

An Image of Sustainable Vernacular Architecture

A CASE STUDY OF APARTMENT HOUSES IN PUTRAJAYA

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Abstract | This study analyses the thermal performance of apartment facades designed based on vernacular architecture in Malaysia. The focus of this study on solar radiation. This study attempts to measure the level of solar radiation and shading performance of the apartment facade designs equipped with shading devices (for passive cooling) in response to tropical conditions. This is called a passive design.

The design does not include mechanical cooling or heating, but in case of using shading devices, it is characterized by roof overhangs, attached roofs, recessed walls, balconies or verandas, and louver screens. Vernacular style is derived from the traditional architecture. The design requires the designer's understanding of nature and the surrounding environment. The knowledge of nature is important in traditional architecture. This design-with-nature approach is best reflected in the climatic design of the building. Two apartments with vernacular architecture in Putrajaya were selected as the case studies. A thermal device named Fluke Ti20 Infrared Camera was used to record a series of thermal images of the surface of the apartment facades. The images of the apartment facade were taken hourly during the field works. The results of the study show that the facade designs of apartments have a good thermal performance due to shading design. In conclusion, apartments designed based on the vernacular architecture including traditional passive cooling features, embedded as a part of the design, suit the tropical climatic conditions of Malaysia and are thermally comfortable.

Keywords | apartment facade; thermal surface analysis, shading design; vernacular style

Introduction | This study examines the apartments designed based on the vernacular architecture style in Malaysia and measures their facade exposure to solar radiation. Apartment houses contain house units which are mainly resided by medium income family while condominium and flat house units are dwelled by high and low income family (Datcu, Ibosa, Candaua, & Matteib, 2005). Excellent facade design helps to block the solar radiation which increases indoor temperature and causes thermal discomfort. The excellent design is cost-effective as it reduces the electricity consumption for

indoor cooling. It also – includes shades which block the sun's direct beam radiation from meeting the surface of apartment facade (Prado & Ferreira, 2005; Arab, 2015). The problem of most apartment facades in Malaysia is that in their design, the focus has been on the architectural styles rather than sustainable features contributing to the reduction of solar radiation. This has resulted in inefficient use of electricity for ventilation and thermal comfort. Nowadays, the apartment houses are a massively-produced, to provide immediate a shelter for a large number of people and little attention has been paid for energy efficiency concept (Al-Obaidi, Ismail, & Rahman, 2014). This study hopes to raise the awareness of the architects about the apartment designs complied with Green Building Index (GBI). Such designs can promote en-

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ergy efficiency and reducing electricity consumption for air conditioning (Omer, 2008). This research is an attempt to develop a guideline for designing optimized apartment facades which can block solar radiation, reduce the electricity cost as well as the indoor temperature (Omer, 2014).

The high-rise apartment buildings were selected as the case study. A high-rise building is a multi-story and tall building with elevator (Cheung, Fuller & Luther 2005). The first high-rise building in the world was constructed in Chicago in the United State in 1930s, followed by the one in the United Kingdom in the 1950s. In the 1960s, the Sulaiman Courts building was constructed as the first high-rise building in Malaysia. (Hoffman, 1996).

VERNACULAR ARCHITECTURAL STYLE

Vernacular architectural style as defined by Mohd (1983) refers to the conditions of the place, environment, local materials and traditions. Malaysian vernacular style is characterized by the local and available rainforest construction materials, elevated ground floor and flexibility of the space design. Such features make the buildings appropriate for the tropical climate. Cut jungle poles, bamboo, rattan ropes and palm trunks and leaves are the main construction materials of the simple traditional Malay houses. These materials can easily be found the nature. The most popular structure of the traditional Malay house is timber post and beam and bamboo or wooden wall having large openings and large indoor open space (Lim, 1987), the large windows help to provide good natural ventilation (Lim, 1984). In 1998, Hassan argued in his study that in the traditional Malay houses, the local materials such as timber and the palm leaves help to reduce the heat. In addition, as these materials are good insulation materials, the vernacular style provides the thermal comfort in the tropical climate.

