Study on Suitable Construction Materials for Swiftlet Farming Using EnergyPlus

Ibrahim S. H.[1], Baharun, A[2], Kabiru, A[3]

[1, 2,3] Faculty of Engineering,

University Malaysia Sarawak(UNIMAS)

94300 Kota Samarahan, Sarawak

e -mail : [1]ihalipah@feng.unimas.my,

[2]bazhaili@feng.unimas.my

[3]kabiruayagi@yahoo.com

Abstract

The swiftlet farming is a new type of business that is gradually growing in our country. This industry would be a great investment for Malaysia which the edible nest is at high price. The building constructed for swiftlet habitat should able to control environmental factors –air temperature, relative humidity and mean radiant temperature. Validated Energy Plus® software is used to simulate the selected construction materials for swiftlet farm building. The result shows that double layer brickworks construction with gap is suitable to fulfill the criteria of swiftlet habitat.

Keywords: Swiftlet farm building, suitable habitat, building materials, environmental factors.

1.0 Introduction

The swiftlet farming is a new industry as compared to other industries established in Malaysia. This industry is defined as the conversions of people-centric buildings into buildings used to accommodate and protect a certain species of swiftlets, eg: *Aerodramus Fuciphagus* species. Most of *Aerodramus Fuciphagus* species produce high quality white edible birds nest. This type of nest could be selling at extremely high price and due to high demand of this product.

Though this industry could promise good income, but for those who are lacking in terms of experience and guidance they might face difficulties and challenge in this business. Most of the farmers built their farm without a proper consultation and did not take environmental factors into consideration in their design. Therefore, this study is relevant in order to give solution in terms of suitable materials chosen for swiftlet farm building.

The ability of the building envelope to control the difference between the outdoor and indoor air temperature is very important. Many factors can affect the efficiency of the control such as climatic factors and the thermo-physical properties of the materials. The process of identifying and understanding the factors is perhaps the most critical part of building design. The key objectives of climatic design are to provide an internal environment that will provide suitable habitat for swiftlet to continue the breeding process and produce high quality edible nest.

Various elements of the building envelopes such as the roof, walls, floor, and opening and their interaction with the external climate should be design carefully.

2.0 Suitable environment for swiftlet farming

In order to provide suitable environment required for this species to breed and survive, study on suitable environment, the building orientation, building materials and envelope should be done further. Therefore, the objective of this study is to create a suitable environment using Energy Plus® for the purpose of accommodating swiftlet population and analyze the macro and micro factor that is related to the swiftlet farming.

Most of *Aerodramus Fuciphagus* species live in the tropical Indo-Pacific region and will not migrate to other places unless the habitat is not suitable for them anymore. Normally, swiftlets will find similar places like caves environment such as abandoned old houses or building. The building design should provide a manipulated conducive breeding environment to attract swiftlets to stay and support the growth of the swiftlet population.

Although the Science and Technology and Environment Ministry has issued a set of guideline for a more systematic management of the local swiftlet industry, the guideline of swiftlet farming design should be focus as well. Without a good environment, the bird will not be attracted to build their nest in the existing building.

The environmental factors play important roles in order to make sure the success of this habitat provided. The environmental factors can be divided into macro and micro factors (Penulis and Budiman, 2005). The macro factor such as altitude and source of food and water are the external factors that promote and attract the swiftlet to live in a certain area or habitat.

The micro environment factors are air temperature, mean radiant temperature, air velocity, relative humidity and light intensity. The air temperature suitable for this habitat is between 25°C- 30°C (Kuan and Lee, 2005) and (Onn, 2008). If the temperature is above 30°C, the saliva will be dried and causes the nest to be shrunk. But if the temperature is too cold such as below 25°C, the saliva will not harden causing difficulties in nest development.

Relative humidity should be between 80 to 90% in order to provide condusive breeding environment and re-creation of a natural cave's micro-habitat environment. If the relative humidity is below 80%, the shape of the nest would be affected, as the nest is drier and the stickiness is lesser, the nest would be thinner and easily shatter. Apart from that, if the humidity is too high, the nest will be yellowish in color and reduce the price of the nest. (Kuan and Lee, 2005) and (Ibrahim *et al*, 2009).

The factors that have to be considered in constructing swiftlet farms are that the lighting condition must not be more than 1 lux (Onn, 2008). The light intensity in swiftlet farm is important because low light intensity means a darker environment. Swiftlets prefer the dark because of several reasons. To swiftlet, darkness means safety to their young babies. Most predators are blind in darkness however swiftlet have a special gift where they use echolocation to find they way in total darkness (Sia and Tan, 2008).

