International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

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

Yasser Arab [a, b*], Ahmad Sanusi Hassan [a], and Bushra Qanaa [b]

[a] *School of Housing Building and Planning, Universiti Sains Malaysia, MALAYSIA*
[b] *Faculty of Architecture, Ittihad Private University, SYRIA*

ARTICLEINFO

Article history:
Received 09 September 2017
Received in revised form 14 March 2018
Accepted 19 March 2018
Available online
21 March 2018

Keywords:
Apartment façade;
Traditional Architecture;
Neo-minimalist Architecture;
Sunlight Shading; Sun path diagram.

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.

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

*Corresponding author (Yasser Arab).. E-mail: yasserarab2005@yahoo.com.

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 mention earlier is new city with Post-Modern design style which shows varieties of architectural style such as Colonial, Modern and Traditional Architectural styles (Hassan, 2005 & 1999). The selected building is a traditional style apartment consists of sixteen stories and located in Precinct KE P16 in Putrajaya (Figures 1 and 2)

Figure 1: First case study Traditional 1 apartment.

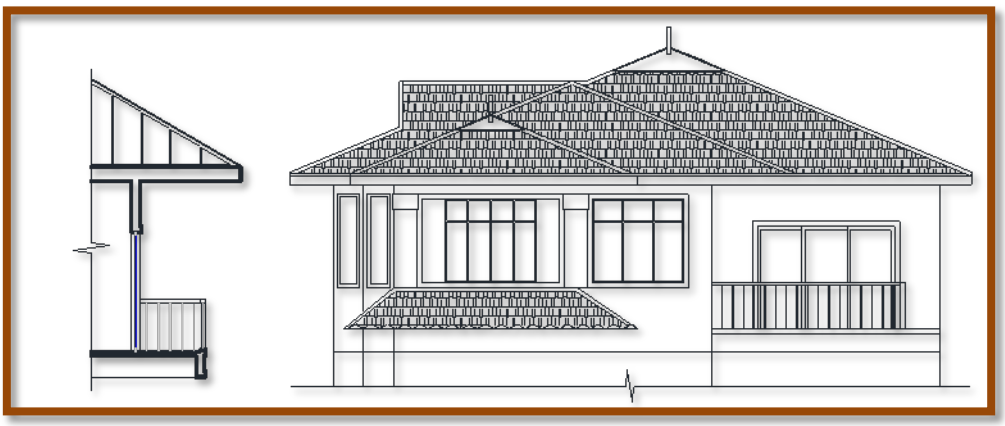

Figure 2: First case study Traditional 1 apartment
(Left: section AA, Right façade) (Arab & Hassan, Malaysia, 2015)

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°

*Corresponding author (Yasser Arab).. E-mail: yasserarab2005@yahoo.com. Volume 9 No.1 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V09/059.pdf.

