Recent Trends in Civil Engineering and Built Environment Vol. 3 No. 1 (2022) 615-620

RTCEBE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/rtcebe
e-ISSN :2773-5184

Lighting Performance at two Different Types of Mosques in Batu Pahat

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DOI: https://doi.org/10.30880/rtcebe.2022.03.01.074
Received 4 July 2021; Accepted 13 December 2021; Available online 15 July 2022

Abstract: A domed mosque has lower illuminance value compare to a pitched roof mosque. This study aims to identify the attribute of lighting performance in the mosque and determine the lighting performance via a comparative study at prayer hall of two different mosques design. It aims to ensure that lighting levels are compatible and meet the standards. Data from Lux meter readings have been taken according to the drawing layout. OriginPro software was being used to create contours of illuminance level. Meanwhile, DiaLux software was being used to design lighting system and interiors of the prayer halls. The data obtained were compared with the recommendation from Malaysian Standard and European Standard. Natural lighting for both mosques did not achieve the recommendation value of both standards. For artificial lighting, both mosques only comply to Malaysian Standards. Mosque with dome need to depend on artificial lighting to improve the appearance in the prayer hall. Recommendations that can be made including substitute LED pendant light at the centre of the domed mosque and install transparent roof at certain area. It would be able to increase the illuminance level at the prayer hall and enhance visual comfort among visitors.

Keywords: Lighting Performance, Dome, Pitched Roof

1. Introduction

Mosque has been built since the 7th century; the earliest model located in Madina was the courtyard of the Prophet Muhammad. During the initial rise of Islam in Malaysia, mosque design within the community setting was basic. It lacked the distinct elements found in mosques in the Middle East. Until now, mosques have been in a revolutionary phase which the design has become more complex and uniform in their shape, which the Ottoman Empire inspired (Baharudin & Ismail, 2016). The mosque's design affected the daylight system, which provides the amount of lighting needed to various angles to get the illuminance level evenly distributed. According to Efe & Varhan (2020), work efficiency and economic development could be increased due to good and accurate lighting. There are two type of lightings which are natural lighting and artificial lighting. Natural lighting is radiation from the sun that

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produces heat and colour. However, artificial lighting is manmade sources that use electric or combustion oxygen and water that emit light.

This study focuses on a mosque with a dome and with a pitched roof to determine the illuminance value between natural and artificial lighting. The amount of lighting inside domed mosque is not in satisfactory condition compares to the pitched roof mosque. The prayer hall is slightly dimmer than the other spaces that require observation to determine lighting performance. This study aims to identify the attribute of lighting performance in the mosque and determine the lighting performance via a comparative study at prayer hall of two different mosques design. Batu Pahat was being chosen for this study because of its highest amount of mosque in Peninsular Malaysia. The pitched roof mosque which is Al-Faizin Tunggul Hitam Mosque, is located at Parit Raja. Meanwhile, Sultan Ismail Jamek Mosque near Batu Pahat town was chosen as the second mosque for this study due to the mosque's structure that comes with a dome. These two mosques were chosen for this study because both mosques located at the roadside that usually receive numbers of visitors.

Illuminance level in the mosque depends on the size of the dome or layer of the roof and sources of lighting that could improve the illuminance in the mosque, specifically in the prayer hall. According to Jamil (2017), the dome was influenced by Byzantine architecture at its establishment. Even though most mosques built with a dome as the main roof design, there is still a mosque built without a dome in Malaysia. Pitched roofs have long been recognized the typical roof structure for the country (Maarof, 2014). This type of mosque is influenced by the local culture and the roof and can be different in shape.

Lighting practice as it developed during the first half of the last century, was based on the concept that the main purpose of lighting is to enable visual tasks to be performed efficiently (Cuttle, 2018). Natural lighting and artificial lighting are sources of lighting. According to Al-Ashwal and Hassan (2017), daylight is a low-cost, energy-free luminous source. Meanwhile, artificial lightings can be classified into three broad categories: accent, task, and ambient lighting. According to Hogrebe (2020), task lighting offers benefits such as providing an excellent psychological sense by giving people authority for their workspace lighting. Instead of satisfying visual needs, ambience lighting also would increase people's well-being (A. Kuijsters et al., 2015).

Lighting standards and regulations are important as a referral for suitable illuminance levels in the mosque. According to Malaysian Standard (MS 1525:2014), indoor lighting requirements depend on the function of the area and work environments such as offices or schools. The recommended lighting level is 100 lux for interior spaces such as mosques, places where Muslims perform prayers, recite the Quran and pursue religious education. By referring to European Standard (ETN) EN12464:2002, the indoor lighting level recommended in the prayer hall is the same as the lecture hall, which is 500 lux and 200 lux for entrance halls.