3.0 General aspect of the Malaysian Climate

The characteristic of the climate of Malaysia is hot and humid with high solar radiation.

Due to the position of Malaysia (latitude at 2°29'N) the sun radiation on the horizontal surface is higher than vertical surface. The rate of solar radiation received on the surface of a building varies throughout the day. The highest radiation is received mainly on the horizontal plane. As the sun rises in the East and sets in the West, these planes receive solar radiation that varies according to time of day. In contrast, North and South elevation are less exposed to solar radiation.

As mentioned the highest radiation falls on horizontal surfaces and this will include the roof of any building. Therefore the roof is a major area of heat gain into the building and to find a suitable material for this part of the construction is crucial. The east and west walls receive a slightly reduced amount of solar heat gain, but at different of times. However, to reduce any solar heat gain through the walls, the building orientation should be based on an East-West direction allowing the longest side of the building to face in a North-South direction.

Tinker (1998) reported that heat gain from the outside to the inside of the building normally happens by conduction, convection and/or radiation. The heat may change its method of transfer during the process of flow. Solar radiation for example, reaches the roof of the building in the form of shortwave radiation when it is absorbed into the top surface, it is then transferred through the roof material by conduction to the inside surface.

Malaysia has a high humidity. The mean monthly relative humidity range is from 70% to 90%, varying from place to place and from month to month. This is an acceptable range for swiftlet habitat.

Adequate ventilation is essential as and this helps to prevents malodorous area by having a continuous and efficient air flow.

4.0 Thermal effects of building materials

The materials used for the building envelope affect the internal temperature. To maintain the range of acceptable internal temperature, the thermal properties of material must be carefully considered. Solar heat gain is well known to be a major climatic problem in the country, therefore the thermal characteristic and properties of the building materials should be able to control this parameter. If materials with suitable thermal properties are selected for walls, roofs and floor, they can significantly provide suitable habitat for swiftlet. Most of building envelopes are normally composed of several layers of different building materials and an act as a barrier that controls the amount of heat entering or leaving the building.

5.0 Building simulation using Energy Plus®

Energy Plus® is a widespread and accepted tool in the building energy analysis community around the world (Stadler *et al*, 2008). Energy Plus® builds on the most popular features and capabilities of BLAST and DOE-2 but includes many innovative simulation capabilities including time steps of less than an hour and modular systems simulation modules that are integrated with a heat balance-based zone simulation. It was primarily selected because it is a well validated code that is reported widely in literatureThe software was shown to give good results when validated under Malaysia climate (Baharun *et al*, 2010) and (Imran, 2011). Simplified approaches in both interface design and modeling technique can help the non-technical designer to make better design choices.

For this study, the focus would be on selection aspect of material to construct the whole swiflet building with the size of 15m x 8m x 11m. A typical swiftlet farming building design with different conditions has been simulated using different building orientations and construction materials. Details of the swiftlet farm building are shown in Figure 1

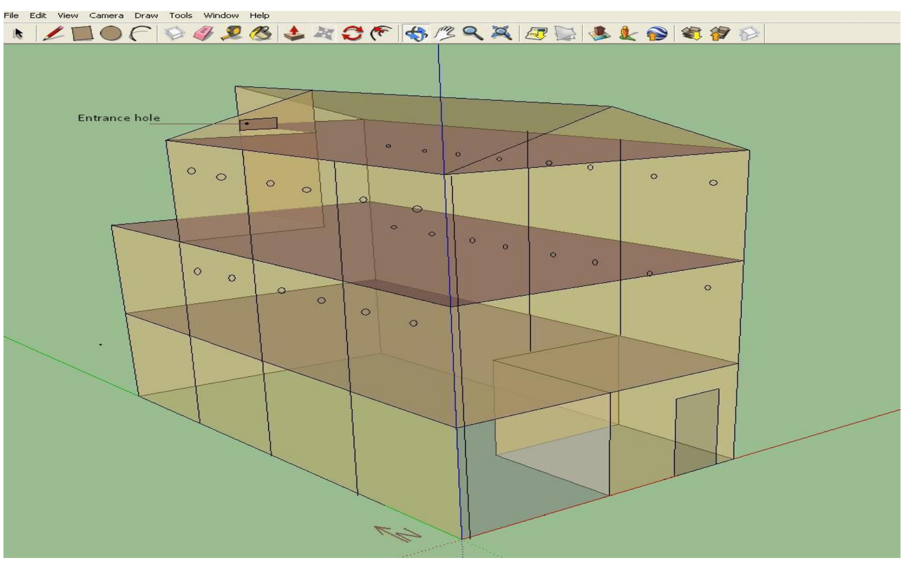

Figure 1: The visualization of the farm in the software.

