Investigating the Effectiveness of Self-Shading Strategy on Overall Thermal Transfer Value and Window Size in High Rise Buildings

Mansour Nikpour, Mohd Zin kandar, Mohammad Ghomeshi, Nima Moeinzadeh, Mohsen Ghasemi

Abstract—So much energy is used in high rise buildings to fulfill the basic needs of users such as lighting and thermal comfort. Malaysia has hot and humid climate, buildings especially high rise buildings receive unnecessary solar radiation that cause more solar heat gain. Energy use specially electricity consumption in high rise buildings has increased. There have been growing concerns about energy consumption and its effect on environment. Building, energy and the environment are important issues that the designers should consider to them. Self protected form is one of possible ways against the impact of solar radiation in high rise buildings. The Energy performance of building envelopes was investigated in term of the Overall Thermal Transfer Value (***OTTV***).In this paper, the amount of ***OTTV*** reduction was calculated through ***OTTV*** Equations to clear the effectiveness of self shading strategy on minimizing energy consumption for cooling interior spaces in high rise buildings which has considerable envelope areas against solar radiation. Also increasing the optimum window area was investigated using self-shading strategy in designing high rise buildings. As result, the significant reduction in ***OTTV*** was shown based on WWR.In addition slight increase was demonstrated in ***WWR*** that can influence on visible comfort interior spaces.

Keywords—Self-shading strategy, high rise buildings, Overall thermal transfer value (*OTTV*), Window to wall ratio (*WWR*).

I. INTRODUCTION

ENERGY performance of the building envelopes was investigated in terms of the overall thermal transfer value ($OTTV$). Window area was represented by the window-to-wall ratio (WWR), defined as the ratio of the total area of windows to the overall gross external walls area. The main cooling load component is solar heat and the design of variables affecting on the building envelope which are shading coefficient and window area [1].

The $OTTV$ is basically a measure of the heat transfer from outside to the indoor environment through external envelope of a building. Solar heat gain through fenestration is considered as the largest provider to building envelope cooling load and the most important parameter for $OTTV$ determinations [2].

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One way to reduce electricity consumption would be to limit heat gain into the buildings, and hence reduce the demand for air-conditioning during hot summer months. Key factors affecting heat gain through building envelopes into the buildings, are building orientation, exterior wall area and its construction type (i.e. thermal insulation and U-value) and surface finish (wall absorption coefficient), window area, glass type (U-value and shading coefficient), external shading, and roof area and its construction details [1].

One way to reduce the cooling requirement would be to have more energy-efficient building envelope (walls, windows and the roof) designs so that the amount of heat gains coming into the building interior could be limited.

A. Overall Thermal Transfer Value ($OTTV$) According to ASHRAE 90A- 1980.

The $OTTV$ concept was introduced in the ASHRAE Standard 90A- 1980. $OTTV$ shows the average heat gain through the building envelope. Smaller $OTTV$ cause less energy consumption for cooling. Three components of the heat gain are considered, namely conduction through an opaque surface, conduction through glass window and solar radiation through glass window. The general $OTTV$ equation can be expressed as [3].

$$OTTV_i = (Q_w + Q_g + Q_s)/A_i = [(A_w \times U_w \times TD_eq) + (A_f \times U_f \times DT) + (A_f \times SC \times SF)]/A_i$$

A_f is the area of fenestration (m^2);
A_i, the gross area of the walls (m^2) $= A_w + A_f$;
A_w, the area of opaque wall (m^2);
DT, the temperature difference between exterior and interior design conditions (C);
Q_g, the heat conduction through glass windows (W);
Q_s, the solar radiation through glass windows (W);
Q_w, the heat conduction through opaque walls (W);
SC, the shading coefficient (dimensionless);
SF, the solar factor ($W/m2$);
TD_eq, the equivalent temperature difference (C);
U_f, the U-value of fenestration ($W/m2K$);
U_w, the U-value of opaque wall ($W/m2K$).
This equation can be expressed in terms of window-to-wall ratio, WWR. Thus

$$OTTV_i = [(1 - WWR) \times TD_eq \times U_w] + [(WWR) \times DT \times (U_f)] + [(WWR) \times SC \times SF]$$

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Where, WWR is the ratio of window area to gross wall $area = A_f/A_i$. As walls at different orientations receive different amounts of solar radiation, the general procedure is to calculate the $OTTV_s$ of individual walls with the same orientation and construction first

$$OTTV_{wall} = [A_1 \times OTTV_1 + A_2 \times OTTV_2 + ... + A_n \times OTTV_n]/A_t w$$
Where,

