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Sunlight Penetration Extent Study on Two Early Modern High Rise Buildings in Kuala Lumpur

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ABSTRACT

The study aims to analyze and compare the sunlight penetration extent for two buildings in Kuala Lumpur with early modern architectural style. The early modern style was popular for residential building in Malaysia during the 1950s to 1970s, and it was the solution for the government in order to provide the maximum number of units to people who moved to live in the major cities at that time. Two early modern residential apartment buildings in Kuala Lumpur were selected to be the case studies of this research, the buildings namely Sri Kelantan and Sri Perak. In order to get the sunlight penetration extent SunTool software were used to conduct the simulation hourly from 8:00 am until 7:00 pm. The findings show that the early modern style was able to provide good shading performance, the corridor and the façade design were able to prevent the unnecessary sunlight to penetrate into the house.

Keywords: Sunlight Penetration; High-rise Building; Early Modern Style; SunTool software; Kuala Lumpur

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SUNLIGHT PENETRATION EXTENT STUDY ON TWO EARLY MODERN HIGH RISE BUILDINGS IN KUALA LUMPUR

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Abstract

The study aims to analyze and compare the sunlight penetration extent for two buildings in Kuala Lumpur with early modern architectural style. The early modern style was popular for residential building in Malaysia during the 1950s to 1970s, and it was the solution for the government in order to provide the maximum number of units to people who moved to live in the major cities at that time. Two early modern residential apartment buildings in Kuala Lumpur were selected to be the case studies of this research, the buildings namely Sri Kelantan and Sri Perak. In order to get the sunlight penetration extent SunTool software were used to conduct the simulation hourly from 8:00 am until 7:00 pm. The findings show that the early modern style was able to provide good shading performance, the corridor and the façade design were able to prevent the unnecessary sunlight to penetrate into the house.

Keywords: Sunlight Penetration, High-rise Building, Early Modern Style, SunTool software, Kuala Lumpur.

1. Introduction

The aim of this research is to analyze and study the performance of façade shading design and the sunlight penetration extent of selected buildings in Kuala Lumpur with early modern architectural style. The study tries to focus on the high-rise apartments buildings because of the necessity of this type of buildings in the current life in a country like Malaysia. High rise apartments are multi-stories buildings serviced with elevators [1, 2]. The first high rise building was built in the United State of America in 1930s, and then in 1950s it was found in the United Kingdom, while in Malaysia Suliman Court apartment is considered as the first high-rise building in 1954. Then the high-rise buildings became popular in Malaysia during the 1970s [3], and now high-rise apartments are popularly used in provide a large numbers of apartment units urban area.

[4]. A survey by the Malaysian Statistic Department in 2010 shows that about 20 percent of the total house type in Malaysia

Were high-rise (apartment, flat or condominium) as shown in Figure 1.

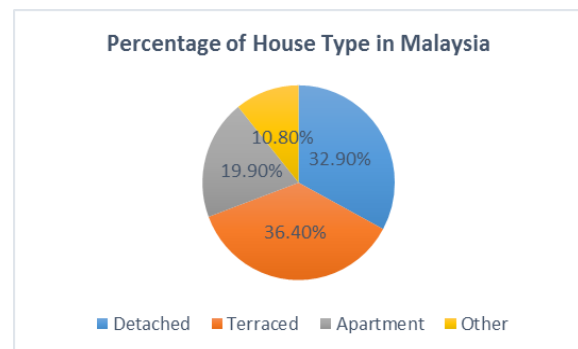


Figure 1. Apartments (apartment/flat/condo) percent 19.9% of the total house type [1].

The early modern architectural style was popularly used between 1950s to 1970s, this type of apartment were the solution of the housing shortage in the country which happened due to the migration from rural areas to the major cities by using mass-production to provide the big demanded number of houses to accommodate more families in the new cities [5, 6]. The architecture style design was simple and focus on the module units, straight lines

and corridor entrance system which go along with rapid technological advancement in the apartment design and increase the production efficiency [7, 8]. Figures 2 show example of the early modern style with simplicity in the colors, design, and construction materials which basically were: bricks, wooden frame glass window, and concrete. The roof design in the early modern style was nearly flat roof with modern construction design.