6.0 Data Analysis

Data analysis will focus on evaluation of selection material type and thickness commonly used to construct swiftlet farming and to see how much each parameter contributes to the provision of suitable environment for swiftlet farming. From this information the favourable ones are to be used to improve the design of a swiftlet farming.

6.1 The Orientation of the Building

The orientation of the building and location of the entrance also affects the population growth of the swiftlet. Set of results obtained from the simulation shown in Figure 2.

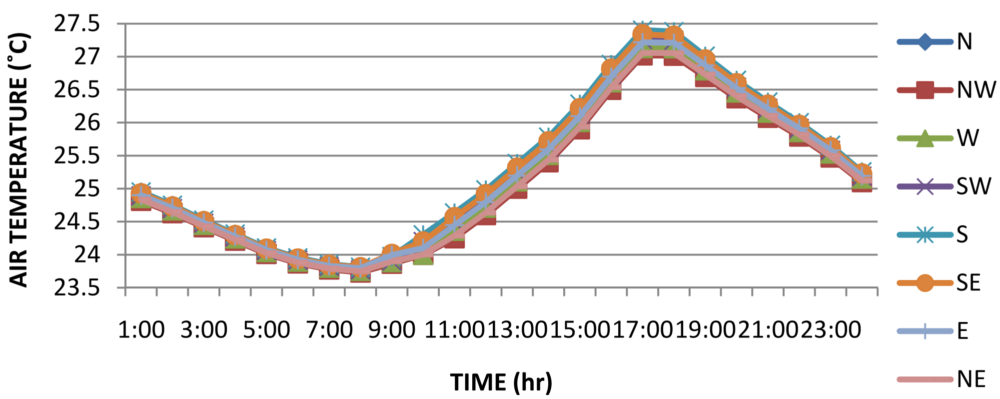

Figure 2: The Building Orientation Aspect

Orientation for East direction has the highest reading of temperature of 27.4˚C. This condition occurs due to the larger area of wall is facing direct to the sunlight caused the wall to be overheated. Orientation for the North and Northwest direction has the lowest reading of temperature. This may happen due to the existence of entrance hole at the front of the building. It can act as a huge ventilation hole to disperse the heat retained in the building.

6.2 The Building Materials and Design

For the simulation process, different materials are chosen to determine the suitability of the materials. The materials description is shown in Table 1.

Table 1: Material description for different wall designs

ITEM	COMPONENT
M1	• 15mm Screed on both exterior and interior side of wall • 100mm Brickwork on both sides with 50 mm air gap in between the brick
M2	• 15mm Screed on both exterior and interior side of wall • 100mm Brickwork
M3	• 15mm Screed on both exterior and interior side of wall • 100mm Concrete block
M4	• Zinc • 50 mm glasswool
M5	• Claytile and roofing felt
M6	• 100mm Lightweight concrete
M7	• 25mm Hardboard
M8	• 10mm asbestos

Figure 3 shows the simulation data on air temperature inside the building using different materials. The data shows that from 11.00 a.m to 4.00 p.m, the air temperature increase gradually. The highest air temperature could be found when 10 mm asbestos used for the walls. The internal air temperature using timber give the lowest value of air temperature compared with the other wall designs. The decrease was mainly due to the low thermal properties of the material.