$OTTV_{wall}$ is the $OTTV$ of the whole exterior wall (W/m^2) and
$A_t w = S(A_i) =$ total gross exterior wall area (m^2) [3].
It has been shown that among the three components of heat gain in the $OTTV$ equation, solar radiation through the fenestration is the most significant [2]. The building variables controlling solar heat gain are SC and window-to-wall ratio (WWR), which are two parameters in the $OTTV$ calculation. Large WWR means high Q_g and low Q_w, and vice-versa. More solar heat gain contributes to more cooling requirements and hence larger air-conditioning plants for buildings [4]. Higher solar heat gain, however, could also mean more daylight available for a day lighting scheme [5]. One way to reduce electricity consumption would be to limit heat gain into the buildings, and hence reduce the demand for air-conditioning during hot summer months. Key factors affecting heat gain through building envelopes into the buildings included building orientation, exterior wall area and its construction type (i.e. thermal insulation and U-value) and surface finish (wall absorption coefficient), window area, glass type (U-value and shading coefficient) , external shading, and roof area and its construction details [6].

B. Concept of OTTV According to Malaysian Standard 1525:2007

The solar heat gain through the building envelope constitutes an important part in cooling load in an air-conditioned building. Solar heat gain into a building is a very important consideration in the design of an energy efficient building. The overall thermal transfer value $(OTTV)$ is an indicator for envelope energy efficiency. The purpose of $OTTV$ is to obtain the design of building envelope to reduce external heat gain and hence reduce the cooling load of the air-conditioning system. The $OTTV$ of the building envelope for a building, having a total air-conditioned area exceeding $4000m^2$ and above should not exceed $50W/m^2$.
The $OTTV$ of building envelope is given by the formula below [7]:
$$OTTV = [A_1 \times OTTV_1 + A_2 \times OTTV_2 + ... + A_n \times OTTV_n]/[A_1 + A_2 + ... + A_n]$$
Where, A_i is the gross exterior wall area for orientation i; and
$0TTV_i$ is the $OTTV$ value for orientation i from below equation.
For a fenestration at a given orientation, the formula is given as below :

TABLE I
SOLAR CORRECTION FACTOR

Orientation	CF
North	0.90
Notheast	1.09
East	1.23
Southeast	1.13
South	0.92
Southwest	0.90
West	0.94
Northwest	0.90

$$OTTV_i = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times CF \times WWR \times SC)$$

Where,
WWR is the window-to-gross exterior wall area ratio for the orientation under consideration;
U_w is the thermal transmittance of opaque wall $(W/m^2 K)$;
U_f is the thermal transmittance of fenestration system $(W/m^2 K)$;
CF is the solar correction factor [7];
Table 1 specifies CF for the various orientation of the fenestration. For the calculation of CF, It is recommended that the nearest predominant orientation be selected.Also a fenestration system may consist of a glazing material such as glass, a shading device and a combination of bothÀccoring to MS1525:2007 table 1 is based on updated (2006) data to match with the current test reference year (TRY) weather data for Kuala Lumpur. Data collected indicates that the average vertical East surface solar radiation is significantly higher than the vertical West surface. This trend is seen to be caused by the normally clear sky in the morning and cloudy sky in the afternoon.
SC is the shading coefficient of the fenestration system [7].

1) Shading Coefficient: The shading coefficient of a shading system is the product of the shading coefficients of its sub-systems, for example
$$SC = SC_1 \times SC_2$$
Where,SC is the effective shading coefficient of the fenestration system;
SC_1 is the shading coefficient of sub-system 1 (e.g. glass); and
$SC_2$is the shading coefficient of sub-system 2 (e.g. external shading devices)
The shading coefficient for glass is the value assessed at an incident angle of 45 to the normal.
The shading coefficient of external shading devices can be obtained from table 2.
$R1$ in Table 2 is the ratio that is defined as the ratio of width of horizontal projection per height of fenestration.

C. Effective Factors on Energy Use in High Rise Buildings

The $OTTV$ and day lighting are two parameters that control building energy use [1]. Chirarattanam (1996) assessed lighting and cooling-energy performance of a building envelope.