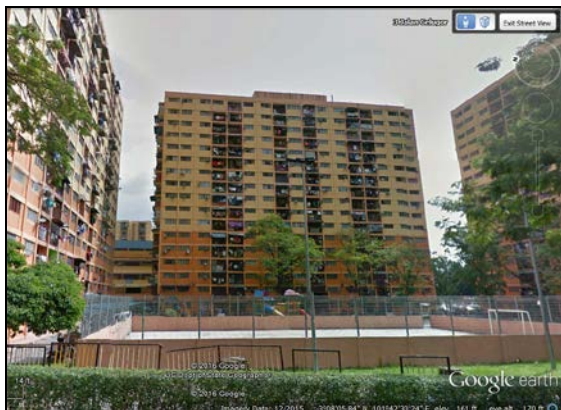


Figure 2. Sri Selangor at Gelugor Road with early modern architectural style.
(Source Google earth street view)

The study aims to provide a better understanding of the performance of façade shading design. Good façade shading design could be the best solution to overcome the problem of heat gain and reduce the energy consumption from the mechanical air conditionings. The good façade design helps to prevent the penetration of the unnecessary sun radiations into the house [9], in other words, the good passive design tries to apply the best shading devices to reach to the comfortable indoor atmosphere level with good daylighting [10].

2. Selected Case Studies

Two apartment buildings with early modern architectural style were selected as the case studies of this research, the two selected building designed with classic early modern features such as using brick walls, reinforce concrete for construction,

corridor entrance system and simple façade design with cement render finishes.

The apartments with open corridor entrance system at the front facade were a very typical design during the early modern period. The corridor functions as accessibility route for the residents to reach their unit's door [11, 12].

The two selected buildings for the computer simulations are located in Sentul, Kuala Lumpur. The first case study is Sri Perak apartment which is located at Jalan 14/484, Bandar Baru Sentul (Figure3 and 4). On the other hand, the second case study is Sri Kelantan apartment located at Jalan Sentul (Figure 5 and 6). Both of the selected case studies are considered from the earliest apartments buildings in Kuala Lumpur.

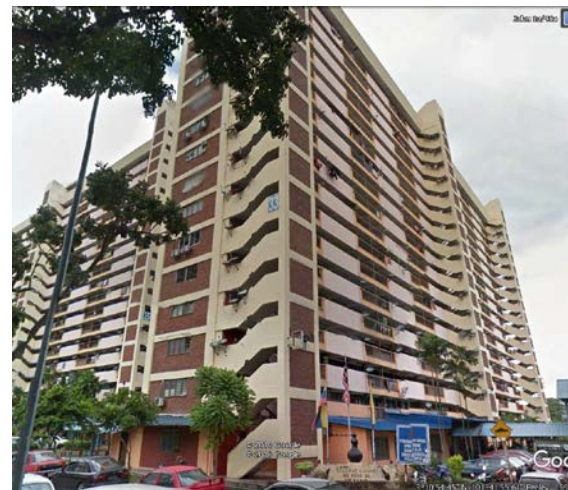


Figure 3. Sri Perak apartment at Sentul, Kuala Lumpur.
(Source Google earth street view)

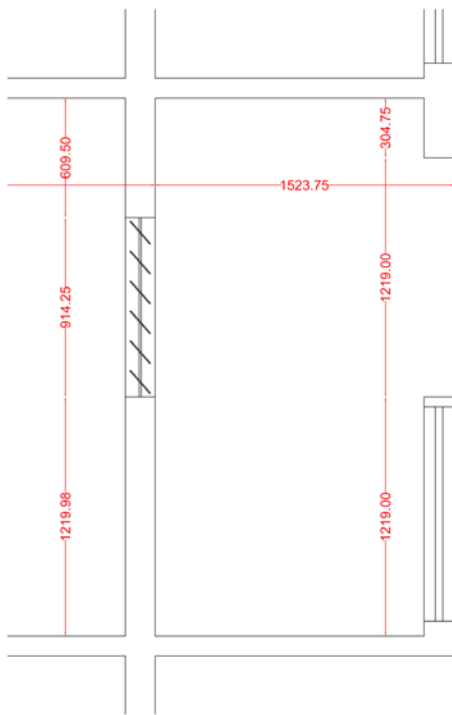


Fig. 4 Façade section of Sri Perak Apartment.



