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The Effectiveness of Green Roof Technology in Mosque Internal Space

Muhd Hairee Mohkatar[1], Abdul Halid Abdullah[1,*],

[1]Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia (UTHM), 86400, Parit Raja, Batu Pahat, Johor, MALAYSIA

* Corresponding Author Designation

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Abstract: Green roof is a necessary system for lowering thermal temperatures. This research aims to study the effectiveness of green roof technology on the thermal efficiency of the mosque's interior space while evaluating the performance of green roof and conventional roof on the mosque's external and internal surface. The research is conducted at the Masjid Kota Iskandar, Nusajaya, Johor which applied green roof technology. This research aims to determine the effectiveness of the green roof to control the temperature of the exterior and interior of the building to reduce the air temperature of the room space that applies green roof technology. Infrared Thermometer equipment and 4 In the 1-meter kit are used to record the temperature readings on the inner and external surfaces of the roof exposed to the sun. This tool reports readings on plots on green roofs and conventional roofs that have been identified. In the marked areas, a total of two readings were recorded. Based on the study that has been conducted, this study can be concluded that the green roof surface can reduce the average temperature on the room temperature 0.6 ^{o}C-1.3 ^{o}C compared to conventional roof surfaces. The results of this research show that the temperature on the green roof is reduced compared to conventional roofs. Therefore, this study is expected to provide useful input to all parties in the construction sectors for expanding the green roof technology in other buildings.

Keywords: Green roof, Thermal, Conventional Roof

1. Introduction

An era of modernization, the world is now plagued with problems such as global warming, air pollution and various problems that can cause the world in disaster. In this regard, the community and some responsible parties have now taken effective measures by applying a green technology system aimed at reducing such disasters. Problems such as global warming, ozone depletion as well as unpredictable weather and temperature, cause experts consisting of professional engineers scientists to explore and implement green technology programs to reduce the impact and problems on the environment [1]. Ventilated roofs or known as green roofs are referred to as eco-roof which is an

**Corresponding author: abdhalid@uthm.edu.my*

alternative to concrete (conventional) roofs that prevent the infiltration process [2]. The use of a green roof is considered beneficial to the environmental charecteristic but it is able to add more space to use a building. The use of green roofs can also reduce and save on the cost of using annual air conditioning for each residential, municipal or building area.

The application of green roof of the building is able to control the roof surface from the heat of the sun. When this condition occurs then the effects of solar heat during the day can be reduced, thus able to reduce the effects of increasingly hot urban heat islands [3]. Increasing the productive use of green roof systems in the city is able to reduce the ambient temperature and thus as a whole can reduce the formation of heat islands in the city. If this method can be widely applied, the thermal comfort performance of city dwellers can be improved, air pollution problems can also be reduced and green roofs can increase oxygen release rate and reduce carbon dioxide levels which cause greenhouse effect in urban environment [4].

1.1 Problem statement

The global crisis that is plaguing the world at this time is becoming more critical where the problems of rising environmental temperatures and global warming are difficult to curb. This is closely related to the rapid development implemented which causes environmental problems such as air, water and soil pollution. The various studies have been done in the present, such as the use of more environmentally friendly materials to create a sustainable environment. The phenomenon of global warming give meaning imbalance in the environment. There is a rise in global temperature of between 0.4 and 0.5 degrees celcius every 5 years beginning in 1952, according to Professor James G Titus, United States Environmental Protection Agency. The global temperature is expected to increase from 0.8 and 3.6 degrees Celsius between 1990 and 2025 [5]. Two important mechanisms that cause global warming are through the greenhouse effect and depletion of the world's ozone layer. Although this effect is caused by environmental pollution, it is actually closely related to human activities that drive the above mechanisms. This widespread emissions of carbon dioxide is one of the factors that cause global warming, thus potentially slowing down the economic growth of a country if not curbed [6]. The day of global warming is very worrying for the world's population coupled with the unpredictable climate that can cause natural disasters to occur around the world [7]. Therefore, the main agenda of governments around the world is to focus on environmental problems, especially the phenomenon of climate change by emphasizing the use of green technology as an alternative in dealing with the problems of this greenhouse effect [8].

1.2 Objectives

This study was carried out in Masjid Kota Iskandar, Nusajaya, Johor. The objectives of this study are to measure the external and internal surface temperature of the roof, and also the air temperature of the interior space. Second objectives is to make a comparison of the thermal performance of the interior space mosque which applies to the green roof surface and the conventional roof surface. Furthermore, to determine the effectiveness of the green roof technology on the thermal performance of the interior space of mosque.

Figure 1: Top view Masjid Kota Iskandar, Nusajaya, Johor

2. Materials and Methods

2.1 Materials

The experiments were performed on two separate roof surface types, a green roof and a conventional roof. The purpose of this analysis is to establish the ability of the green roof to regulate the surface temperature at the site. The research design used in this study is by collecting the temperature data by plotting areas on the outer and inner surfaces of green roofs and conventional roofs.

