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Passive Cooling by Shading Devices in High Rise Buildings in Tropical Climate

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***Abstract*—The importance of this paper is providing fundamental statistics for rational and outdoors shading planning, whilst designing high rise and residential buildings, shading gadgets additionally lessen the excessive use of cooling energy, lights. One of a kind techniques are been used to improve indoor thermal surroundings, using a most advantageous shading device to reduce sun absorption within the indoor environment.**

This paper explains distinctive cooling and electricity savings with the help of shading gadgets on façade glazing with exclusive configurations for thermal performance. Glazed façade on high rise building are generally the norm, this paper looked into how shading devices on high upward push buildings have a tendency to reduce sun radiation thinking about a tropical area like India.

***Index Terms*—Daylight, Exterior shading device, Glazing, Passive low energy, Sustainability, Thermal comfort.**

I. Introduction

High rise buildings commonly require shading devices to reduce the amount of power needed for cooling. The usage of solar manage and shading devices is a vital element of many energy-green building techniques. The principle purpose of introducing shading gadgets in high rise buildings is to create a relaxed inner surroundings that is cool in the summer time and warm in the winter.

Nicely-designed solar manage and shading devices can dramatically lessen building peak warmness gain and cooling necessities and improve the herbal lighting quality of constructing interiors. Depending on the quantity and area of fenestration, discounts in annual cooling electricity intake of 5% to 15% had been reported. Shading devices offer the possibility of differentiating one constructing facade from another façade.

The most effective method to cool a building in summer is to keep the heat from building up in the first place. The most important passive cooling strategy, regardless of mass, is shading. Shading is a simple method to block the sun before it can get into the building. Shading can reduce the peak-cooling load in buildings, thus reducing the size of the air conditioning equipment that will run fewer hours and consume less energy. Shading minimizes the incident solar radiation and cools the building effectively and hence dramatically affect building energy performance. In this paper different methods that can be employed to shade the buildings, which provides natural cooling and finally helps in energy conservation in buildings have been discussed.

II. Importance of Shading Devices in High Rise Buildings in Tropics

The aim of putting shading devices in a building is to maintain a comfortable indoor temperature. It reduces heat gain and Improves the natural lighting quality of building interiors. Trees Planted serve as shading devices and beautifies landscape and provides oxygen to the occupants. Internal shading devices also help to create a sense of privacy. The easiest way to reduce the energy required to cool a building is to avoid heat gain.

Advantages of shading devices in high rise building in the tropics:

Sun shading devices reduces glare, it also reduces cooling load, and there is limited reduction of daylight.

Disadvantages of shading devices in high rise building in the tropics:

Shading devices obstruct part of views in a building, some shading devices tend to disorient facades.

III. Differentiated Facade Treatment

The solar geometry explains that the publicity of each facade to the sun is specific, and varies through orientation. each façade calls for distinctive technique of shading the north elevation (in the northern hemisphere) does no longer require shading because except in the summer time months within the morning and night-time, no solar penetration takes place. Whilst solar shading devices are set up it might of vain. It's far pleasant to restrict as a whole lot as feasible fenestration on the north elevation as there will be little or no solar warmth benefit and lots direct warmth loss from this facet. If fenestration is needed for day lighting fixtures, then it's important to pick a fairly green glazing assembly to lessen strength transfer.

The south elevation permits for the perfect control of sun strength. Shading devices are generally designed as horizontal projections above the windows, the length of the projection is decided as a geometric function of the height of the window and the attitude of elevation of the solar at sun noon. Such shading devices may be designed to absolutely get rid of sun penetration in the summer time and allow for complete solar penetration

throughout the winter whilst such is favored for passive heat benefit.

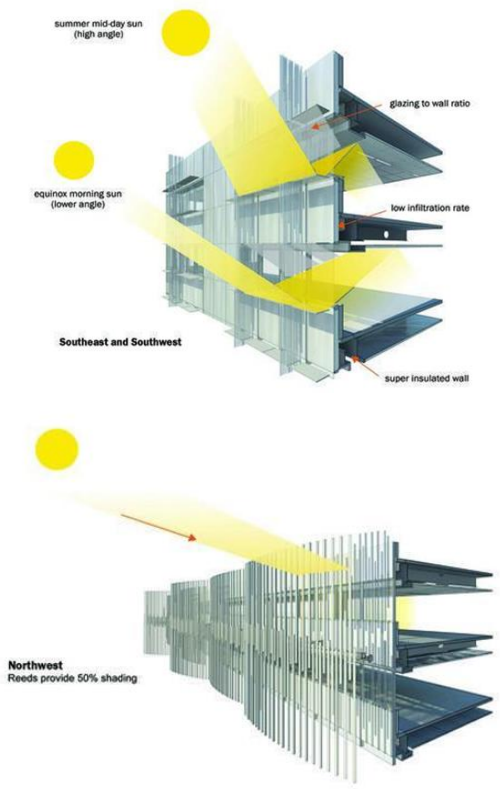

Fig. 1. Shading devices mounted on southeast and southwest to provide 50% shading (Google image)