PASSIVE DESIGN

A building with passive design means that the building does not need mechanical cooling or heating systems, and reach the thermal comfort using natural daylight, air ventilation systems and orientation (Commonwealth of Australia, 2008). When the residents feel that the temperature is not too high nor too low, it means that the building has achieved the thermal comfort. Cena and Clark (1978) define the passive design as 'the expression of satisfaction by the users' to the thermal environment. In the last three decades, passive thermal design has received much attention by scholars around the world and the interest was initially reinforced by the primary global agenda on sustainable development in Rio Summit in 1992. This study aims to provide a better understanding of shading devices in passive design in the tropical regions. Passive design is the building design which does not include mechanical cooling or heating, but in case of using shading devices, it is characterized by roof overhangs, attached roofs, recessed walls, balconies or verandas, and louver screens. The selected case studies in this research were located in Putrajaya, Malaysia.

The climate in Malaysia can be described as warm-humid characterized by the following features (Lim, 1987) :

1. The average temperature is usually between 22°C and 32°C
2. The humidity is high during the year is about 75% or more in average.
3. The wind speed is low - in general, and usually a strong wind brings rain.

The building can obtain the thermal comfort in the tropical regions as follows:

1. The main three factors which should be controlled in order to achieve the thermal comfort are temperature, humidity and solar radiation.
2. The main technique to reach the thermal comfort adjust-



Fig. 1: the selected case studies. Photo: Fateme Khozaei, 2016.

ed with the human being body temperature 37°C is to keep a balance between the outdoor and indoor environment by reducing the solar radiation to its minimum level and decrease the heat gain from direct sunlight.

3. Direct solar radiation is the main source of heat gain, so the designer should pay more attention to the façade shading design and building materials in order to thermal comfort.
4. Designing the buildings with good natural ventilation based on either stack effect or air flow helps to provide better living conditions for the residents in a region with hot and humid climate such as Malaysia.

METHODOLOGY

This field survey was conducted to record the surface temperature of the selected apartment facades using thermal imager device Fluke Ti20. This device is available at the School of Housing, Building and Planning, Universiti Sains Malaysia. Fluke is used to measure the surface temperature of apartment in the -field . The camera provides super image quality , advanced features with a premium viewing experience, an extensive feature set, and highly detailed images. the Infrared Camera makes it possible to solve the problems of solar radiation in the field. , store the images in one location for comparison over time and get the questions answered without leaving the field.

Fluke Ti20 camera includes software is a modular suite of tools that allows the researcher to view, optimize and analyze infrared or IR images. The researcher can generate fully customizable reports. SmartView® software is intuitive and easy to use. These features makes it ideal for those having basic needs, yet it delivers the performance specialized thermographers require for advanced reporting and analysis. The software combines digital and infrared images into a single image, delivers strikingly crisp detailed images and makes the

analysis possible. SmartView software allows the researcher to use this patented technology capture and annotate the images and quickly import them into the reports.

CASE STUDIES

The facades of two apartment in Putrajaya, the new administrative capital city of Malaysia were selected for this study. The federal government decided to build Putrajaya to have a new capital city in the 1990s (Moser, 2009). The decision was made to design the newest and most developed city in Malaysia, and the most common building style was post-modern architectural style, which was a mixture of traditional, modern and colonial styles (Hassan, 2005) and later with simple and minimal styles known as neo-minimalist style. The city was planned to be an intelligent and ideal garden city with capability of housing 250000 people (Scott, 1998). Putrajaya city is located about 25 km south of Kuala Lumpur on the highway between Kuala Lumpur and the Kuala Lumpur International Airport. The location gives more importance to this city (Ariffini, 2003; Hassan, Arab & Ismail, 2015).

Two selected cases which are based on the vernacular architectural style are about 7 km away from each other, the first case study is Kwarters Kerajaan (Government Quarters). It is an apartment complex with sixteen storiy- buildings designed , located at Block A1, Jalan P 16, Presint 16, Putrajaya. The second case study is a Public Housing Complex with seventeen storiy buildings called Block 9A located at Jalan P9 C/1, Presint 9, Putrajaya (Fig.1) . Both case studies consist of pyramid, pitch and overhang roofs and other traditional style's shading elements.

