areas and shading devices effectively contribute to the thermal comfort in hot and humid climate region [8].
In most climates any effort to ensure thermal comfort by passive means would reduce the active control requirements. One of the most significant technologies for energy savings in a building is the facade. There are two major components of comfort in built environment, first incident solar radiation on building facade and second natural ventilation (NV). Properly designed double-skin facade building not only supports the passive heating strategy in the cold period of the year but also enhances natural ventilation (NV) in the building. Use of ventilation shaft combined with ventilated windows reduces the entry of solar heat gain into the building, thereby reducing peak cooling load [9].

III. CONCLUSIONS

1. Comfort of built environment depends on several parameters such as climatic condition, building location and orientation, size, location, glazing material and aspect ratio of window.
2. Keeping all other factors constant window glazing plays an important role in heat gain in built environment.
3. The functional parameters that significantly impact the comfort in the building have been identified as indoor temperature and light.

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