The Infrared Thermometer and 4 In 1 Meter Kit have been used to obtain the temperature of the roof surface exposed to the sun. The Infrared Thermometer and 4 In 1 Meter Kit report the reading on the plots marked as a green roof and a conventional roof in Figure 2. A total of two readings (high and low) will be recorded in the area indicated. Temperature readings are recorded for each interval of 2 hours for 10 hours starting from 8 am until 6 pm. A process used by the 4 in 1 Meter Kit to quantify the data for the green roof surface. The exterior temperature readings (exposed), room temperature, relative humidity (RH) and wind speed can also be captured by this instrument.

Figure 2: Method of retrieving data

3. Results and Discussion

3.1 Comparison of Outer Surface Temperature of Green Roof & Conventional Roof

Figure 3 shows the temperature graph that has been tested, which is a different between the external temperature of the green roof and the conventional roof. This graph found the temperature range of the outer surface of the roof for green roofs between 28.4°C - 33.4 °C, while for conventional roofs between 31.9 °C - 39.4 °C. The external surface temperature readings are uniform for green roofs and do not have abrupt changes during the afternoon and evening, such as the external surface temperature on conventional roofs. The temperature of the external surface of the green roof is lower than the conventional roof that was recorded at 8.00 am to 6.00 pm, based on the temperature differential indicated.

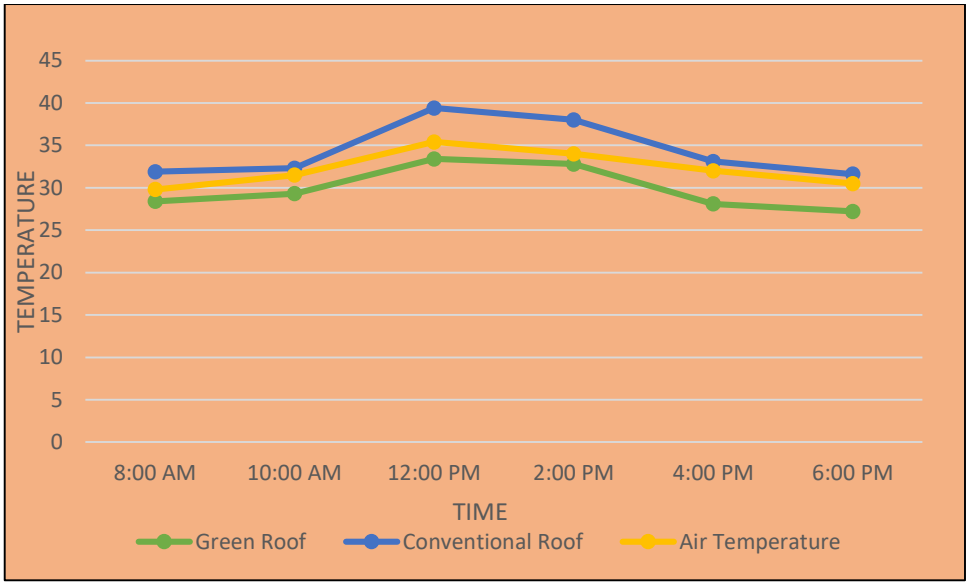

Figure 3: Comparison of outer surface temperature of green roof & conventional roof

3.2 Comparison of Internal Surface Temperature of Green Roof & Conventional Roof

Figure 4 shows the graph of the internal surface temperature of the green roof and the conventional roof which was observed at 8.00 am to 6.00 pm. The observed data is in good weather and suitable for the observed day. The temperature range of the internal surface of the conventional roof is greater than the temperature of the internal surface of the green roof, which is between 29.8ºC and 36.4ºC, while the temperature range of the internal surface of the green roof is between 27.2ºC and 31.0ºC. Temperature changes can be seen higher to the temperature of the internal surface of the conventional roof than the internal surface of the green roof in parallel with the exposed external temperature which is at 12.00 mid to 4.00 pm. Other than that, the difference in internal surface temperature is not very significant between the two internal surfaces.

