ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

# Shading Devices in High Rise Buildings in the Tropics

[1]Mustapha Adamu Kaita , [2]Dr.Halil Alibaba

[1]Mustapha Adamu Kaita is currently pursuing M.arch program at eastern Mediterranean university northern Cyprus, turkey
[2]Asst.Prof.Dr. Halil Ali Baba is currently a full time lecturer at Eastern Mediterranean University Northern Cyprus, Turkey

***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, and also the use of a reflective glazing system to reduce sun absorption within the indoor environment. High rise buildings with large glazed façade face a fantastic over heating hassle because of solar radiation.**

**This paper explains distinctive cooling electricity savings while shading gadgets are applied on façade glazing with exclusive configurations and 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 Malaysia, and Singapore as a case study .take a look at, and concerning buildings decided on in Malaysia the overall studies has a tendency to show that shading devices are the most green passive cooling layout approach to help control sun radiation in excessive upward thrust buildings located in the tropics.**

***Keywords:*** **daylight, Exterior shading device, glazing, passive low energy, sustainability, thermal comfort.**

## 1. INTRODUCTION

High rise buildings commonly require shading devices to reduce the amount of power needed for cooling. Excessive upward thrust buildings are actually uncovered to sunlight and it's far important to have the ability to manipulate the amount of daylight admitted into a building, moreover controlling and diffusing herbal illumination will enhance day lights. 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. Sun manipulate and shading gadgets can also enhance user visual comfort by controlling glare and lowering comparison ratios. This regularly leads to accelerated delight and productiveness. Shading devices offer the possibility of differentiating one constructing facade from another façade,

Shading devices is pretty advocated for homes in hot–humid vicinity [1] Stewart (1977) and [2] Yeang (1987). Numerous studies had been conducted on shading devices regarding the effects of sun radiation

Efforts are made for modern-day buildings to maximize both esthetic results of outside façade and sustainable buildings, shading gadgets are taken into consideration very critical with recognize to eco-friendly area creation building.

homes in hot humid climates consume up to 40% of total electricity globally (Hassan et al.2014.the motive at the back of this is because commercial homes within the tropics are often hooked up with air-conditioning and mechanical ventilation to hold and beautify thermal consolation .those systems consume the most strength amongst all building offerings.(kwon.et.al.2014)

**Table 1. Statistics of electricity use in Malaysia, 2013**

| Sector | Consumption coverage, % |
|---|---|
| Agriculture | 0.3 |
| Commercial | 32.7 |
| Industrial | 45.4 |
| Residential | 21.4 |
| Transport | 0.2 |

*Source: Energy Commission Malaysia, 2013.Fig 1: statistic table*

There are many reasons why shading devices are required in high rise buildings, this leads to a **RESEARCH QUESTION:**

Is the application of shading devices on high rise buildings in the tropics the most efficient passive cooling design strategy?

## 2. LITERATURE REVIEW

### 2.1 Problem statement:

High rise buildings consume more energy than any other sector, 76% of building energy comes from fossil fuel, high rise buildings located in the tropics that lack shading devices tend to have a high risk of increase in cooling loads, and consequently heating up the indoor environment .furthermore the introduction of shading devices and reflected glazed façade tend to reduce high load of cooling down the building..

### 2.2 Aim:

This paper looked into how various shading devices can actually be integrated into high rise buildings be it an office building or a residential condominium in the tropics to improve the indoor thermal environment.

### 2.3Methodology:

Literature reviews that have been published and also articles on shading devices, and the effects of cooling load on buildings served as the basis of this research paper.

### 2.4 Scope:

Basically the scope of this research focused on the use of shading devices on high rise buildings to improve thermal comfort in the tropics.

## 3. IMPORTANCE OF SHADING DEVICES IN HIGH RISE BUILDINGS IN THE 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 Trees when used as shading devices can beautify landscape and provide oxygen, internal shading devices tend to create a sense of privacy.