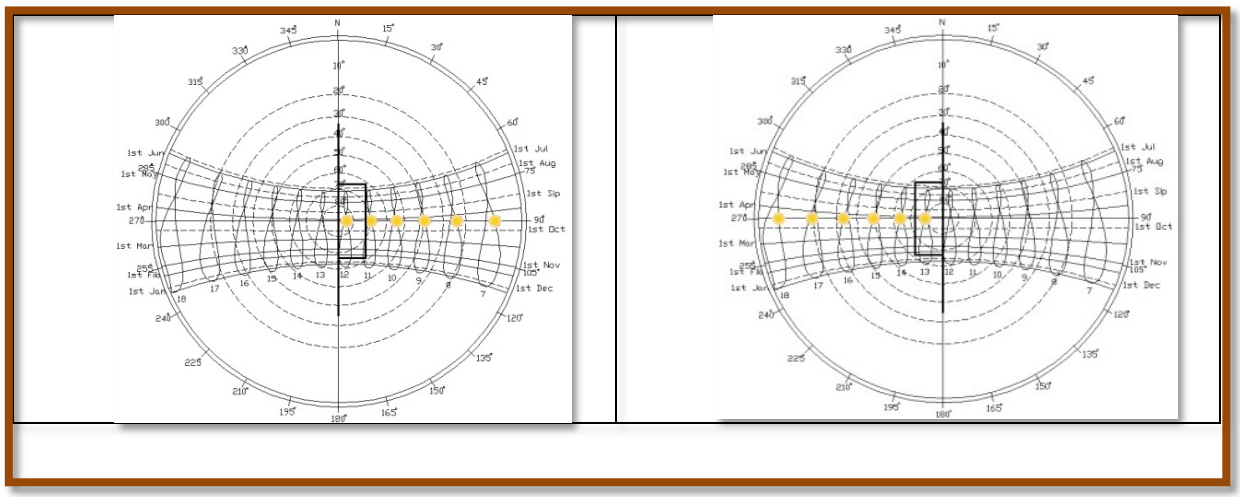

Figure 4: Sun path diagram shows the position of the sun perpendicular to the house facade from 7am to 12pm at orientation of 90° (left) and from 1pm to 6pm at orientation of 270° (right). Source: SunTool Software. (Hassan & Arab, 2014)

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.

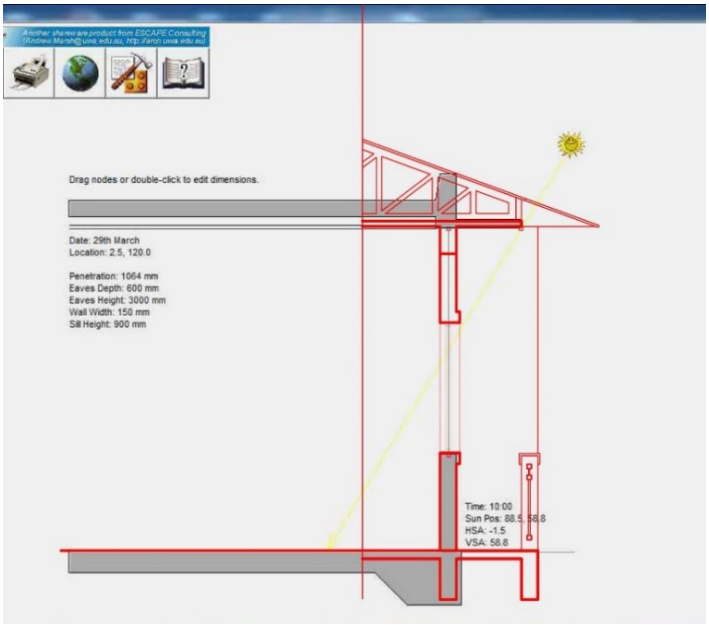

Figure 5: SunTool software (window section) (Arab & Hassan, 2015)

4. SUNLIGHT SHADING

The main areas of the facade are opaque and glazing areas made from reinforce concrete columns and beams cladded 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 x GW (1),