**Figure 5 Sri Kelantan apartment at Sentul, Kuala Lumpur.
(Source Google earth street view)**

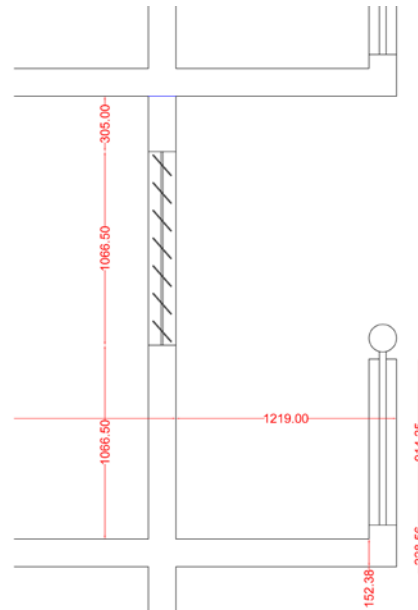


Figure 6. Façade section of Sri Kelantan Apartment.

3. Research Methodology

The goal of this research is to simulate and then analyses the direct sunlight penetration extent from the front façade of the two selected case studies, after that compare the results between the two front façade of the selected early modern architectural style buildings. The study uses SunTool Software to conduct the sunlight penetration simulation hourly from 8:00 am until 7:00 pm. The hourly computer simulation will be done when the sun-rays are perpendicular to the east building's façade from 8:00 pm until 1:00 pm and the west building's façade from 2:00 pm until 7:00 pm as in average the sun rises at 7:20 am and sets around 7:25 pm in March where most simulation will be conducted. The sun orientation and azimuth data which are provided in Table 1 and Figure 7 will be keyed into the software in order to ensure that the façade are exposed to the maximum amount of the direct sunlight at the simulation hours in both east and west façade [13, 14]. In order to get the maximum direct and perpendicular sun-rays to the case studies' façade, the study will be limited to east façade (90°) or west (270°) orientation¹¹, but in order to get the sun-rays perpendicular to the building's façade, the

azimuth will not always be 90 and 270, some small changes could be applied on the azimuth as shown in Table 1[15].

Table 1. Date, time, and azimuth of the sun when the sunlight extent penetration of façade was calculated for cases in Malaysia.

Orientation	Time	Date	Azimuth
East 90°	8:00 am	23 March	90°
	9:00 am	25 March	90°
	10:00 am	27 March	89.8°
	11:00 am	28 March	90.1°
	12:00 pm	29 March	90°
	1:00 am	29 March	92.2°
West 270°	2:00 am	16 September	90.5°
	3:00 am	29 March	89.8°
	4:00 am	18 September	89.8°
	5:00 pm	26 March	89.9°
	6:00 pm	24 March	89.9°
	7:00 pm	22 March	89.9°

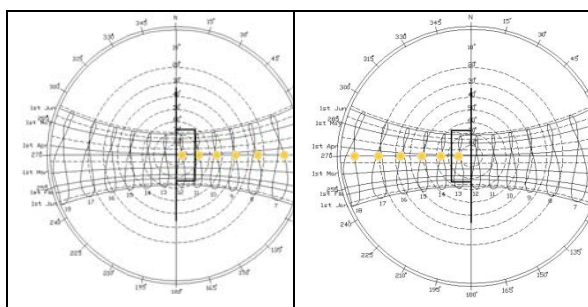


Fig 7. Sun path diagram shows the position of the sun perpendicular to the apartment facade from 8 am to 1 pm at the orientation of 90° (left) and from 2 pm to 7 pm at the orientation of 270° (right). Source: SunTool Software [14, 16]

After keying all the data of the orientation, time, and dates into SunTool software in order to do the simulation the façade section information and dimension will be keyed into the software as well, then SunTool will be able to simulate and provide all required results hourly from 8:00 am to 7:00 pm of all selected case studies [17] (Figure 8)

Since the SunTool software is limited to few façade section types, the results figures will be imported into AutoCAD in order to draw the missing parts and to get the final result of and overcome the software limitation problem. Figure 9.