### 3.1 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.

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

**3.2 Disadvantages of shading devices in high rise buildings in the tropics:**

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

**3.3 Differentiated Façade 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 favoured for passive heat benefit.

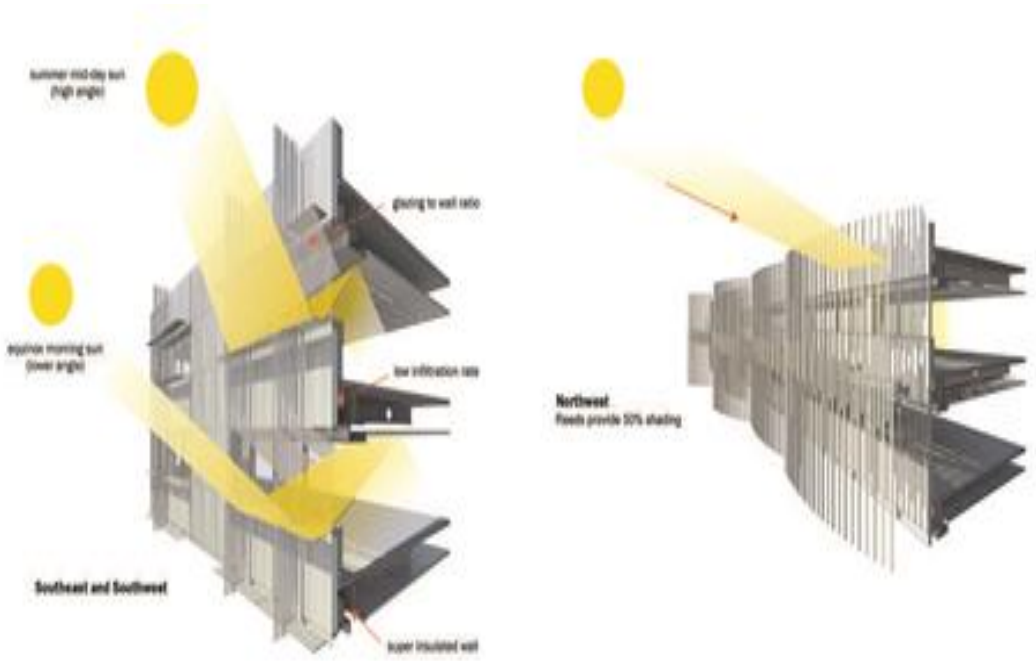


**Fig 1: shading devices mounted on southeast and southwest to provide 50% shading (Google image)**

**3.4 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 rate 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

**3.5 Materials used for Shading Devices:**

Many different materials may be used for the shading devices depending on the performance and appearance required. Typical materials used include;

-Metals (solid and perforated), Timber,-Glass (coated/tinted, fritted, sand blasted, photovoltaic

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

### *3.5.1 Aluminium and stainless steel sun shading devices:*

Solar shading device preserve your building making it cool and relaxed whilst giving a sleek and present day appearance. These low upkeep aluminium sunscreens permit diffuse natural daylight in at the same time as preserving out the heat. Sunshades remove the want for window treatments such as blinds, tinting, or curtains.

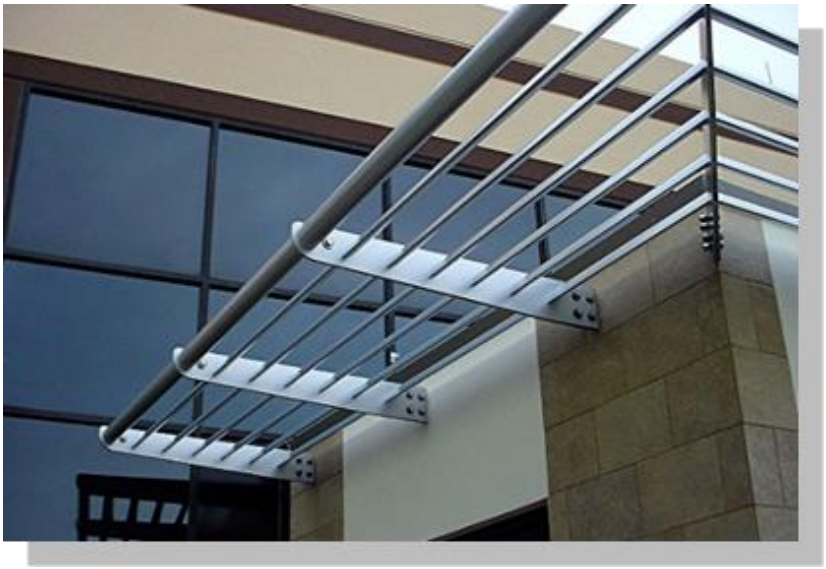

**Fig :2 Aluminium sun shading device on a building(google image)**

### *3.5.2 Timber Shading Device:*

Timber wood has been traditionally used for many forms of solar shading and this is because of its versatility, ease of work and easy maintenance. Basically the main aim why designers choose wood for shading device is because of its appearance .the main purpose of wood as solar shading device is to regulate sun's rays in the building interior.