Things to be considered when designing Shading Devices:

There are basically different types of shading devices that can be integrated into a building so before taking any decision designers, Engineers ,architects need to take this highlighted points into consideration:

1. Understand the sun path of the environment
2. Select the shading type-Horizontal,- Vertical, - Egg crate
3. Identify category-Fixed shading devices, -Adjustable shading device,-Movable shading, device-Dynamic shading, device-Automatic shading device.
4. Calculate the design dimensions -To understand horizontal and vertical shadow angles

IV. Shading of Buildings

The performance of solar passive cooling techniques such as solar shading, insulation of building components and air exchange rate was evaluated. In the study a decrease in the indoor temperature by about 2.5°C to 4.5°C is noticed for solar shading. Results modified with insulation and controlled air exchange rate showed a further decrease of 4.4°Cto 6.8°C in room temperature. The analysis suggested that solar shading is quite useful to development of passive cooling system to maintain indoor room air temperature lower than the conventional building without shade. Although shading of the whole building is beneficial, shading of the window is crucial. The total solar load consists of three components; direct, diffuse and reflected radiation. To prevent passive solar heating, when it is not wanted, a window must always be shaded from the direct solar component and often so from the diffuse and reflected components. Decisions on where and when to include shading can greatly affect the comfort level inside a closed space. Shading from the effects of direct solar radiation can be achieved in many ways:

- Shade provided by the effect of recesses in the external envelope of the building.
- Shade provided by static or moveable external blinds or louvers.
- Transient shading provided by the orientation of the building on one or more of its external walls.
- Permanent or transient shading provided by the surrounding buildings, screens or vegetation.
- Shading of roofs by rolling reflective canvass, earthen pots, vegetation etc.

The different criteria of shading of buildings for various climatic zones have been given by Bansal. They are given in the following Table-1.

TABLE I
Criteria of Shading for Various Climatic Zones
(Bansal et. al. 1988)

Climatic zones	**Requirements**
Hot and Dry	Complete year round shading
Warm and humid	Complete year round shading, but design should be made such that ventilation is not affected
Temperate	Complete year round shading but only during major sunshine hours
Cold and cloudy	No shading
Cold and sunny	Shading during summer months only
Composite	Shading during summer months only

Shading by overhangs, louvers and awnings etc.

Well-designed sun control and shading devices, either as parts of a building or separately placed from a building facade, can dramatically reduce building peak heat gain and cooling requirements and improve the natural lighting quality of building interiors (Fig. 1). The design of effective shading devices will depend on the solar orientation of a particular building facade. For example, simple fixed overhangs are very effective at shading south-facing windows in the summer when sun angles are high. However, the same horizontal device is ineffective at blocking low afternoon sun from entering west-facing windows during peak heat gain periods in the summer. The shading devices can be classified as given below:

a) Movable opaque: Roller blind curtains, awnings etc. reduce solar gains but impede air movement and block the view.
b) Louvers: They are adjustable or can be fixed. To a

certain extent impede air movement and provide shade to the building from the solar radiation.

c) Fixed: Overhangs of chajjas provide protection to the wall and openings against sun and rain.

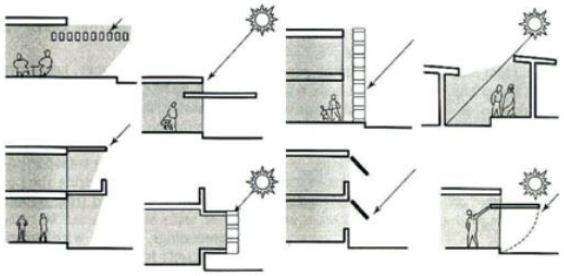

Fig. 2. Different types of shading devices (Google image)

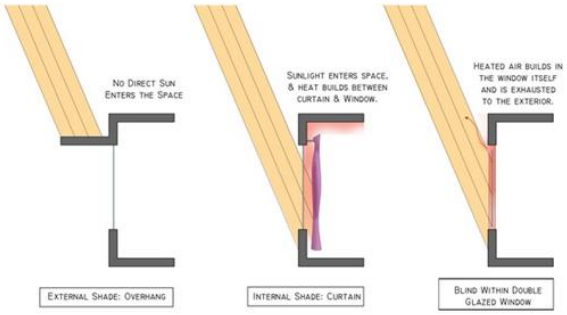

Fig. 3. Different types of shading devices (Google image)

