



COMPARATIVE STUDY ON SHADING PERFORMANCE BETWEEN TRADITIONAL AND NEO-MINIMALIST STYLE APARTMENT IN MALAYSIA

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ABSTRACT

This study compares shading performance on the front façade of two different architectural style apartments in a tropical region. The front façades of two high-rise apartment buildings in Putrajaya and Penang, Malaysia are selected in this study. The first case study is a sixteen stories apartment building with traditional architectural style located at Precinct KE P16 in Putrajaya. Putrajaya is the administrative city for the federal government, and it is considered the latest new city in Malaysia which showcases postmodern design which exhibits a range of complex geometric elements blending with colonial, modern and traditional architectural style. The second case study is Bayswater condominium with neo-minimalist style, a twenty six stories apartment located at the east cost of Penang Island, Malaysia. The research concludes that the shading elements and the façade design such as having recessed wall with the balcony and roof overhang make traditional architectural style is very sufficient and effective to provide good shading system during all the simulation hours except for the first and the last hour of the day due to the sun position angel.

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1. INTRODUCTION

This research discusses the sunlight shading performance and comparisons of the results between traditional and neo-minimalist architectural style apartment façade. This study tries to propose a guideline for architects to overcome the problems of brightness and overheating due to the insufficient façade design in term of shading performance (Bakhlah & Hassan, 2012; Arab & Hassan, 2015). This research focuses on the traditional and neo-minimalist apartment architectural style and examines the shading performance of the façade design as they are very common styles in Malaysia. One of the recent studies was by Ismail and Idris (2002) , and Lim, Ahmad and Ossen (2013) issues on heat gains due to exposure of modern and contemporary high rise building facades to direct sunlight. The other study was by Abdul Rahman (1995) and Omer (2008) on housing

design related to thermal comfort with integration of passive design solution to tackle solar radiation. The study will be based on computer software to do the simulation in order to get the sunlight shading, this study will be limited to two architectural style apartments in Malaysia the Traditional and Neo-Minimalist style which are presently the most popular styles in this region.

2. CASE STUDIES

Two high-rise apartment buildings were selected as the case studies for the simulation on shading performance in this study. The first case study is a traditional architectural style apartment in Putrajaya the administrative city for the federal government, the city of Putrajaya as mentioned earlier is a new city with Post-Modern design style which shows varieties of architectural styles such as Colonial, Modern and Traditional Architectural styles (Hassan, 2005 & 1999). The selected building is a traditional style apartment consisting of sixteen stories and located in Precinct KE P16 in Putrajaya (Figures 1 and 2)



Figure 1: First case study Traditional 1 apartment.

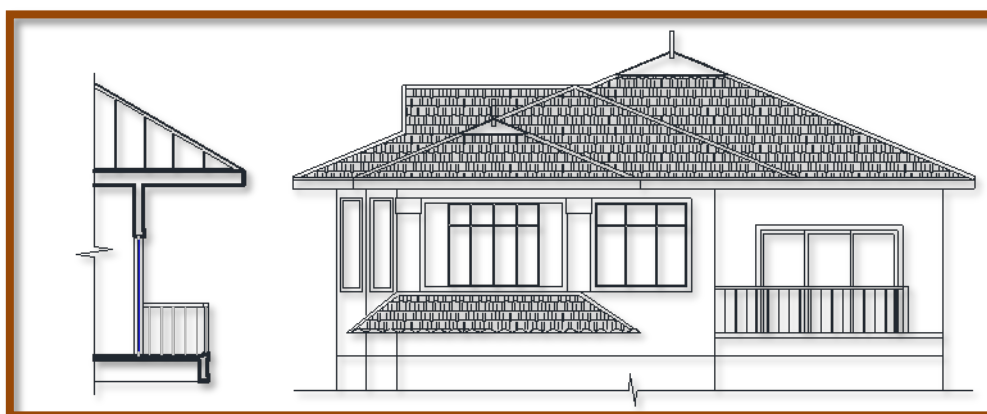


Figure 2: First case study Traditional 1 apartment
(Left: section AA, Right façade) (Arab & Hassan, Malaysia, 2015)

On the other hand the second case is Waterbay condominium a Neo-Minimalist style, the twenty six stories apartment is located at the east cost of Penang Island, Malaysia. Penang (latitude 5° 25' 0" N, longitude 100° 19' 0" E) is the considered to be the second important state in Malaysia, which witnessed great developing progress during the last decade Figure 3 (Arab & Hassan, 2015). The study is limited to the door section of the living room of each case study as the residents spend most of the day time in this room.