**Fig 3: vertical wooden fins attached to curved building face Langley academy (Patrick Hislop & Philip O'Leary).**

### *3.5.3 Use of photovoltaics as sun shading device:*

Photovoltaics can also be used as shading devices to control natural daylight in a building and at the same time producing electricity.it can be integrated into building shading devices phovoltaics panels can readily replace timber or plastic

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

lovres(robert and guariento,2009)there are basically two types of photovoltaics shading systems which are movable and movable fixed element.fixed photovoltaics is more expensive because it is automated as such needs a lot of mechanical power.

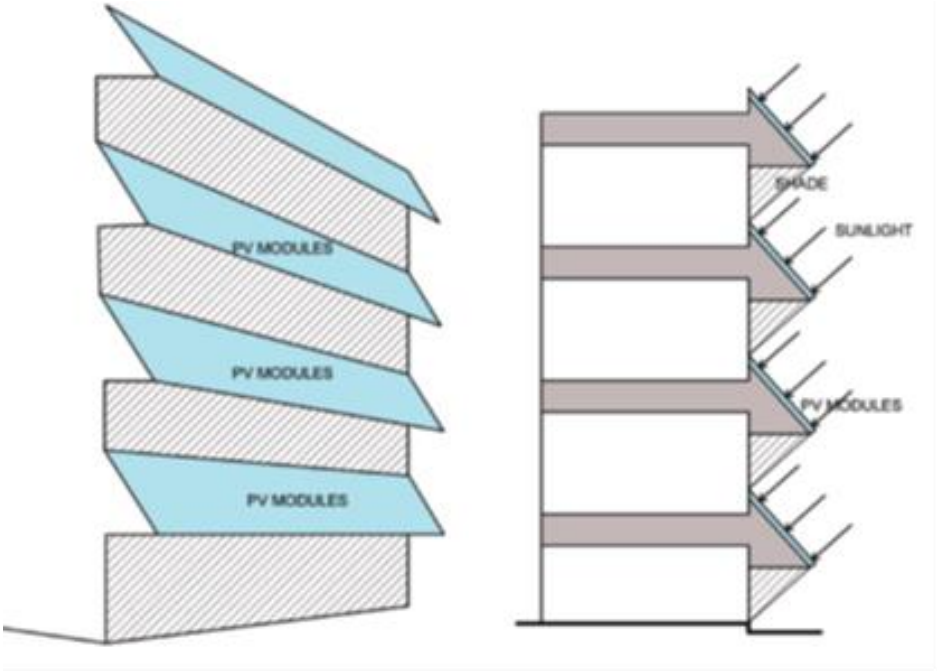


**Fig :4 Saw-Tooth PV Facade Consisting of Overhanging PV Shade Screens (Jahanara 2013)**

## 4. CASE STUDY

### 4.1 National library, Singapore:

The building was designed by a renowned Malaysian green architect, Dato Kenneth yeang, using shading devices efficiently on the west façade to help reduce solar radiation thus enhancing indoor comfort .it is iconic because of its sustainable design (eco-friendly).shading devices uniformly placed on the façade it was opened in 2005 located in the tropical climate of Singapore.

**Fig 5: National library Singapore (Arch daily image)**

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

**Fig 6: close up view national library Singapore (Google image)**

### 4.2 Menara Kuala Lumpur:

Menara prudential is a building located in the heart of Kuala Lumpur which attempts to implement sun shading devices as green building approach. Taking natural light as an advantage to reduce electrical lighting consumption, it's not an easy task to control direct solar radiation from the sun penetrating into buildings, it's normally very hot and comes with glare which is the major problem. Which as a result of that the designers attempted to design a sustainable building. The designers of menara prudential attempted to reduce the amount of glare from daylight through various designs of shading devices in hot humid climate of Malaysia.

**Fig 7: menara prudential Kuala Lumpur one of new high rise buildings which attempt to implement sun shading devices as eco-friendly design approach**

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

**Fig 8: shading devices extruding out from the building diffusing sunlight before penetrating the building. (Google image)**

### 4.3 CLIMATIC ANALYSIS:

#### *4.3.1 Climate of Kuala Lumpur Malaysia:*

Malaysia is located in the equatorial region situated in south east Asia and has a tropical rainforest climate, situated near the equator Malaysia climate is categorized as equatorial, being hot and humid throughout the year the average rainfall is 250 centimetres in a year and average temperature is 27 c (80.6)f. local climates are affected by the presence of mountains ranges throughout Malaysia the coasts have a sunny climate temp ranges between 23 & 32

