

Shading Performances On Neo-Minimalist And Colonial Style Apartment In Penang, Malaysia

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Abstract | This study aims to measure the sunlight shading performance on the two front apartment façades with different design of the architectural styles in Malaysia. Two case studies of high-rise apartments in Penang were selected for a comparative study of the results of sunlight shading performance. The first case study is Halaman Kristal apartment, a thirty one stories high rise with a mix of European and traditional architectural styles so called the colonial architectural style located in Jelutong, Penang. On the other hand, the second case study is twenty six stories Bayswater condominium designed with early neo-minimalist style located at the east cost of Penang Island, Malaysia. Penang with a latitude 5° 25' 0" N and longitude 100° 19' 0" E is in tropical climate. Nowadays, it is second most important state in Malaysia, which has witnessed great developing progress during the last decade. SunTool software is used in the survey to calculate shading area on the high rise façade. The survey will be conducted in hourly intervals from 8:00 am to 7:00 pm at a position when the sun path is perpendicular to the house façade, and then the comparison between these two designs will be made from the results of the computer simulations. The research finds that the colonial style has slightly better results of its shading performance compared to the neo-minimalist style in the morning and evening hours. The recessed wall and balcony design at Halaman Kristal is more effective shading elements compared to those at Bayswater Apartment. The elements block sunlight penetration to the indoor area and solar radiation to the façade wall. The important focus is the facade design for the late evening hours after 5:00 pm where the use of vertical louver and attached roof overhang as the additional shading devices are important to tackle solar radiation.

Keywords | Apartment Façade; Colonial; Early Neo-Minimalist; Sunlight; Shading.

Introduction | The aim of this research is to analyse and examine the sunlight shading performance of two different case studies of the colonial and neo-minimalist architectural style, and to do a comparative study on shading performance of the high rise façade designs of these two different architectural styles (Bakhlah & Hassan, 2012; Arab

& Hassan a, 2015; Al-Obaidi, Ismail, & Rahman, 2014). The selected case studies are located in Penang, Malaysia located at a tropical region (Yeang, 1987). This study is a part of the research aims to analyse the façade design performance of high-rise apartment buildings in order to measure the problem caused by the inefficient façade shading design (Omer, 2014; Ismail & Idris, 2002), and to contribute research findings to overcome the problem of heat gains due to solar radiations (Omer, 2008; Rahman, 1995; Royle & Terry, 1990).

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The Case Studies

Two of high-rise apartments in Penang Island, Malaysia (latitude 5° 25' 0" N and longitude 100° 19' 0" E) were selected to be the case studies in this research. Penang is considered as the second most important state in Malaysia which has witnessed rapid economic developments during the last decades (Lim, 1987). The first selected case study is Halaman Kristal apartment, a thirty one stories apartment building with late colonial architectural style, the building is located in Lengkok Free School, Jelotong, Penang (Fig. 1). Late colonial architectural style has modern design of neo-classical style with colonial roof design decorated with colonial motifs. Bayswater Condominium is selected as the second case study in this research which is a twenty six stories apartment with early neo-minimalist architectural style. Early neo-minimalist architectural style has simple geometric façade design with simple roof with an influence from modern architecture. The building is located at Gelugor, Penang island as indicated Fig. 2 (Arab, 2015; Hassan, Arab, & Ismail, 2015).

Methodology

The research aims to measure shading area of the case studies, the shading area will be calculated using SunTool computer simulation software (Arab & Hassan, 2015 b). This study is to measure the shading performance of the front façade of the two selected high rise apartments with different architectural styles. The simulations were made when the buildings expose to the maximum level of direct sunlight during the day hours. The simulations will be conducted when the angle of the sunlight rays are perpendicular to the selected building façade (the east façade during the morning hours and the west façade in the evening hours) in hourly intervals from 8:00 am to 7:00 pm (Mazloomi, Hassan, Bagherpour, & Ismail, 2010; Arab & Hassan, 2015). In order to get reliable simulation results, this study will be limited to the sun path changings to get the perpendicular sunlight rays to the east façade (90°) and west (270°) (Hassan & Arab, 2012) as indicated in Table 1 and Fig. 3. The limitation of this study is that the maximum exposure to the direct sunlight is limited to certain dates and times in the year where there are several



Fig. 1: Halaman Kristal apartment with colonial architectural style. (Left & Middle: Photos, Right: Section A-A).



Fig. 2: Bayswater condominium of minimalist architectural style. (Left & Middle: Photos, Right: Section B B).