RESULTS OF THE ANALYSIS

The study analyzes the photos to measure the surface temperature of the apartment façades in the case studies. the

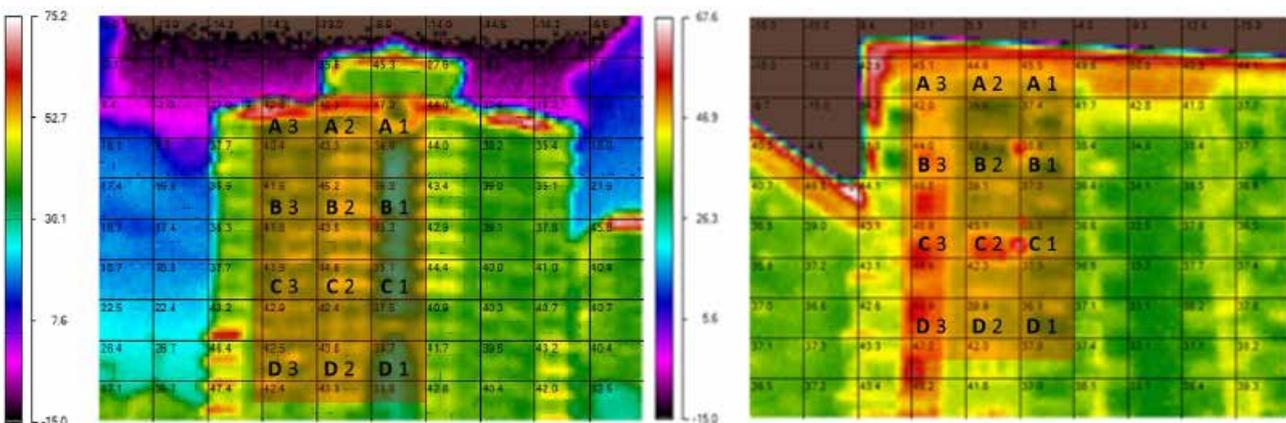


Fig. 2: the selected areas to be studied on each building. Source: Authors.

thermal imager camera was positioned at an eye level perpendicular to the façade, and 45 m away from the building positioned. The thermal shots were taken at hourly intervals from 2:00 pm to 5:00 pm. No thermal shot was taken after 5:00 pm due to unfavorable weather condition, cloudy sky, and raining which normally start after 5:00 pm. The other limitation of this study was difference between the small angle of buildings which 2 degrees. Four selected pointed areas, A1-3, B1-3, C1-3 and D1-3 series, were analyzed (Fig. 2). The comparisons were made for the selected pointed areas.

DISCUSSION

As can be seen in Table 1 and Figure 3, the findings of the surface temperatures at the apartment facades in the case studies are as follows:

- The highest temperature in the case study 1 recorded at point C2 with 62.4°C at 5:00 pm, while it was 64.3°C at point D3 in the case study 2 at 4:00 pm.
- The lowest temperature recorded in the case study 1 was at point D1 with 33.8 °C at 2:00 pm, whereas it was 37 °C at point B1 in the case study 2 at the same hour.
- In general, the results show that all selected points in the case study 2 have higher average surface temperature than the points in case study 1 except for point A at 2:00 pm, point B and C at 5:00 pm.
- The largest difference in average surface temperature between the two buildings was at point C with 9.4 °C at 4:00 pm.

- The highest average thermal surface in the case study 1 was 55.37°C at 5:00 pm followed by 50.22°C at 4:00 pm and 41.83°C at 3:00 pm while the lowest was 40.28°C at 2:00 pm.
- On the other hand the highest average surface temperature in the case study 2 was 57.49°C at 4:00 pm followed by 55.97°C at 5:00 pm, 46.14°C at 3:00 pm and 40.96°C at 2:00 pm.
- The average of all hourly intervals shows lower temperature in the first case study 1 than case study 2.
- The findings show that at 2:00 and 5:00 pm the temperature differences were smaller than 1°C, while at 4:00 pm the temperature had the largest difference at 6.63°C.