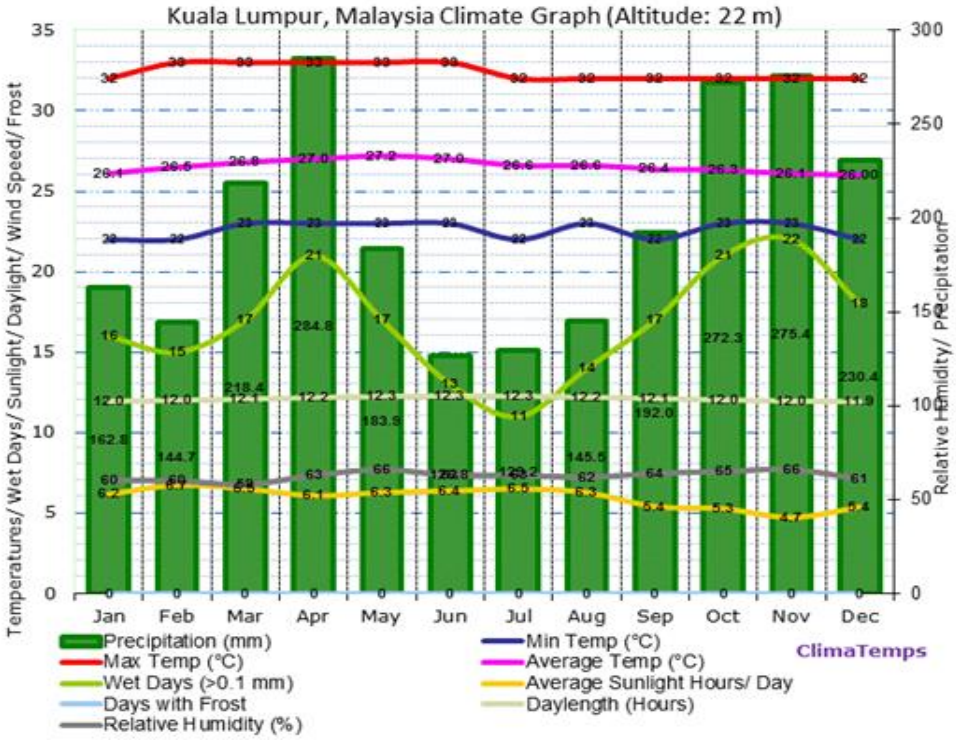


**Fig 9 :climate graph of kuala lumpur no dy or wet season throughout the year.**

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

### *4.3.2 Climate of Singapore:*

Singapore is located north of the equator and has a tropical climate it stays hot and humid throughout the year. Temperature averages 31 Celsius with a minimum of 25c and maximum of 37c with little seasonal variation, although it's slightly cooler December and January and extremely hot in April and May. Owing to its geographical location and maritime exposure .its characterized by uniform temperature and pressure high humidity and abundant rainfall.