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TABLE II
SHADING COEFFICIENT OF HORIZONTAL PROJECTIONS

| Ratio(R1)	Orientation	Shading Coefficient(SC)
$0.3 - 0.4$	North/South	0.77
$0.3 - 0.4$	East	0.77
$0.3 - 0.4$	West	0.79
$0.3 - 0.4$	Northeast/Southeast	0.77
$0.3 - 0.4$	Northwest/Southwest	0.79
$0.5 - 0.7$	North/South	0.71
$0.5 - 0.7$	East	0.68
$0.5 - 0.7$	West	0.71
$0.5 - 0.7$	Northeast/Southeast	0.69
$0.5 - 0.7$	Northwest/Southwest	0.72
$0.8 - 1.20$	North/South	0.67
$0.8 - 1.20$	East	0.60
$0.8 - 1.20$	West	0.65
$0.8 - 1.20$	Northeast/Southeast	0.63
$0.8 - 1.20$	Northwest/Southwest	0.66
$1.30 - 2.00$	North/South	0.65
$1.30 - 2.00$	East	0.55
$1.30 - 2.00$	West	0.61
$1.30 - 2.00$	Northeast/Southeast	0.60
$1.30 - 2.00$	Northwest/Southwest	0.63
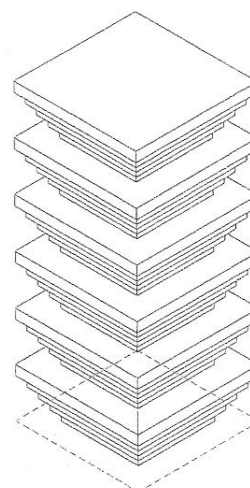
Fig. 1. Self-shaded high rise building

By choosing appropriate envelope parameters such as the WWR, optimum performance can be achieved [8]. Building and volume have important factors on energy efficiency. Building with larger floor space is smaller energy efficiency. Larger volume buildings tend to be more efficiency. Taller and narrower buildings are more energy efficient [9]. According to Capeluto (2002) self shading geometry forms provide the best solution for improvement energy performance in buildings [10]. According to Lam (2005) the amount of heat coming through the building envelope is proportional the total gross exterior wall area [1]. Ling (2007) revealed that vertical wall in high rise buildings received 86.6 percent of the annual solar insolation [11]. Self-protected form is one of possible ways against the impact of solar radiation in high rise buildings [10]. Self-shading building envelopes are suggested for solar prevention cite11. It's clear that self-shading strategies reduce solar insolation on vertical surfaces. Ling (2005) identified optimum self-shading projection ratio for high rise building in Malaysia (figure1) [11]. Lam (2005) indicated that important factors can effect on $OTTV$ are WWR and shading coefficient and U-Values for the opaque walls and windows [1]. WWR and shading coefficient are the most important variables on solar radiation for most of the building envelope heat gain [6].

II. METHODOLOGY

This paper identified the amount of $OTTV$ reduction in self-shaded high rise buildings in comparison with other high rise buildings with no shading strategies through $OTTV$ calculation to clear the effectiveness of self shading strategy on minimizing energy consumption for cooling interior spaces in high rise buildings which has considerable envelope areas against solar radiation. Also increasing the optimum window area was investigated using self-shading strategy in designing high rise buildings.According to Malaysian standard 1525:2007 In the second calculation process the amount of $OTTV$ was considered fixed then the optimum ratio of WWR

was recalculated due to previous WWR optimization that is identified by Zain-Ahmed et al (1998).

III. FINDING AND DISCUSSION

A. OTTV Reduction Determination

To calculate the amount of $OTTV$ reduction in each orientation $OTTV$ equation was used.

$$OTTV = 15 \times a \times [(1 - WWR) \times U_w] + [6 \times (WWR) \times U_f] + [194 \times (CF) \times (WWR) \times (SC)]$$

According to Malaysian standard 1525:2007, the amounts of (CF) s solar correction factors for each orientation is given. Therefore CFs for different orientations are as follow: CF for North and south is 0.9.also CFs for East and West orientation are considered 1.23 and 0.94 respectively. SC (shading coefficient) for building that has no shading device equal to 1. Also according to ASHRAE 2005,
$SHGC$ for $3mm$ clear glass is 0.87.
With taking in to account that
$SHGC = 0.87 \times (SC)$
therefore with consideration both Malaysian Standard 1525:2007 and ASHRAE 2005 , for those buildings that has no shading devices such as horizontal, vertical devices and egg-crates louvers, SC equal to 1.
Projecting floors in self shading buildings act as horizontal shading devices. According to Malaysian standard shading coefficients of horizontal projection depends on the ratio which is defined the width of horizontal projection per height of fenestration. For this case the ratio is 1.Therefore according to table 2, SC for North and South orientation equal to 0.67 and for East and West orientations were considered 0.60 and 0.65 respectively. For calculating the magnitude of $OTTV$ reduction in self shading buildings, other parameters (like Absorptivity of opaque wall, U_w and U_f) were considered fixed to clear the effectiveness of self shading buildings on $OTTV$ reduction. However these parameters are crucial but in this research were considered the same. Therefore