CONCLUSION

The results show that both case studies have similar a pattern in term of the thermal façade at the hourly intervals. Apartments designed based on the vernacular architecture including traditional passive cooling features suit the tropical climatic conditions of Malaysia and are thermally comfortable. The features includes Using roof overhangs, attached roofs, recessed walls and balconies or verandas. The architects can use this study as an example and optimize façade designs by using the traditional shading elements, minimizing the sunlight exposure to the façade surface, and decreasing the amount of solar radiations penetrating the indoor atmosphere.

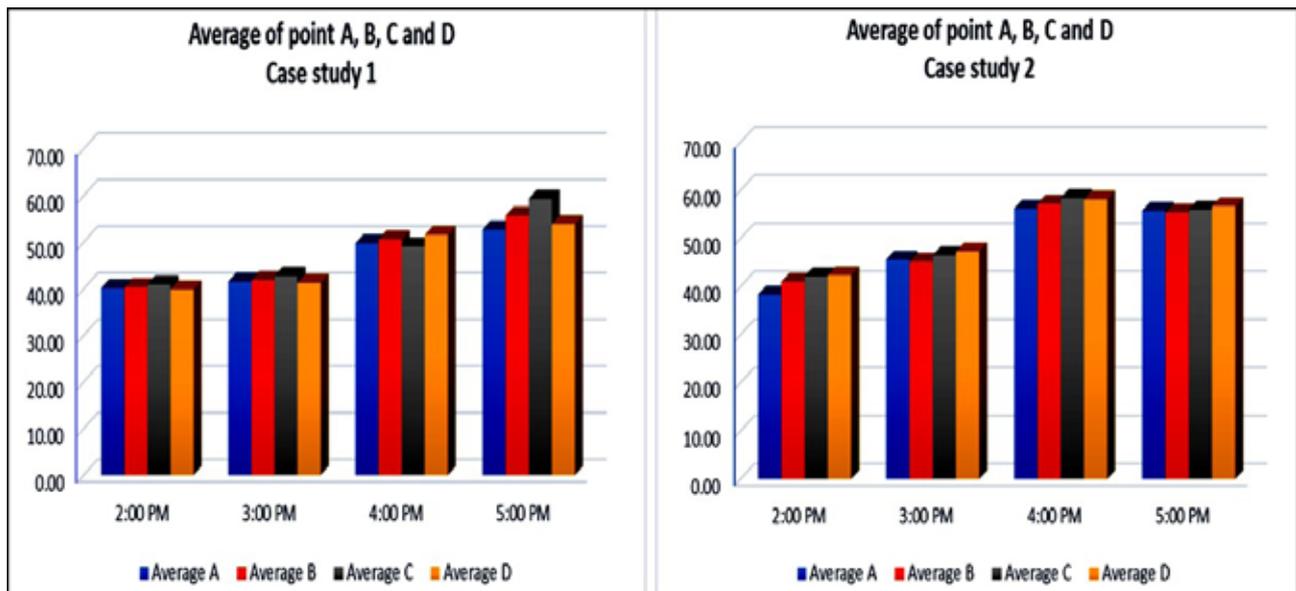


Fig. 3: The comparison of the average temperature in two case studies. Source: Authors.

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Table 1. The average results of the selected points (points: A, B, C and D) for both case studies. Source: Authors.

Temperature	Case 1 Vernacular style (%)					Case 2 Vernacular Style (%)				
	Time	A	B	C	D	Average	A	B	C	D
2:00 PM	40.10	40.27	40.93	39.83	40.28	38.33	40.97	42.17	42.37	40.96
3:00 PM	41.50	41.83	42.77	41.23	41.83	45.60	45.17	46.50	47.30	46.14
4:00 PM	49.70	50.57	49.07	51.53	50.22	56.20	57.20	58.43	58.13	57.49
5:00 PM	52.67	55.63	59.30	53.87	55.37	55.77	55.37	56.03	56.70	55.97

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