Figure 3: Waterbay condominium of Minimalist style (Left: Photo, Right: Section)

3. METHODOLOGY

The extent sunlight penetration results will be calculated using SunTool computer simulation software, the goal of this study is to get the extent of sunlight penetration and façade shading area when the buildings expose to the maximum level of direct sunlight in the day time, the simulation will be done when the sunlight rays are perpendicular to the building’s façades (the east façade during the morning hours and the west façade in the afternoon and evening hours), then the survey will be able to discuss the efficiency of facade’s shading design (Mazloomi, Hassan, Bagherpour, & Ismail, 2010). The study will be limited to the changing of the sun path to get the perpendicular of the sunlight to the east (90°) and west (270°) Table 1 and Figure (4) in order to get the results at the maximum exposure level, and also the other limitation is that there are at certain times and dates that the sun path’s azimuth is not possible to have perfectly at 90° (Hassan & Arab, 2013; Arab & Hassan, 2012). In these cases, the closest azimuths nearest to 90° will be used when the simulation is made from 8:00 am to 6:00 pm, which are listed in Table 1.

Table 1: Time, date and azimuth of the sun when the sunlight extent penetration of façade was calculated for cases in Malaysia. (Hassan & Arab, 2014)

Orientation	Time	Date	Azimuth	Orientation	Time	Date	Azimuth
East 90°	7 am	23 March	90°	West 270°	1 pm	16 September	90.5°
	8 am	25 March	90°		2 pm	29 March	89.8°
	9 am	27 March	89.8°		3 pm	18 September	89.8°
	10 am	28 March	90.1°		4 pm	26 March	89.9°
	11 am	29 March	90°		5 pm	24 March	89.9°
	12 pm	29 March	92.2°		6 pm	22 March	89.9°

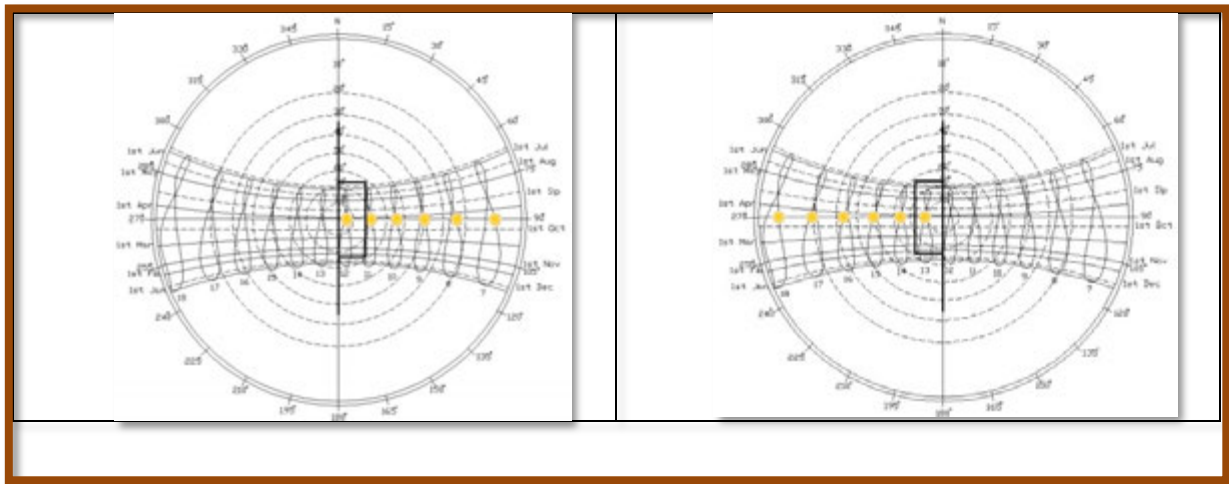


Figure 4: Sun path diagram shows the position of the sun perpendicular to the house facade from 7am to 12pm at orientation of 90° (left) and from 1pm to 6pm at orientation of 270° (right). Source: SunTool Software. (Hassan & Arab, 2014)

In order to get the correct building orientation and positions, all locations, times, dates and orientations data will be keyed in the SunTool software to do calculate the percentage of the façade shading area (Figures 5 and 6), and then the facade's dimensions such as depth of exterior shading device, height, wall's width and sill height will be keyed in the SunTool software. The software will be able to do the simulations after drawing the façade section and enter all required data.