A. Design Recommendation for Shading Devices

Given the wide variety of buildings and the range of climates in which they can be found, it is difficult to generalize the design of shading devices. However, the following design recommendations generally hold true:

- Study of the sun angles is important for designing the shading devices. An understanding of sun angles is critical to various aspects of design including determining basic building orientation and selecting shading devices.
- Fixed shading devices, using correctly sized overhangs or porches, or design the building to be "self-shading" should be installed. Fixed shading devices, which are designed into a building, will shade windows throughout the solar cycle. Permanent sun shades may be built into the building form and this is often given the French terminology of - brise soleil (Fig. 4). They are most effective on the south-facing windows. Awnings that can be extended or removed can also be considered for shading the windows. The depth and position of fixed shading devices must be carefully engineered to allow the sun to penetrate only during predetermined times of the year. In the winter, overhangs allow the low winter sun to enter south facing windows. In the summer, the overhangs block the higher sun.

Fig. 4. Brise soleil – shading devices integrated with the building façade

- Limit east/west glass. Glass on these exposures is harder to shade from the eastern morning sun or western evening sun. Vertical or egg-crate fixed shading works well if the shading projections are fairly deep or close together; however, these may limit views. The use of landscaping can also be considered to shade east and west exposures. North-facing glass receives little direct solar gain, but does provide diffuse daylight.
- In hot and dry climates, the movable blinds help to reduce the convective heat gain caused by the hot ambient air. In warm and humid climates where the airflow is desirable, they impede ventilation. In composite climates, the light colored/ reflective blinds block the solar radiation effectively.
- Internal shading, in the form of blinds or curtains, is often used to block the unwanted solar gains coming through a window. The effectiveness of any shading device located inside the window is a function of how well it reflects short wave radiation back out through the glass. Darker blinds or curtains may reduce solar penetration into the space and may be helpful, but not as effective as exterior shading because it still convert most of the sunlight into heat within the building envelope since heat has already penetrated the building .
- Any shading device will affect the view out of a window and this maybe a crucial factor in favoring one form of shading over another form. If shading devices are used, they will have a major, if not an overwhelming affect upon the external appearance of a building, and therefore they need to be considered at the outset if they are to be used.

V. CONCLUSION

Different shading techniques can be employed to shade the building, which minimize the incident solar radiation and cool the building effectively and hence affect building energy performance. Using any or all of these strategies will help to keep the building cool. Sometimes we need to supplement

natural cooling with mechanical devices. Fans and evaporative coolers can supplement our cooling strategies and cost less to install and run the air conditioners. Shading reduces the peak cooling load in buildings, thus reducing the size of the air conditioning equipment that will run fewer hours and consume less energy. Incorporation of such techniques would certainly reduce our dependency on artificial means for thermal comfort and minimize the environmental problems due to excessive consumption of energy and other natural resources. Solar shading can help to reduce cooling energy consumption and improve indoor thermal environment. Appropriate shading design not only achieves higher energy efficiency, but also reduces incremental costs. This paper provides suggestions for solar shading designs for both residential and commercial buildings by comparison of the incremental costs. These results help architects optimize the building design with suitable solar shading devices. So it is necessary:

- Shading devices should be able to moderate or control direct, diffuse and reflected solar radiation, and glare, whilst ensuring that day lighting and natural ventilation are not excessively reduced.
- Shading devices may be designed to protect opaque as well as transparent surfaces.
- Shading devices that both protect against solar radiation and redistribute daylight can reduce cooling loads and the use of artificial lighting.
- For visual comfort, good daylight distribution is important.
- Fixed shading devices are effective in excluding summer sun but admit low angled winter sun. They can reduce internal luminance in cloudy conditions. They give minimal control of diffuse and reflected light.
- Internal shading devices should be considered in terms of day lighting and glare control, since they can control diffuse and reflected light.
- External adjustable shading can provide shading without reducing internal light levels, and is effective in controlling low angled direct sunlight, diffuse and reflected light, and glare. It must be robust enough to resist wind damage.
- Retractable shading devices may reduce ventilation when deployed to provide full shading during the cooling season.
- Mid-pane shading devices provide effective glare control, and are protected from weathering.
- Vegetation can shade whole facades and roofs, reducing conductive as well as radiative heat gains. Evergreen species can be used to reduce reflection from water bodies, roads, paved areas and buildings.
- The shading effect of vegetation depends strongly on the type, the species, and the age of the plant.
- Advanced glazing should not normally be considered as a complete shading solution, but can improve a building's shading performance when used in conjunction with other devices. Window films are highly applicable in a retrofit situation.
- Simple shading devices, correctly designed, are often as effective as hi-tech systems.

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