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

SOA = SH x L - SGA (2),

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

EOA = TOA - SOA (3),

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

TOA = FH x L - TGA (4),

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

TGA = GH x GW (5),

where: GH = Glazing Height

EGA = TGA - SGA (6),

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

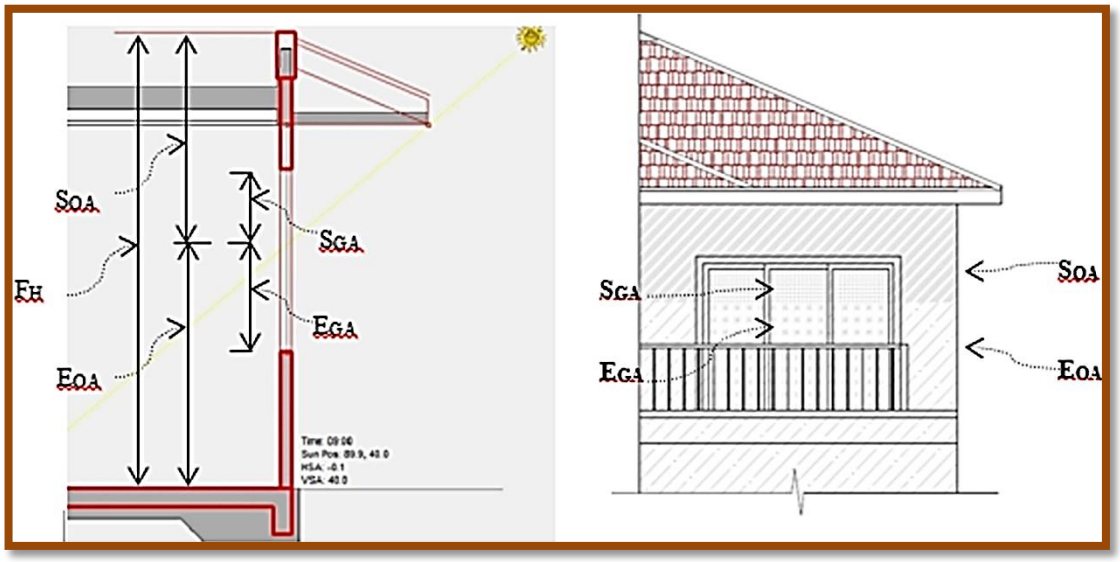

Figure 6: Formulas' abbreviation on facade and section in the calculation of the amount of shading area (Arab & Hassan, 2015)

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 8% 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.

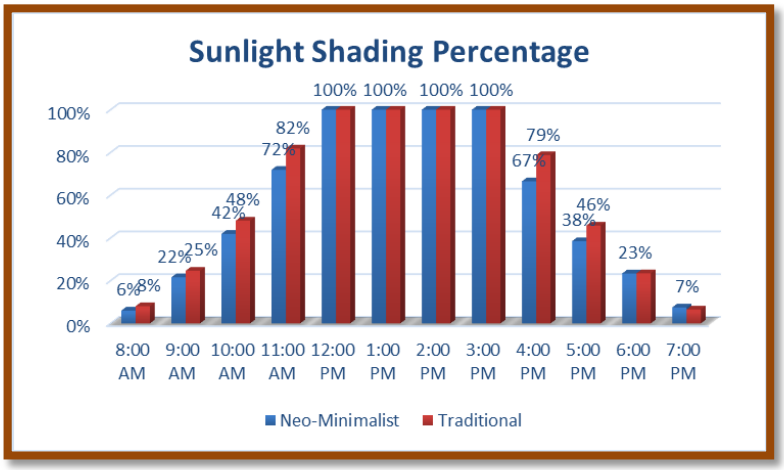

Figure 7: Sunlight Shading Performance in Traditional and Neo-Minimalist architectural style.

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

The authors would like to express appreciation for the financial support under Research University Grant by Universiti Sains Malaysia.

9. REFERENCES

Arab, Y., & Hassan, A. S. (2012). Daylighting analysis of pedentive dome's mosque design during summer solstice with case studies in Istanbul, Turkey. International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 167-183.

Arab, Y., & Hassan, A. S. (2015). The Extent Sunlight Penetration Performance in Neo-Minimalist Style Apartments in Penang, Malaysia. International Conference on Biological, Civil and Environmental Engineering (BCEE-2015) (pp. 1-3). Bali, Indonesia: International Institute of Chemical, Biological & Environmental Engineering.

Arab, Y., & Hassan, A. S. (2015). The Sunlight Shading Performance in Traditional Style Apartment, Case Study of Putrajaya, Malaysia. American Transactions on Engineering & Applied Sciences, 119-128.

Arab, Y., & Hassan, A. S. (2015). The Sunlight Shading Performance in Traditional Style Apartment: Case Study of Putrajaya, Malaysia. American Transactions on, 4(2), P 119-128.

Bakhlah, M. S., & Hassan, A. S. (2012). The study of air temperature when the sun path direction to ka'abah: with a case study of Al-Malik Khalid Mosque, Malaysia. International Transaction Journal of Engineering, Management & Applied Sciences & Technologies, 185-202.

Hassan, A. S. (1999). Putra Jaya: The Direction of Malaysian New Town. Proceedings of the 5th International Congress of Asian Planning Schools Association (APSA) (pp. 165-175). Seoul, South Korea: Seoul National University.

Hassan, A. S. (2005). Konsep Rekabentuk Bandar di Semenanjung Malaysia: Kuala Lumpur dan

*Corresponding author (Yasser Arab).. E-mail: yasserarab2005@yahoo.com. Volume 9 No.1 ISSN 2228-9860 eISSN 1906-9642. http://TUENGR.COM/V09/059.pdf.