Table 1: Illuminance level recommendation

Standard	Illuminance Level Recommendation (lux)
Malaysian Standard (MS1525)	100
European Standard	200-500

Source: (MS 1525:2014, EN 12464:2002)

2. Equipment and Method

2.1 Equipment

The equipment that used in this study including Lux Meter and Laser Distance Meter. Lux Meter was used to measure the illuminance level (Lux) at each point at a specific area. While for Laser Distance Meter, this equipment was being used to obtain the precise distance therefore form gridline for both prayer halls.

2.2 Method

The illuminance reading was taken when artificial light was switched on and off at Al-Faizin Tunggul Hitam Mosque and Sultan Ismail Jamek Mosque. The reading from the Lux Meter was being recorded at three different times which are at 9:00 am, 5:00 pm and 9:00 pm for both mosques. The data was collected on each point with the total of 90 points (1.7m x 2.7m) for Al-Faizin Tunggul Hitam Mosque and 225 points (2.6m x 2.8m) for Sultan Ismail Jamek Mosque. OriginPro is a software that is used for data analysis and plotting graphs as well as contour. This software was used to create illuminance contour according to the results of the Lux Meter reading. The data was also compared to Malaysian Standard and European Standard to identify whether the illuminance value comply to both standards. DIALux software was used to design the interior of both mosques that comes with lighting system. This test aimed to determine the differences in illuminance value between two mosques with a different design.

3. Results and Discussions

The mosques' interior was designed using DIALux software including the lighting system with positions of artificial light according to real condition of the mosque. Figure 1 shows the interior and lighting system of both mosques from front view, back view and top view using DIALux software. Some artificial lights are mounted to the wall resulting to the lighting unequally distributed inside the mosque.

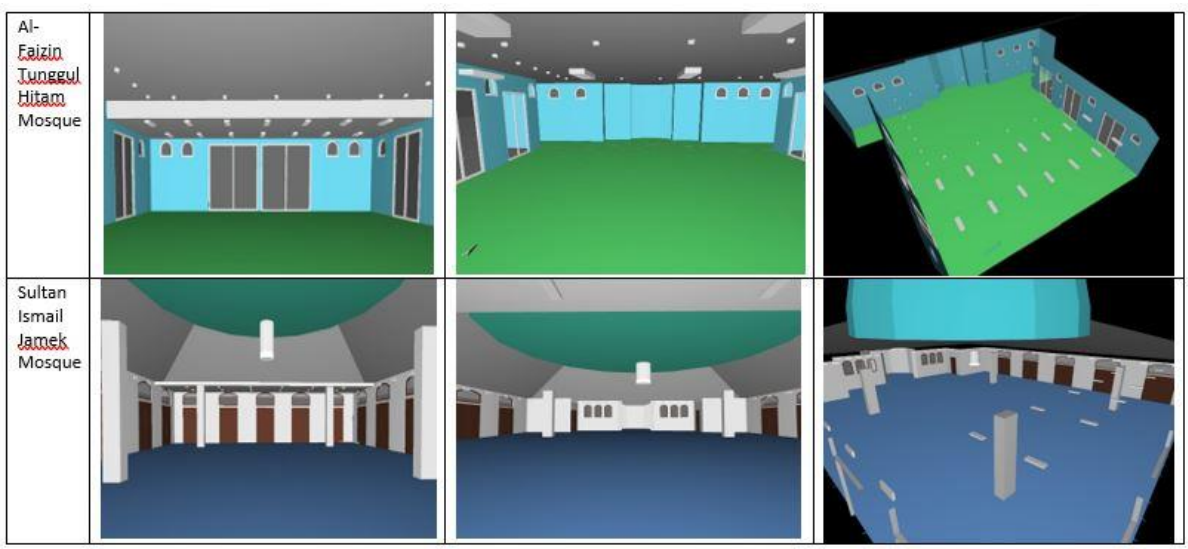

Figure 1: Interiors of both mosques using DIALux software

While for data recorded from Lux meter, the OriginPro software was used to create illuminance contour as shown in Figure 2. The lighting performance is determined in this study by reviewing the illuminance contour created by OriginPro software.