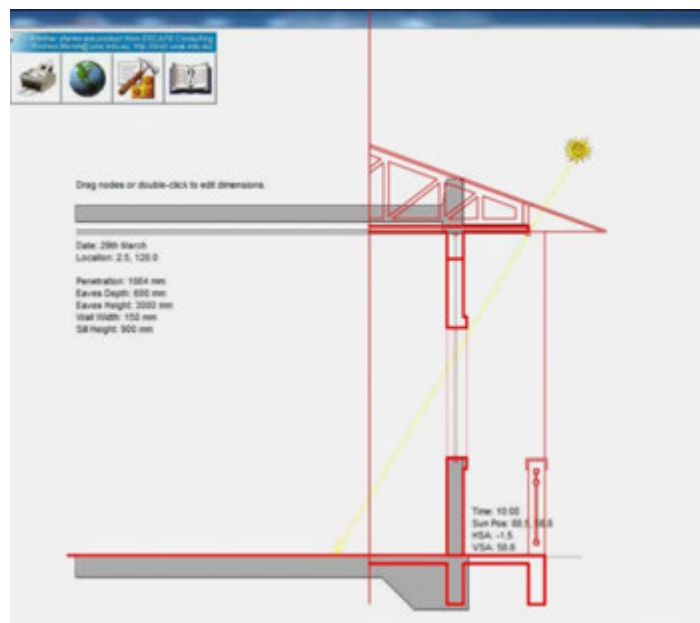


Figure 5: SunTool software (window section) (Arab & Hassan, 2015)

4. SUNLIGHT SHADING

The main areas of the facade are opaque and glazing areas made from reinforce concrete columns and beams clad with bricks and glasses windows. The amount of shading area of opaque and glazing areas will be calculated by 'SunTool' program (Figure 6) the amount of shading and exposed area will be calculated based on the following formula:

$$SGA = SGH \times GW \quad (1),$$

where: SGA = Shaded glazing area, SGH = Shading Glazing Height, GW = Glazing Width,

$$SOA = SH \times L - SGA \quad (2),$$

where: SOA = Shaded opaque area, SH = Shading Height, L = Length of façade,

$$EOA = TOA - SOA \quad (3),$$

where: EOA = Exposed opaque area, TOA = Total Opaque Area

$$TOA = FH \times L - TGA \quad (4),$$

where: FH = Floor Height, TGA = Total Glazing Area

$$TGA = GH \times GW \quad (5),$$

where: GH = Glazing Height

$$EGA = TGA - SGA \quad (6),$$

where: EGA = Exposed glazing area, TGA = Total Glazing Area.

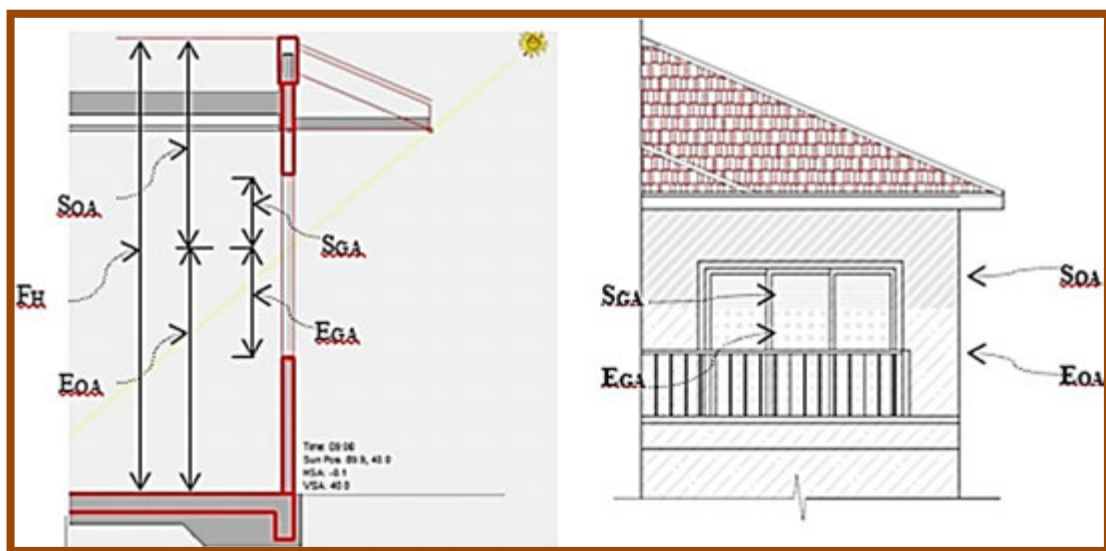


Figure 6: Formulas' abbreviation on facade and section in the calculation of the amount of shading area (Arab & Hassan, 2015)

5. RESULTS ANALYSIS

This study analysis compares the façade sunlight shading performance of two different architectural style apartment, the first is with traditional style in Putrajaya, while the other case study has neo-minimalist façade design located in Penang, Malaysia. The comparison will be between the living room door sections in both case studies. Table (2) and Figures 7 show the results of the shading area both case studies.