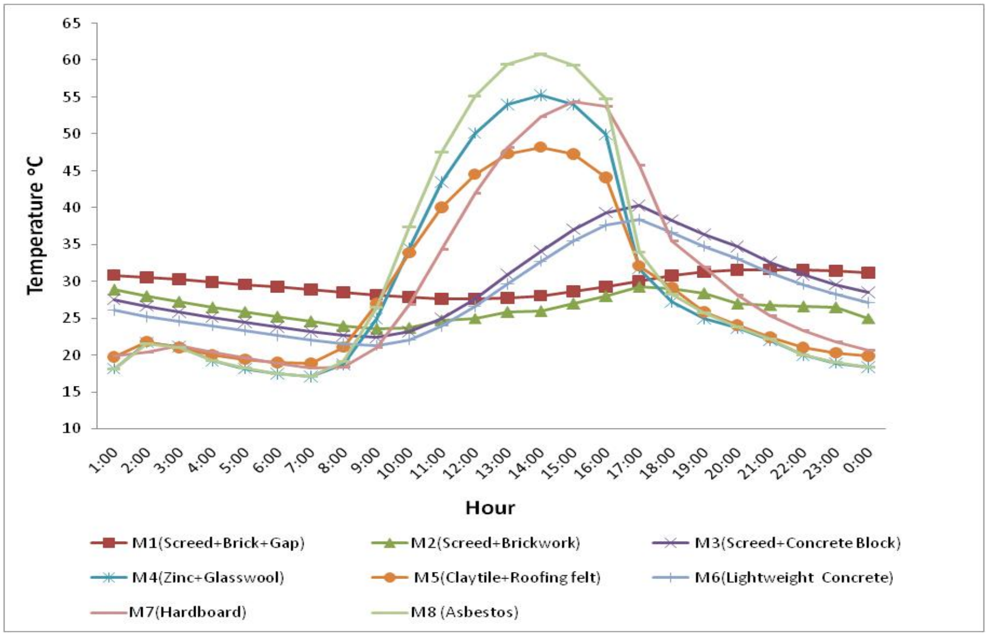

Figure 3: Comparison of Wall Design Aspects

As stated by Kuan and Lee (2005) and Onn (2008), acceptable internal air temperature for swiftlet habitat should be in the range 25^{o}C to 30^{o}C. Therefore, two type of building materials component chosen, M1(Screed+Brick+Gap) and M2(Screed+Brick) for analysis on internal air temperature, mean radiant temperature and relative humidity.

6.3 Air Temperature

Figure 4 shows that for double layer brickwork (M1), the air temperature could be retained due to the existence of insulator in the walls. Heat from the exterior of the walls will transfer through and will retain in the walls. The air gap in the wall cause the heat to transfer gradually compared to single layered brickwork. The process is repetitive and thus a constant range of temperature can be preserved. The temperature reading for this design maintains in the range of 25 to 30˚C.

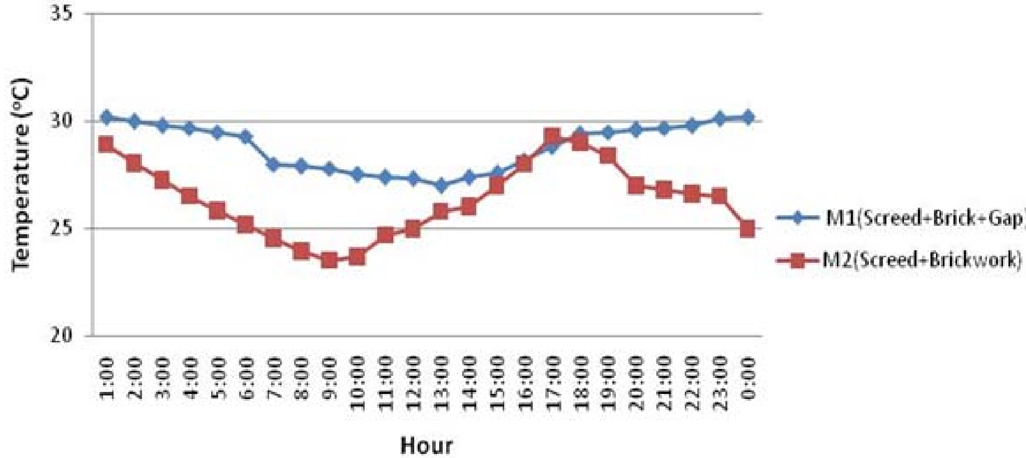

Figure 4: Comparison of the air temperature

6.4 Mean Radiant Temperature

Figure 5 shows data of mean radiant temperature inside the building using two type of component of materials (M1 and M2). The highest reading taken is 31 ˚C at 3.30 p.m. for M2 components. It can be seen from Figure 4, mean radiant temperature compared to air temperature (Figure 4) for M1 and M2 is around 2˚C.