these parameters can be omitted in the calculation process. The ratio WWR was kept parametrically in the calculation process because the amount of reduction in $OTTV$ depends on the WWR. Therefore the amount of $OTTV$ reduction is a function of WWR. Where $OTTV$ is $OTTV$ for entire building envelope that has no shading strategy
and $OTTV_{ss}$ is $OTTV$ for entire building envelope in self-shaded building.
The differences between $OTTV$ and $OTTV_{ss}$ identified the amount of $OTTV$ reduction in entire To calculate the amount of $OTTV$ reduction, $OTTV$ was calculated for two conditions with different SC for each direction. For example for North orientation;

$$OTTV_n = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times 0.9 \times WWR \times 1)$$

$$OTTV_{ssn} = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times 0.9 \times WWR \times 0.67)$$

Where $OTTV_n$ is $OTTV$ for North orientation for building that has no shading strategy
and $OTTV_{ssn}$ is $OTTV$ for North orientation of self-shaded building.
The differences between $OTTV_n$ and $OTTV_{ssn}$ identified the amount of $OTTV$ reduction in North orientation with using self-shaded strategy in designing . Therefore;

$$OTTV_n - OTTV_{ssn} = (194 \times 0.9 \times WWR \times 1) - (194 \times 0.9 \times WWR \times 0.67)$$

$$OTTV_n - OTTV_{ssn} = 57.61 \times WWR$$

Also for other orientation the amounts of $OTTV$ reduction are as follow:
For South orientation $CF = 0.92$ therefore;

$$OTTV_s = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times 0.92 \times WWR \times 1)$$

$$OTTV_{sss} = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times 0.92 \times WWR \times 0.67)$$

Where $OTTV_s$ is $OTTV$ for South orientation for building that has no shading strategy.
and $OTTV_{sss}$ is $OTTV$ for South orientation of self-shaded building.
The differences between $OTTV_s$ and $OTTV_{sss}$ identified the amount of $OTTV$ reduction in South orientation with using self-shaded strategy in designing . Therefore

$$OTTV_s - OTTV_{sss} = (194 \times 0.92 \times WWR \times 1) - (194 \times 0.92 \times WWR \times 0.67)$$

$$OTTV_s - OTTV_{sss} = 58.89 \times WWR$$

For East orientation $CF = 1.23$ therefore;

$$OTTV_e = 15 \times a \times (1 - WWR) \times U_w + 6(WWR) \times U_f + (194 \times 1.23 \times WWR \times 1)$$

$$OTTV_{sse} = 15 \times a \times (1 - WWR) \times U_w + 6(WWR)U_f + (194 \times 1.23 \times WWR \times 0.60)$$

Where $OTTV_e$ is $OTTV$ for East orientation for building that has no shading strategy
and $OTTV_{sse}$ is $OTTV$ for East orientation of self-shaded building.
The differences between $OTTV_e$ and $OTTV_{sse}$ identified the amount of $OTTV$ reduction in East orientation with using self-shaded strategy in designing . Therefore

$$OTTV_e - OTTV_{sse} = (194 \times 1.23 \times WWR \times 1) - (194 \times 1.23 \times WWR \times 0.60)$$

$$OTTV_e - OTTV_{sse} = 95.44 \times WWR$$

For West orientation $CF = 0.94$ therefore;

$$OTTV_w = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times 0.94 \times WWR \times 1)$$

$$OTTV_{ssw} = 15 \times a \times (1 - WWR) \times U_w + 6 \times (WWR) \times U_f + (194 \times 0.94 \times WWR \times 0.65)$$