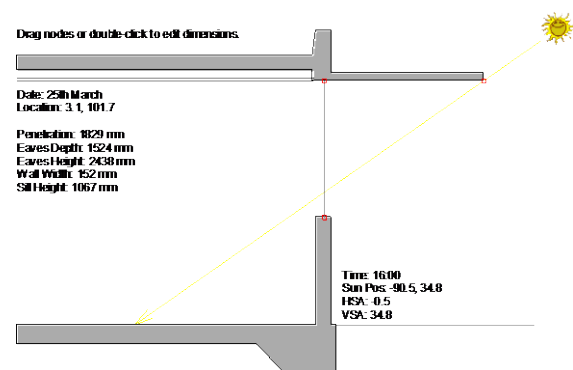


Fig 8 Example of the simulation window using SunTool program.

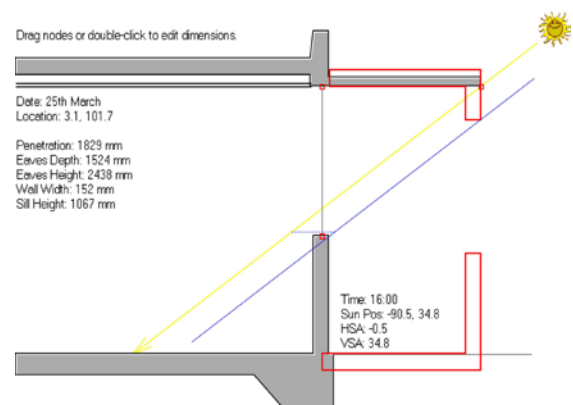


Fig 9 adding the missing Part of the section.

4. Analysis & Results

The results of simulation are shown in Table 2 and Figure 10. The results were taken hourly from 8:00 am to 7:00 pm in

all of the three case studies as mentioned earlier in the methodology.

Table 2. The extent of sunlight penetration from the building simulation.

Sunlight Extent Penetration		
Time	Sri Perak	Sri Kelantan
8:00 AM	11650	11678
9:00 AM	3503	3802
10:00 AM	0	1512
11:00 AM	0	0
12:00 PM	0	0
1:00 PM	0	0
2:00 PM	0	0
3:00 PM	0	0
4:00 PM	0	0
5:00 PM	1841	2134
6:00 PM	5117	5386
7:00 PM	25046	24941

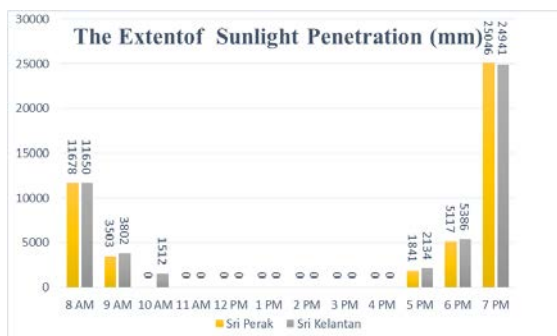


Figure 10. Line chart graph which shows the sunlight penetration extent of the two case studies.

The results in Table 2 show that in Sri Perak apartment the sunlight penetration starts with 11791 mm at 8:00 am and 3503 mm at 9:00 am, the façade shows an excellent shading performance with no any sunlight penetration from 1:00 a until 4:00 pm. Then the evening hours show some sunlight penetration at 5:00 and 6:00 pm with 1841 and 5117 mm respectively. The last hour of the simulations shows the maximum extent of sunlight penetration with 27083 mm.