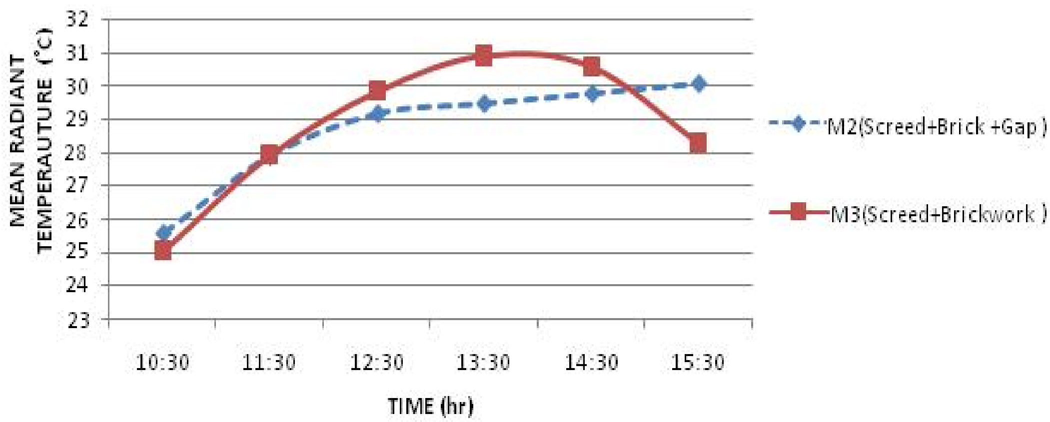

Figure 5: Comparison of Mean radiant temperature

6.5 Relative Humidity

Figure 6 shows the relative humidity for M1 and M2 components. M1 component could retain the level of relative humidity in the range of 85%. M2 components show different range of relative humidity.The lowest reading taken is 78% at 3.30 p.m. The highest reading taken is 95 % at 10.30 p.m.

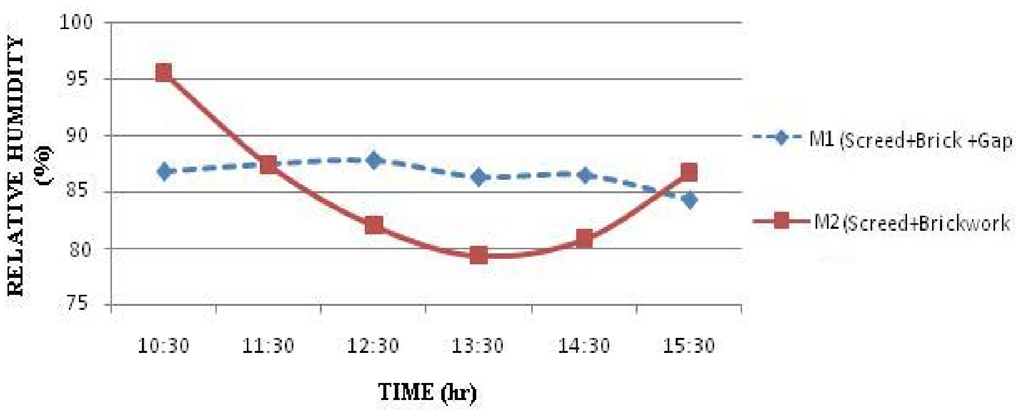

Figure 6: Comparison of the relative humidity

7.0 Conclusion

The building orientation should be based on East-West orientation to reduce the effect of direct solar radiation. The swiftlet building should be designed with the double-layer brickwork. The result shows that double layer brickworks construction with gap is a suitable to fulfill the criteria of swiftlet habitat with air temperature between 25°C- 30°C with mean radiant temperature difference only 2°C, relative humidity 80% -90% and could reduce the effect of solar radiation.

References

Baharun,A., Ibrahim,S.H., Abdullah., O., and Ooi, K.B. (2010) "Validation of modelling and simulation Part 1, Conditions above ground", Kathmandu University Journal of Engineering, Science and Technology.Vol.1: Issue 2/2010

Chai, T.W., (2009). The Study On Suitable Habitat for Swiftlet Farming. B.Eng(Honours) Thesis. Universiti Malaysia Sarawak (UNIMAS)

Ibrahim S. H., Teo W.C., and Baharun, A. The Study on Suitable Habitat for Swiftlet Farming, UNIMAS e-Journal of Civil Engineering –Vol.1: Issue 1/August 2009

Imran, S (2011) Sarawak General Hospital Main Block Building: Retrofit features fo Energy Efficiency, MEng.Thesis, Universiti Malaysia Sarawak (UNIMAS)

Kuan, H. and Lee, J., (2005). *Swiftlet Farming - The Complete Introductory Guide to Swiftlet Farming*, Penang : Struan Inc. Sdn. Bhd.

Onn, T. W., Construction and Management of Swiftlet farm, http://www.crystalswiftlets.com/cs5.html

Penulis,T. and Budiman, A. (2005). *Budidaya. & Bisnis Sarang Walet*. Jakarta. Niaga Swadaya

Stadler, R. Firestone, D. Curtil, C. Marnay,(2008) On-site generation simulation with EnergyPlus for commercial buildings. Available from: http://simulationresearch.lbl.gov/EP/ep_main.html.

Tinker J.A.,(1998),Low Income Housing: Thermal Performance of Roofs, Proceedings of Conference on Low and Low-Medium Cost Housing Development, 9 -10 July, 1998 Kuching, Sarawak, Malaysia.