Where $OTTV_w$ is $OTTV$ for West orientation for building that has no shading strategy
and $OTTV_{ssw}$ is $OTTV$ for West orientation of self-shaded building.
The differences between $OTTV_w$ and $OTTV_{ssw}$ identified the amount of $OTTV$ reduction in West orientation with using self-shaded strategy in designing . Therefore;

$$OTTV_w - OTTV_{ssw} = (194 \times 0.94 \times WWR \times 1) - (194 \times 0.94 \times WWR \times 0.65)$$

$$OTTV_w - OTTV_{ssw} = 63.82 \times WWR$$

For calculating the amount of $OTTV$ reduction for whole building, $OTTV$ for whole of building was calculated for two conditions. And then difference between two condition was investigated . for simplifying the result, the envelope areas for two condition and for each orientation were considered equal. Therefore $A_n = A_s = A_e = A_w = A$,Then

$$OTTV = [A_1 \times OTTV_1 + A_2 \times OTTV_2 + ... + A_n \times OTTV_n]/[A_1 + A_2 + ... + A_n]$$

$$OTTV = [(A \times OTTV_n) + (A \times OTTV_s) + (A \times OTTV_e) + (A \times OTTV_w)]/(A + A + A + A)$$

$$OTTV_{ss} = [(A \times OTTV_{ssn}) + (A \times OTTV_{sss}) + (A \times OTTV_{sse}) + (A \times OTTV_{ssw})]/(A + A + A + A)$$

Where $OTTV$ is $OTTV$ for entire building that has no shading strategy

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TABLE III
REDUCTION THE AMOUNT OF $OTTV$S IN DIFFERENT ORIENTATION AND
WHOLE BUILDING WITH USING SELF-SHADING STRATEGY

Orientation	$OTTV$ Reduction
North	$57.61 \times WWR$
South	$58.89 \times WWR$
East	$95.44 \times WWR$
West	$63.82 \times WWR$
Whole Building	$68.94 \times WWR$

and $OTTV_{ss}$ is $OTTV$ for entire of self-shaded building. The differences between $OTTV$ and $OTTV_{ss}$ identified the amount of $OTTV$ reduction in building with using self-shaded strategy in designing . Therefore;

$$OTTV - OTTV_{ss} = [A[(OTTV_n - OTTV_{ssn}) + (OTTV_s - OTTV_{sss}) + (OTTV_e - OTTV_{sse}) + (OTTV_w - OTTV_{ssw})]]/[4(A)]$$

$$OTTV - OTTV_{ss} = [A(57.61 \times WWR + 58.89 \times WWR + 95.44 \times WWR + 63.82 \times WWR)]/[4(A)]$$

$$OTTV - OTTV_{ss} = 68.94 \times WWR$$

The amounts of $OTTV$ reduction in different orientation and whole of building are collected in the table 3 .

The effectiveness of self-shading strategy on $OTTV$ determining shows reduction the amount of $OTTV$ in different orientation, especially in east orientation with $95.44 \times WWR$. However the self-shading strategy on $OTTV$ has the least effect with $57.61 \times WWR$ reductions for the North orientation. Also it is obvious that the influence of the self-shading strategy depends on WWR. if the ratio of WWR are increased the amount of $OTTV$ decrease significantly with using self-shading strategy in designing. The amount of $OTTV$ reduction for different ratio of WWR varies between 0 W/m2 for no glazing envelope to $68.94 W/m^2$ for whole glazing envelope.

B. Calculating Optimum WWR

Zain-Ahmed et al (1998) demonstrated that the solar gains increased as the WWR increased. The heat gains from lighting decreased from 10 to 25 percent WWR but increased again from 30 percent WWR, although no supplementary lighting was used. This shows that the optimum window opening for day lighting is 25 percent WWR. Any further increase in glazing size will actually increase the thermal gains. Therefore according to Zain-Ahmed et al (1998) the optimum window size is 25 percent WWR in Malaysia [12]. In this calculation process at first the amount of $OTTV$ was calculated for $WWR = 0.25$ for building without shading device then the optimum WWR with using self shading device was found through equalization $OTTV$ with new condition under shade of self-shading form. $OTTV$ for each orientation should be calculated For determination the Amount Of $OTTV$ for a whole building with no shading device and $WWR = 0.25$. Also a which is defined Solar

absorptivity for opaque wall was considered fixed with 20 percent for white color wall in all calculation process.
U_w, for $30mm$ common concrete wall is $2.4 W/m^2 K$ and U_f, for $3mm$ clear glass is $5.9 W/m^2 K$.
SF for all orientation was specified and $SC = 1$ for building has no shading device. So amounts of $OTTV$ for different orientation are as follow:

$$OTTV = 15 \times a(1 - WWR) \times U_w + 6(WWR) \times U_f + [194 \times (CF) \times (WWR) \times (SC)]$$

$$OTTV_n = [15 \times (20/100) \times (1 - 0.25) \times 2.4] + [6 \times (0.25) \times 5.9] + [194 \times (0.90) \times (0.25) \times (1)]$$

$$OTTV_s = [15 \times (20/100) \times (1 - 0.25) \times 2.4] + [6 \times (0.25) \times 5.9] + [194 \times (0.92) \times (0.25) \times (1)]$$

$$OTTV_e = [15 \times (20/100) \times (1 - 0.25)2.4] + [6 \times (0.25) \times 5.9] + [194 \times (1.23) \times (0.25) \times (1)]$$

$$OTTV_w = [15 \times (20/100) \times (1 - 0.25) \times 2.4] + [6 \times (0.25) \times 5.9] + [194 \times (0.94) \times (0.25) \times (1)]$$

As areas in all orientation was considered same. Therefore $OTTV$ for whole building is as follow:

$$OTTV = [A \times (57.9 + 58.87 + 73.90 + 59.74]]/4(A)$$

$$OTTV = 62.60 W/m^2$$

Values for all parameters were set in $OTTV$ Equation except WWR, to determine optimum size for window in self- shaded buildings. $OTTV$ for different orientation in self-shaded building are as follow:

$$OTTV_{ssn} = 15(20/100)(1 - WWR)2.4 + 6(WWR)5.9 + [194(0.90)(WWR)(0.67)]$$

$$OTTV_{sss} = 15(20/100)(1 - WWR)2.4 + 6(WWR)5.9 + [194(0.92)(WWR)(0.67)]$$

$$OTTV_{sse} = 15(20/100)(1 - WWR)2.4 + 6(WWR)5.9 + [194(1.23)(WWR)(0.60)]$$

$$OTTV_{ssw} = 15(20/100)(1 - WWR)2.4 + 6(WWR)5.9 + [194(0.94)(WWR)(0.65)]$$

$OTTV$ for whole self-shaded building are as follow:

$$OTTV_{ss} = [A \times [(7.2 + 145.18 \times (WWR)) + (7.2 + 147.78 \times (WWR)) + (7.2 + 171.37 \times (WWR)) + (7.2 + (146.73 \times (WWR))]]/4(A)$$

$$OTTV_{ss} = 7.2 + 152.76 \times (WWR)$$

The amount of $OTTV$ that is determined as a function of WWR, is equaled to $62.60 W/m^2$, Then WWR was calculated. Therefore

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$$62.60 = 7.2 + 152.76 \times (WWR)$$

$$WWR = 0.36$$

Since the optimum size of window was considered 0.25 in common buildings with no self-shading strategy.with using self-shading strategy the optimum size of window can be more with 0.36.However the amount of $OTTV$ was considered the same.It means with using self-shaded strategy in buildings if WWR was considered 0.36 the amount of $OTTV$ will be equal to $OTTV$ buildings with $WWR = 0.25$ as while they have no shading device. Therefore we can infer from this, that Self-shaded strategy can increase optimum size of windows in buildings because however the amount of WWR in this case increased but the amount of $OTTV$ didn't increased. it means in designing process if the amount of WWR increased 11 percent and also self-shaded strategy was used, The amount of heat which transfer from outside to inside of building would not be changed. In addition not only this strategy doesn't more heat gain but also it causes more daylight enter to interior of buildings. Therefore probably it causes that electricity use for artificial lighting decrease. Finally occupants can use more from the view of outside of buildings.

IV. Conclusion

Self-shaded strategy in buildings especially in high-rise buildings effect on minimizing the amount of $OTTV$. This reduction is $68.94 \times WWR$ as a case in Malaysia. The effect of Self-shaded strategy is more significant if the amount of WWR increase .Also optimum size for window can be increased with using this strategy in designing buildings.Therefore self-shading designs are mainly to minimize solar radiant heat gain and meet the current code of practice for overall thermal-transfer value $OTTV$ standard. This is an effective approach to allow architectural design to have a more flexible building facade design, and to enhance a more energy-efficient and greener building development. Energy savings mean not only low electric-lighting and reduced-peak electrical demands, but also reduced cooling loads and the potential for smaller heating, ventilating and air-conditioning ($HVAC$) plants The initial, running and maintenance costs of a building due to lower $HVAC$ plant capacity and smaller peak electrical-demand can be saved.

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