On the other hand in Sri Kelantan apartment

5. Discussion

The study results and discussion of the sunlight penetrations extent find the followings:

- The two case studies have the similar behavior of shading performance at most of the day hours.
- Sri Perak Façade design shows great shading performance from 10:00 am to 5:00 pm with preventing all the sun rays from penetrating into the unit and show zero sunlight penetration. While Sri Kelantan shows the same from 11:00 am until 4:00 pm.
- The maximum sunlight penetration in Sri Perak apartment is 25046 mm while in Sri Kelantan is 24941 at the last hour of the simulation 7:00pm.
- At 8:00 am Sri Perak and Sri Kelantan have almost the same extent of sunlight penetration with 11678 and 11650 mm for Sri Perak and Sri Kelantan in order.
- At 9:00 am when the sun start rising up, Sri Kelantan has longer extent of sunlight penetration with 3802 mm and 3523 for Sri Perak.
- The next simulation hour show only minimal penetration of sunlight for Sri Kelantan with 1512 mm, with 0 mm for Sri Perak.
- In the evening at 5:00 and 6:00 pm the results show the sunlight penetration with 1841 and 5117 mm in Sri Perak and 2134 and 5386 mm in Sri Kelantan Façade respectively.
- The last hour of the simulation shows the maximum extent of sunlight penetration in both case studies due to the very low angle of the sun at 7:00 pm with 25046 and 24941 mm at Sri Perak and Sri Kelantan in order.
- The early modern style provided better shading performance than a neo-minimalist and colonial buidings which was simulated in previous researchs for Yasser Arab 2015 and 2016 as shown in Figures 11 and 12.

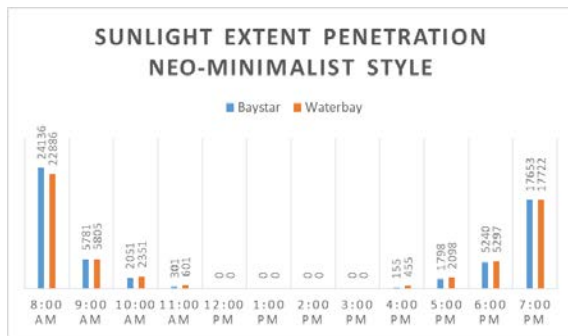


Figure 11 Line chart graph shows the sunlight penetration extent of neo-minimalist buildings [9].

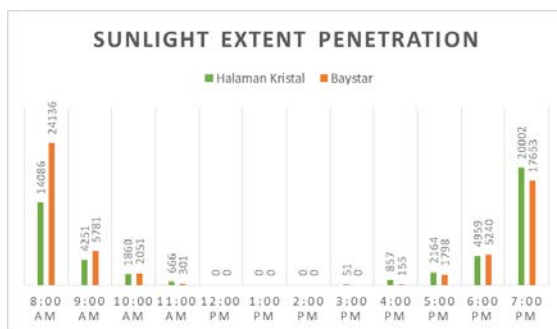


Figure 12 Line chart graph shows the sunlight penetration extent of neo-minimalist and Colonial style buildings [18].

6. Conclusion

The study finds and concludes that the early modern architectural style that applied for the case studies apartment has an excellent shading performance. The study findings show that the last hour of the simulation records the maximum distance of extent of sunlight penetration followed by the first hour and that is due to the low angle of the sun position. However, the results find that early modern architectural style was able to provide an excellent shading performance during the most of the day hours, and especially the afternoon hours which are the most important hours because of the intensive perpendicular sun-ray that is the cause of the main reasons of the heat gain and increasing the indoor temperature. The façade design and the open corridor system are very efficient in term of shading performance; the shading elements manage

to prevent the unnecessary sun radiations from penetrating into the apartments without any sunlight extent penetration during hours of the daytime in Kuala Lumpur. The sunlight penetration during morning hours does not consider bad because of the low intensity of the sunlight and it is considered good for our bodies. The research is strongly recommending to study and reuse the early modern shading elements in the new building design in order to reduce heat gain and as a result to reduce using the mechanical conditioning and energy saving.

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