Table 2: Shading Area percentage in both case studies.

Time	Traditional Style	Neo-Minimalist Style
8:00 AM	8%	6%
9:00 AM	25%	22%
10:00 AM	48%	42%
11:00 AM	82%	72%
12:00 PM	100%	100%
1:00 PM	100%	100%
2:00 PM	100%	100%
3:00 PM	100%	100%
4:00 PM	79%	67%
5:00 PM	46%	38%
6:00 PM	23%	23%
7:00 PM	7%	7%

Table 2 and Figure 7 show the simulation results of the sunlight shading of both of traditional and neo-minimalist case studies. The results show that the traditional style has slightly better performance during the early morning hours, starts with 8% total shading area at the first simulation hour and then increases to 25%, 48% and 82% shading area at 9:00, 10:00 and 11:00 am respectively. On the other hand the neo-minimalist style apartment starts the day with 6% shading area and goes up from 9:00 to 1:00 am with 22%, 42% and 72% total shading area in order. The noon hours show an excellent façade shading performance in both of traditional and neo-minimalist architectural style with 100% façade shading from 12:00 to 3:00 pm.

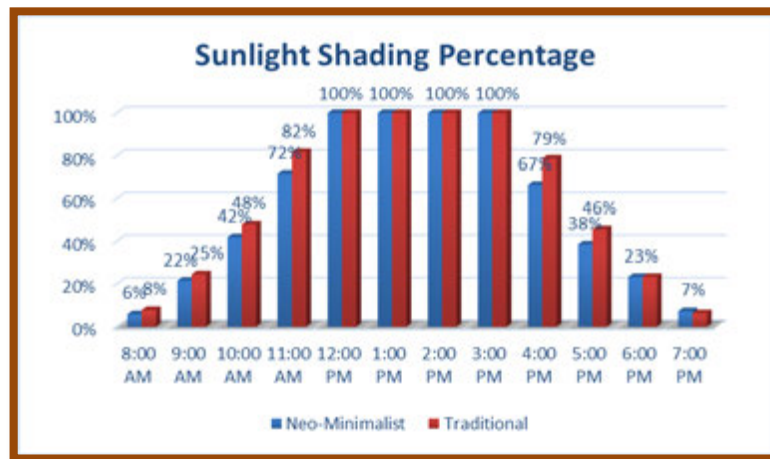


Figure 7: Sunlight Shading Performance in Traditional and Neo-Minimalist architectural style.

6. FINDING

From the analysis, this study compiles with the finding as follows:

- The simulations show that both case studies have similar shading behaviour during afternoon and late evening hour.
- The sunlight shading area is in minimum amount during the early morning and late evening hours, while the maximum during the noon hours.
- Both of the case studies façade have an excellent shading performance mostly from 12:00 until 3:00 pm with 100% façade shading area.
- The minimum shading area in the early morning and late evening hours is due to the small sunlight angle.

- The results show that the façade of the Traditional style apartment has slightly better shading performance than Neo-Minimalist style apartment during the first three simulation hours.
- The findings show that the Traditional and Neo-Minimalist façade design have same simulation results in the afternoon and late evening hours.

7. CONCLUSION

The study concludes that the traditional architectural style building has better shading design than the new-minimalist building style, the early morning and late evening hours show the minimum level of façade shading area in both of traditional and neo-minimalist building because of the very small angle of the sun rays and the sun position in the sky at these hours (Landry & Breton, 2009; Arab & Hassan, 2015), the results show that both case studies have similar façade shading area behavior in most of the simulation hours. However, the simulations find that the Traditional architectural style has better shading performance during most of the day time. The recessed wall with balcony and other shading elements are very effective in the Traditional style façade design to prevent the extent of sunlight penetration from getting inside the house deeply except for the first and last hour of simulation because of the angle of sun position and provide good shading areas on the east and west facades of the building. This study will provide a good example and guideline for the architects and designer for better façade shading design.

8. ACKNOWLEDGEMENT

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