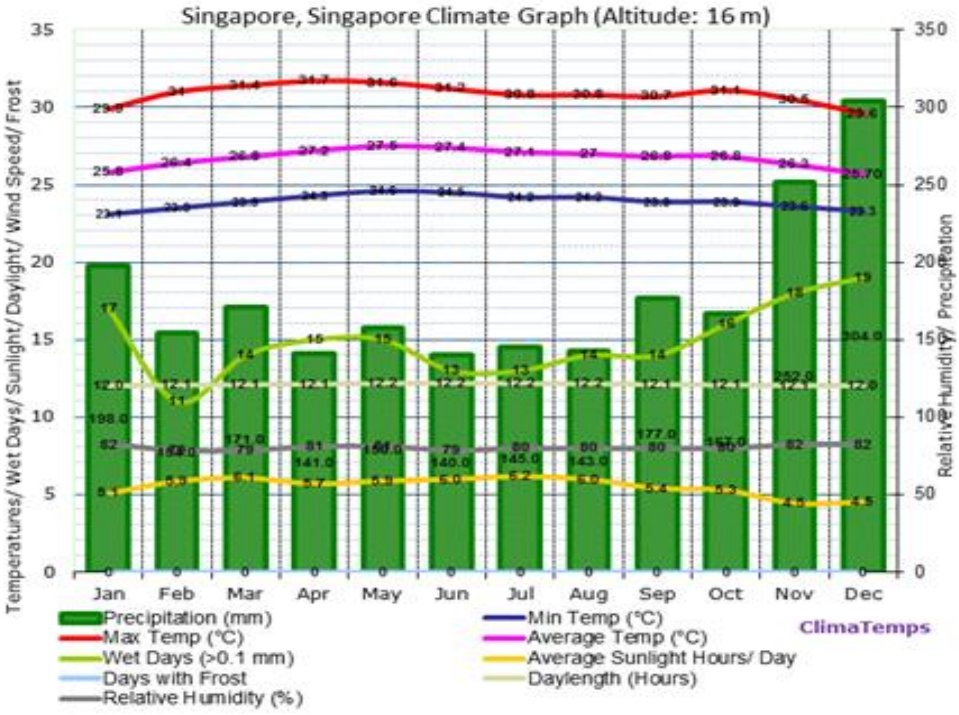


**Fig: 10 climate graph of Singapore, a tropical wet climate constantly moist.**

## 5. FINDINGS AND DISCUSSIONS

In the first case study ken yeang a Malaysian architect made an effort towards an approach in sustainability in the tropics, he was given the chance to impart his mark of sustainability in the tropical region due to intense hot climate of the region ken yeang oriented the building from east-west axis to avoid exposure of afternoon sun while the south west side has a permanent wall preventing direct sun radiation into indoor environment.

The designers fitted a sun shading blades onto the building's façade to help prevent glare and heat due to hot humid climate of the region. And on the other side sun shaded glass panels were installed to let in natural light. Hence minimizing the use of artificial lighting during work hours.

Inside the building interior the designers planted 120 species of tropical plants which help in regulating daytime temperature inside the building. The building is incorporated with smart technology systems .the rain sensors reduce amount of water that goes into irrigation systems for indoor gardens. Light sensors switch off if there is sufficient day lighting inside the building and also motion sensors have been installed to function only when they are needed .air conditioning system is adjusted so often in the building maintaining a decent indoor temperature.

Taking into consideration of green materials and also ken yeangs dream to reduce the impacts of buildings materials on natural environment. The building has achieved up to 31% in energy savings compared to other non-green building of its size .natural library Singapore is keenly done sustainable building that help towards environmentally low-impact design.

The second case study is located within the coronary heart of Kuala Lumpur it was an evaluation on glare from daylight via diverse designs of shading devices in warm humid weather. present day homes in Malaysia typically use large glass home windows, with much less or no-shading gadgets applied on facades that are especially for cultured cause. Many new buildings within the tropics are constructed in this sort of manner that there is considerable daylight hours in the interior

ISSN 2393-8471

International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)
Vol. 3, Issue 2, pp: (37-46), Month: October 2016 – March 2017, Available at: www.paperpublications.org

space and on the same time preventing glare by means of using sun shading device the simple idea is to clear out bright daytime from out of doors for visible comfort. Architects and designers came up with the answer of shading gadgets on façade to help clear up heat benefit in buildings and discount of strength for lights and cooling down the building against solar radiation.

**Fig: 11 window without shading device allowing sun rays and glare into building interior (Google image)**

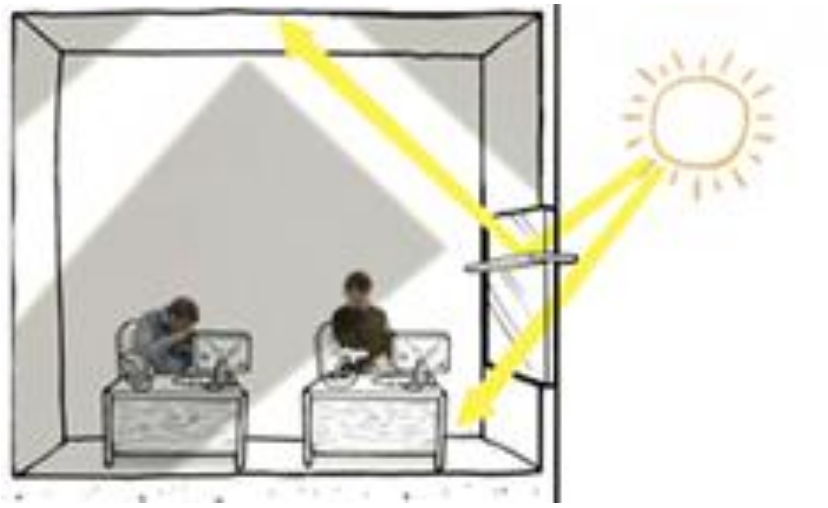

**Fig: 12 window with horizontal sun shading device diffusing daylight and preventing the effect of glare in the indoor environment hence improving thermal comfort. (Google image)**

## 6. RESULTS AND ANALYSIS

The importance of this study is mainly visual comfort due to daylight filtered by shading devices. The definition of visual comfort is the amount of light on a surface furthermore ensuring that people have enough light for their activities.