Table 1: Time, date and azimuth of the sun when the sunlight extent penetration of façade was calculated for cases in Malaysia. Source: 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°

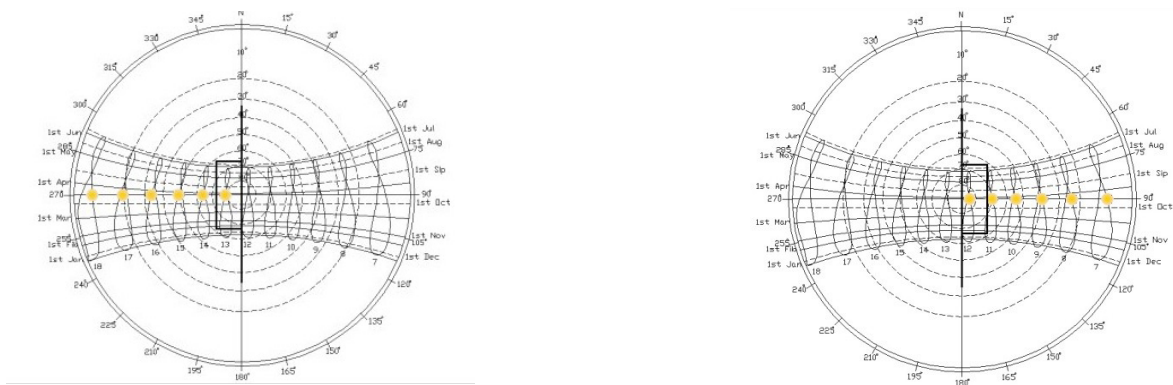


Fig. 3: Sun path diagram shows the position of the sun perpendicular to the house facade from 7am to 12pm at orientation of 90° (left) and from 1pm to 6pm at orientation of 270° (right) (SunTool Software). Source: Hassan & Arab, 2014.

positions with the sun path's azimuths not exactly 90° or 270°. As a result, the study will use the closest azimuth to 90° and 270° in the morning and afternoon hours respectively (Arab & Hassan, 2013).

All information of the times, dates, locations and orientations data will be keyed into the SunTool software in order to get the correct positions and orientations of the two case studies and to do the simulations (Saleh, 1990). SunTool software will provide the calculations to figure out the percentages of the façade shading area based on the provided dimensions, height, width and depth of the wall façade and window sill to the façade sections for both of the case studies. The SunTool output (sunray and window section drawing) will be imported into Autocad in order to redraw the actual sun ray after adding the parallel sun ray to the sun ray with the edge of the external shading device. This simulation step cannot be added in SunTool software which shows the exposed and shaded area on the external wall of the apartment façade as illustrated in figure 4. A comparative analysis will be assessed to the simulation's results of the two case studies to get the findings of shading performance of the façade designs.

SUNLIGHT SHADING

The façade is divided into opaque and glazing areas, the shad-

ed area is an accumulation of shaded opaque and glazing areas. In order to get the total shaded area, the research used the following formula and illustrated in Figure 5:

$$SA = SH \times L$$

Where: SA = Shading Area, SH = Shading Height, L = Length of facade

Result Analysis

This study analyses and compares the shading performance of the two high-rise residential building façade, the first case study is Halaman Kristal apartment with colonial architectural style, whereas the second case study is Bayswater condominium with early neo-minimalist architectural style. Both of the case studies are located in eastern part of Penang, Malaysia. The study will compare the shading performance at the living room façade of both case studies with the results of shading areas shown at hourly interval from 8:00 am until 7:00 pm. table 2 and figure 6 show the results in both of the case studies.

Table 2 and figure 6 show the simulation results if the shading area percentage of both Halaman Kristal and Bayswater façade. The study finds that the colonial style has better shading performance during the early morning and late evening hours. The results of Halaman Kristal started with 23% and

Table. 2: Shading area percentages in the case studies. Source: Authors.

Time	Halaman Kristal Colonial Style	Bayswater Early Neo-Minimalist Style	Differences Halaman - Bayswater
8:00 AM	23%	6%	+17%
9:00 AM	32%	22%	+10%
10:00 AM	44%	42%	+2%
11:00 AM	64%	72%	-8%
12:00 PM	100%	100%	0%
1:00 PM	100%	100%	0%
2:00 PM	100%	100%	0%
3:00 PM	90%	100%	-10%
4:00 PM	59%	67%	-8%
5:00 PM	42%	38%	+4%
6:00 PM	31%	23%	+8%
7:00 PM	22%	7%	+15%

32% while Bayswater had 6% and 22% of the façade shaded at 8:00 and 9:00 am respectively, and then at 10:00 am both case studies have slightly more than 40% of the façade being shaded by the shading devices. Between 12:00 and 2:00 pm both case studies had excellent shading performance with 100% of the façades being shaded. Bayswater façade had better results at 11:00 am, 3:00 and 4:00 pm with 72%, 100% and 67% compared to Halaman Kristal with 64%, 90% and 59% of shading area respectively. Finally, the last three hours of simulations show better shading performance at the facade of Halaman Kristal with 42%, 31% and 22% than Bayswater with 38%, 23% and 7% at 5:00, 6:00 and 7:00 pm respectively.

Discussion

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

1. The simulation results show that colonial façade design has better shading performance than early neo-minimalist façade design during the morning and evening hours.
2. The results show that both of the colonial and early neo-minimalist façade designs have an excellent shading performance with 100% of the façade area shaded during the afternoon hours from 12:00 to 2:00 pm.
3. Poor shading performance was recorded during the early morning before 10:00 am and the late evening after 5:00 pm which had casted the shade on the facade wall less than 50%.
4. The finding shows that the colonial style (Halaman Kristal) has overall better performance than the early neo-minimalist style apartment (Bayswater). It has slightly better design recessed wall and projected balcony.
5. The finding proposes the use of vertical shading devices like louvers to block the late evening sunlight to avoid solar radiations to the facade wall.
6. The finding finds that no roof overhang integrated to the apartment designs. It proposes the application of the attached roof overhangs to the apartment design to increase the shading performance.