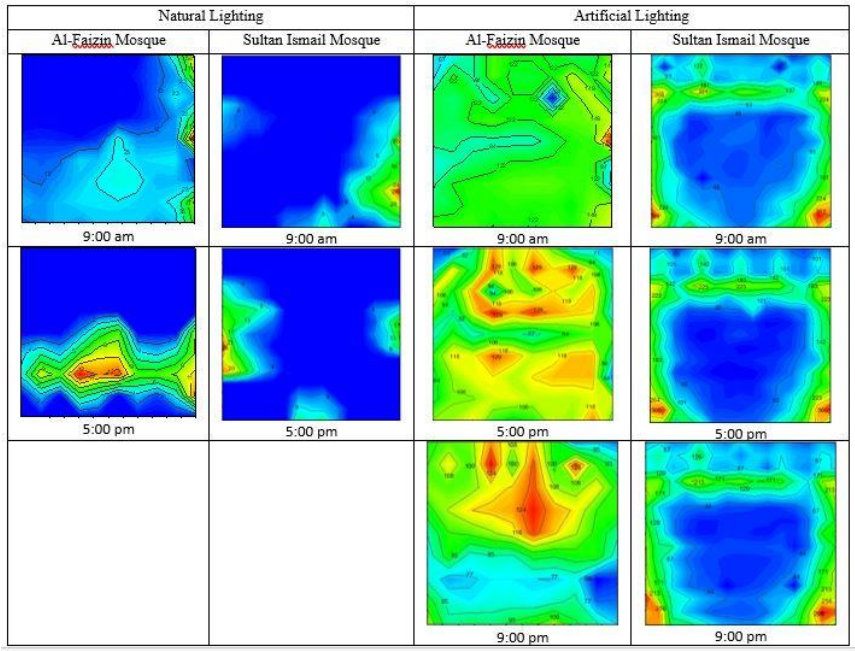

Figure 2: Illuminance contour at both mosques

In the illuminance contour, red colour indicates the area with highest illuminance value. While blue colour indicate lowest illuminance value at the area. Al-Faizin Tunggul Hitam Mosque displays different position of highest illuminance value. Meanwhile, Sultan Ismail Jamek Mosque displays similar contour pattern for 3 different times indicating the region with the lowest illuminance value at the centre. The average illuminance value for artificial lighting for domed mosque is lower compared with pitched roof. Comparing the illuminance value of artificial lighting with Malaysian Standard and European Standard, both mosques only comply with MS1525:2014. However, natural lighting for both mosques did not comply with either Malaysian Standard or European Standard. Figure 3 shows the different position of highest illuminance value for both mosques due to various position of artificial lightings at the prayer halls.

The lighting design system, design of building and condition of the building become the issues that could affect the incompatible illuminance level with the standards. The various types of lighting will result in different lighting distribution to the area. In this study, there are at least two types of lighting applied to a region, with a sprinkling of different lighting that shows the different levels of lighting during the test. The data reading is also affected by the position of the artificial light. Some artificial light is not accurately measured, resulting in an illuminance reading level of a combination of multiple lighting sources.

The condition of the building consists of the surface area and the colour of the ceiling, wall, and floor. Depending on the range, these colours have their respective reflection and absorber. The walls and ceilings in both mosques are a variety of bright colours that not absorbing the light. There is also no curtain at both prayer halls, allowing natural light to pass into the hall.

Figure 3: The condition of mosque and position of artificial lights
(Source: Fieldwork)

The design of a building also plays an important role in determining the lighting performance of an area. The mosques were designed to have a spacious area according to their function as a prayer hall. However, one point would differentiate the lighting distribution inside the prayer halls of both mosques, which is the type of roof. Pitched roof mosque has a better illuminance level with artificial lighting because the light reflects correspondingly, resulting in proper lighting received for the prayer hall. Meanwhile, Sultan Ismail Jamek Mosque equipped with a large dome and a huge interior space as in Figure 4. Light reflection does not occur under the dome area due to weak light reflection over long distances. The atmosphere of the mosque's interior is very gloomy due to the lack of lighting due to the lights being too high. The light source from the sidewall cannot drift off well, resulting in a gloomy atmosphere and substandard lighting performance.

Figure 4: Sultan Ismail Jamek Mosque's dome
(Source: Fieldwork)

4. Conclusion

In conclusion, Al-Faizin Tunggul Hitam Mosque and Sultan Ismail Jamek Mosque average illuminance value for artificial lighting only compatible with Malaysian Standard. Natural lighting for both mosques did not comply with the standards. However, most of the natural and artificial lighting findings had a lower illuminance value, especially at the centre of the prayer hall of domed mosque. The value of lux at the surrounding region is higher than the standard recommendation for artificial lighting because of natural lighting. In European Standard, the suggested illuminance level was 200-500 lux. The average illuminance value did not achieve the minimum suggestion for both natural and

artificial lighting for Al-Faizin Tunggul Hitam Mosque and Sultan Ismail Jamek Mosque. The designation and planning of the lighting are critical to have an appropriate lighting system for the prayer hall. There are several things to consider when installing a lighting system, including the lighting demand, the architecture of the building, and the background of the space. In this circumstance, replacing the chandelier with a higher illumination and installing a transparent roof in specific areas, such as increasing the lighting level in the mosque centre, may help the interior ambience brighter.

Acknowledgment

The authors would like to thank the Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia for its support and those who involved in this study.

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