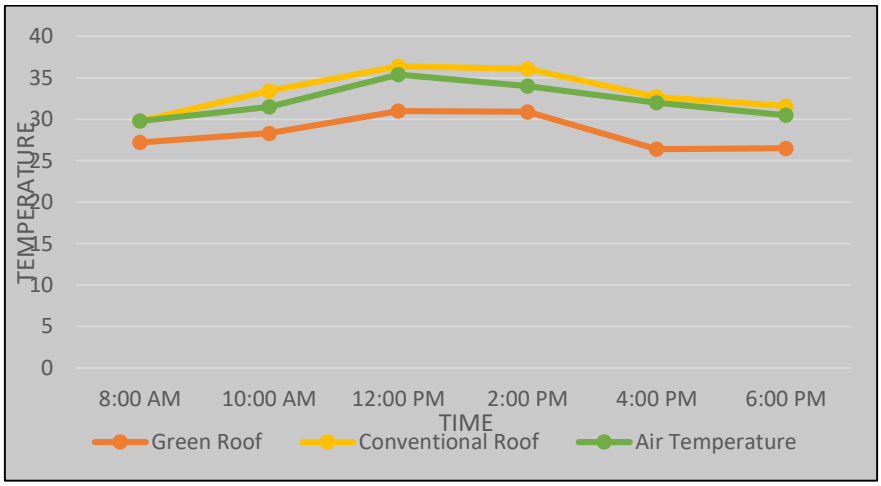

Figure 4: Comparison of internal surface temperature of green roof & conventional roof

3.3 Comparison of the Green Roof & Conventional Roof of Room Temperature

Figure 5 shows a room temperature graph for a comparison of areas applying green roofs and conventional roofs in the Majid Kota Iskandar area. The room temperature provides temperature information for the room applying green roofs and conventional roofs on the upper surface of the ceiling. This graph shows a slightly higher range value at the temperature taken in a room using a conventional roof of 28.3 ºC - 33.6 ºC. During the duration from 8.00 a.m. to 12.00 noon, all room

temperatures drastically rise due to the exterior temperature exposed to both. At 12.00 noon, room temperature for green roofs and conventional roofs approached the maximum reading, and room temperature readings steadily decreased until 6.00 pm in the afternoon.. The exposed outdoor temperature affects both the room temperature which applies the green roof technology and the conventional roof in the area of the Kota Iskandar Mosque.

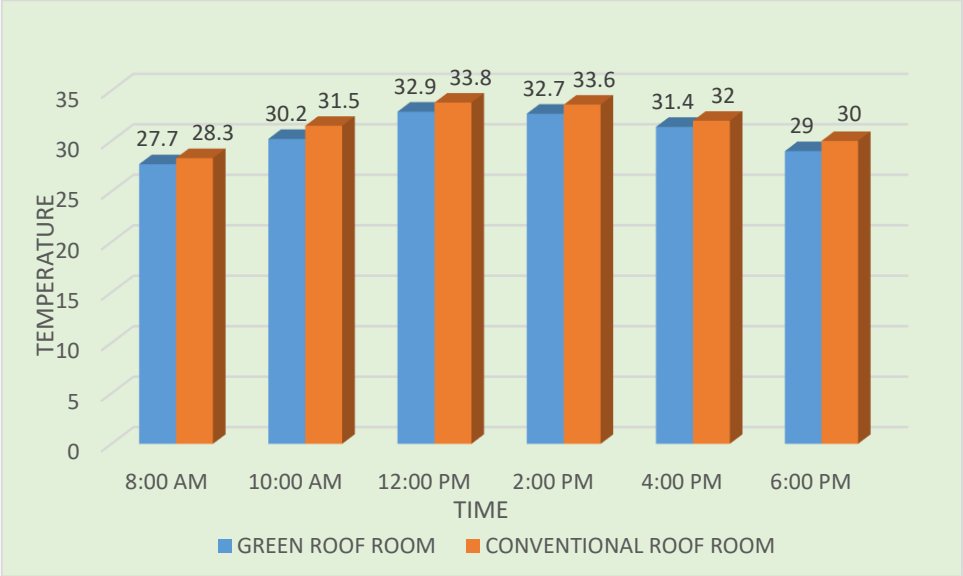

Figure 5: Comparison of green roof & conventional roof of room temperature

4. Conclusion

From the results of the research conducted on the surface area of the roof and room space involved in the Kota Iskandar Mosque, Nusajaya, Johor which is applying with green roof area and conventional roof. With the same general conditions and structures, a series of data were taken to make a comparison of the effectiveness of green roof technology on the thermal performance of the mosque's interior space. Using the reading device in the recorded area, a sequence of data was recorded within 10 hours from 8.00 am until 6.00 pm.The data shows that the surface area of the green roof, the internal surface of the green roof and also the room temperature applying the green roof show lower temperature readings compared to the area using conventional roof. For conventional roof, the temperature reading rises sharply compared to the green roof surface when it reaches noon. The overall variation in the temperature range of the external surface temperature of the roof is 1.5°C to 6.0°C from the difference of the green roof and the conventional roof, although from 2.6°C and 6.3°C for the internal surface of the roof (ceiling). For the average room temperature range difference between the two volumes is only 0.6°C – 0.9°C. As a result of this result, it was found that green roof technology reduces the increase in heat, especially in the afternoon and is able to provide a rate of heat reduction into the building. The effect of this heat reduction can increase the lifespan of a building and can also save on building maintenance costs. Furthermore, the green roof technology system is able to provide a more conducive environment to humans and achieve both the objectives of the study.

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