Conclusion

This study concludes that in general, the Halaman Kristal apartment with colonial style has slightly better shading design performance than the early neo-minimalist façade design of Bayswater Condominium. The contributions of this research is that having better recessed wall and balcony design will able to create better shading performance to the facade wall. As both of the apartments have excellent shades from 11:00 am to 3:00 pm, the most important focus must

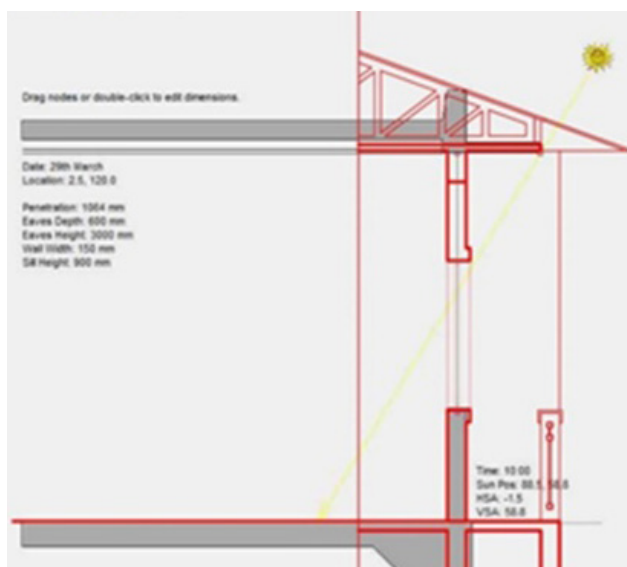


Fig. 4: SunTool software (window section). Source: Arab & Hassan, 2015.

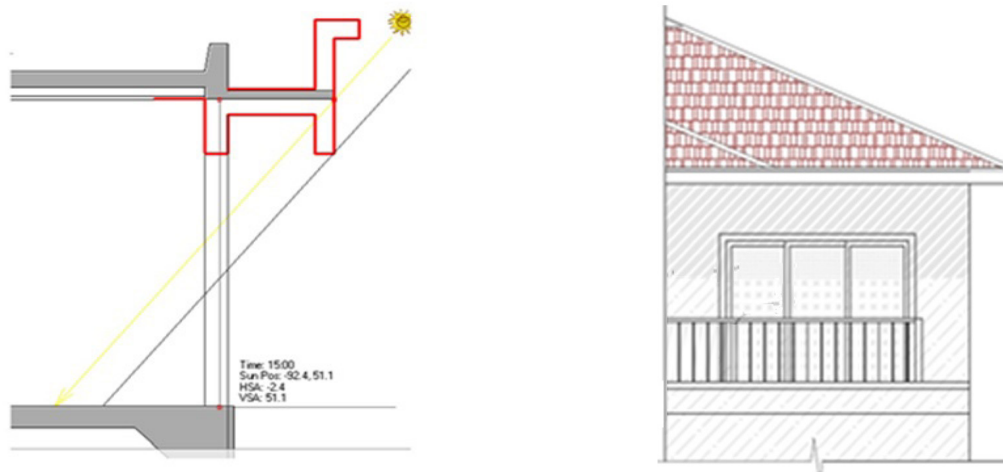


Fig. 5: A section and front elevation of the apartment unit which illustrate the calculations of the formula. Source: Authors.

be the facade design for the early morning and late evening hours. The design must apply vertical louver and attached roof overhang as the additional shading devices to tackle this problem to reduce solar radiation (Landry & Breton, 2009; Arab & Hassan, 2015). During the afternoon and early morning and evening hours, the recessed wall and balcony are very effective shading devices (Arab, 2015). This study will provide a good example and guideline to the architects and facade designer to optimise the use of shading devices in order to reduce solar radiation.

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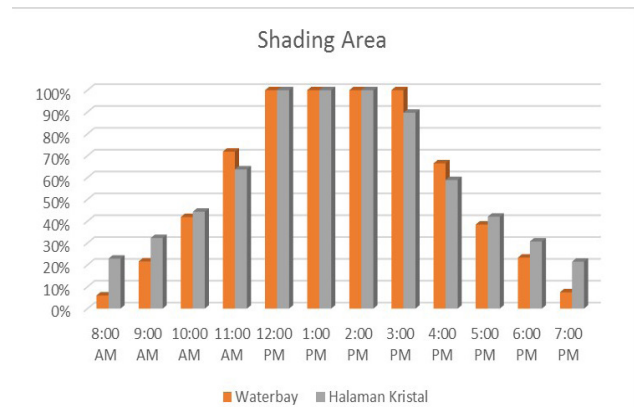


Fig. 6: A bar chart of sunlight shading performances of colonial and neo-minimalist architectural style. Source: Authors.

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