Study by Azni indicates that the light shelf with sloped overhang performs the best in reducing daylight factor (DF) and glare near windows .however field measurement of office buildings with shading devices in Kuala Lumpur conducted by Zurian et al. (2003) indicates that sloped overhang produced glare at windows.

Glare happen when there is an excessive amount of light coming directly from a source, reflected from a glossy surface, studies addressing glare are common. Questions in relation to glare from daylight remain unknown and unresolved (boubekri and boyer 1992).sufficient amount of illuminance does not necessarily means good lighting however the quality or suitability of lighting must be considered (szokolay 1980).

The need for the use of external shading devices is considered the most effective than the internal ones Givoni, (1976)

## 7. CONCLUSION

Shading devices have filtered the illuminance coming from outside extensively. Glare can be seen through every shading device. The vertical shading devices are the most suitable to reduce glare, while the egg rate shading device is considered the least suitable. This shows that all shading devices can be applied in hot humid climate such as Malaysia the vertical is particularly the most preferable by the occupants.

This paper technically shows that if the appropriate shading device is used on a high rise building it will drastically reduce high consumption of energy needed for cooling and lighting, and also the reduction of glare to the occupants due to daylight hence improving thermal comfort .which results to an eco-friendly or sustainable design. That help towards an environmentally low impact design. Furthermore the application of shading devices on high rise buildings should be considered to solve the issues bothering inhabitants and designers for decades, e.g. glare. The design strategy is sustainable and has low impact to the environment.

## REFERENCES

[1] Al-Tamimi, N. A., & Fadzil, S. F. S. (2011). The potential of shading devices for temperature reduction in high-rise residential Buildings in the tropics.procedia engineering, 21,273-282.

[2] Van Moeseke, G., Bruyère, I., & De Herde, A. (2007). Impact Of control rules on the efficiency of shading devices and free cooling for office buildings.building environment, 42(2)784-793

[3] Denan, Z., & Majid, N. H. A. (2015). An Assessment on Glare from Daylight through Various Designs of Shading Devices in Hot Humid Climate, Case Study in Kuala Lumpur, Malaysia. International Journal of Engineering and Technology, 7(1), 25.

[4] Daylighting by Greg D.Ander, FAIA https://www.wbdg.org/resources/daylighting

[5] Yeang, K. (2007). 4 green design in the hot humid tropical zone.

[6] Patrick Hislop with Philip O'leary, External solar shading with wood http://www.trada.co.uk/downloads/publications/Externalsolarshading.pdf .

[7] Konya, A. (2013). Design primer for hot climates. Elsevier.

[8] Ogunyemi, O. A., Fadeyi, A. A., & Alabi, S. A. (2015). External Shading Design Strategies within the Tropical-Modernist Nigeria: Lessons for Nigerian Designers. International Journal of Innovative Research and Development|| ISSN 2278–0211.

[9] Shaw, John H, Solar Radiation .Ohio journal of science http://hdl.handle.net/1811/4066

[10] Duarte, R., Leandro, S. O., Teixeira, A. R., & Bigode, C. (2005). Glazing-related problems due to high temperatures in double, skin façades.

[11] Chirarattananon, S., Rugkwamsuk, P., & Matuampunwong, D. (2010). Optimizing Benefits of Multiple-Slat Shading Device and High Performance Glazing on High-Rise Buildings. Journal of Sustainable Energy & Environment, 1(4).

[12] Don Powler, FAIA, joseph bourg.sun control and shading devices https://www.wbdg.org/resources/sun-control-and-shading-devices

[13] Lau, A. K. K., Salleh, E., Lim, C. H., & Sulaiman, M. Y. (2016). Potential of shading devices and glazing configurations on cooling energy savings for high-rise office buildings in hot-humid climates: The case of Malaysia. International Journal of Sustainable Built Environment.

[14] Kuala Lumpur climate analysis https://www.timeanddate.com/weather/malaysia/kuala-lumpur

[15] Lam, J.C. and D.H.W. Li, An analysis of daylighting and solar heat for cooling-dominated office buildings. Solar Energy 1999; 65(4): 251-262.

[16] Le Roux H., (2003).The Networks of Tropical Architecture. Journal of Architecture.