Bandar-Bandar di Sekitarnya. Penang: Universiti Sains Malaysia Press.

Hassan, A. S., & Arab, Y. (2014). The Extent of Sunlight Penetration Performance on Traditional Style's Apartment Façade in Putrajaya, Malaysia. Modern Applied Science, 8(5), 132.

Hassan, A. S., & Arab, Y. (2013). The essence of design with light: Single pedentive dome mosque in Turkey and Bosnia Herzegovina during winter solstice. In S. Omer, & A. S. Hassan, From Anatolia to Bosnia: Perspectives on Pedentive Dome Mosque Architecture. Penang: Universiti Sains Malaysia Press.

Hassan, A. S., & Arab, Y. (2014). The Extent of Sunlight Penetration Performance on Traditional Style's. Modern Applied Science, 8(5), 132-142.

Ismail, A. M., & Idris, M. F. (2002). Issues in tropical architecture: High-rise buildings and wind driven. Proceeding of The 2nd Civil Engineering National Seminar. Penang: Universiti Sains Malaysia.

Landry, M., & Breton, P. (2009). Daylight simulation in Autodesk 3ds Max Design 2009-advanced concepts. Autodesk Inc.

Mazloomi, M., Hassan, A. S., Bagherpour, P. N., & Ismail, M. R. (2010). Influence of Geometry and Orientation on Flank Insolation of Streets in an Arid Climate City. American Journal of Engineering and Applied Sciences, Pages 540-544.

Omer, A. M. (12.9 (2008)). Energy, environment and sustainable development. Renewable and sustainable energy reviews, 2265-2300.

Rahman, A. M. (1995). Housing design in relation to environmental comfort: A comparison of the traditional Malay house and modern housing including work in the tripartite programme between Universiti Sains Malaysia, the Welsh School of Architecture and the UK building research. Building research and information, 23(1), 49-54.

Professor Dr. Ahmad Sanusi bin Hassan teaches in Architecture Programme at the School of Housing, Building and Planning, University Sains Malaysia (USM). He obtained Bachelor and Master of Architecture from the University of Houston, Texas, USA. He was awarded a PhD degree from the University of Nottingham, United Kingdom. He was promoted to Associate Professor and later Full Professor. His research focuses on computer simulation on daylighting and thermal comforts, architectural history and theory, and housing in urban design. He is one of the nine regional writers involved in the preparation of Guideline: Agenda 21 for Sustainable Construction in Developing Countries: A Discussion Document, which was launched at The Earth/World Summit, Johannesburg in September 2002. At the university, he lectures in architecture courses related to urban design, studio, history, Computer Aided Design (CAD), and computer movie animation. He has integrated all these specialisations into his research, teaching, consultation and publications. He had designed several architectural projects such as mosque, USM guest house and a proposal for low-cost houses for fishermen community.

Yasser Arab is a research assistant and currently pursuing his PhD in sustainable architecture on Resident's Satisfaction and Sun Shading Model of Apartment Façade in Penang at school of Housing, Building and Planning, Universiti Sains Malaysia (USM), Penang, Malaysia, he is teaching Studio For first year student and involved in supervising student of Master of architecture. He obtained his Master degree in Sustainable Architecture from Universiti Sains Malaysia, his research was related to natural lighting in Turkish Mosques. He got his bachelor of architecture from Ittihad Private University, Aleppo, Syria. He is registered Architect in the Syrian Engineers Union.

Bushra Qanaa is an architect; she obtained her bachelor of architecture from Ittihad Private University, Aleppo, Syria. She is a registered Architect in the Syrian Engineers Union. She worked for two and half years with Midmac company in Aleppo, Syria.

Note: The original work of this article was reviewed, accepted, and orally presented at the 3rd International Conference-Workshop on Sustainable Architecture and Urban Design (ICWSAUD 2017), a joint conference with the 3rd International Conference on Engineering, Innovation and Technology (ICEIT 2017), held at Royale Ballroom at the Royale Chulan Penang Hotel, Malaysia, during 13-15th November 2017.