Roof Materials for Energy Saving in Thailand

Chumnan Boonyaputthipong[1, a], Ph.D.

[1] Faculty of Architecture, Khon Kaen University, Khon Kaen, Thailand, 40002
[a] bchumn@kku.ac.th

ABSTRACT

A roof is one of the most important characteristics of Thai architecture especially a house, traditionally. Also, the roof is a part of the house that mainly affects energy saving due to heat allowance pass to and release from indoor space. The study, based on model experiments, targets to find out the effect of roof materials on indoor air temperature. This study purposes to give information of selecting types of roof materials for a house in Thailand. Models, 1x1x1 meter boxes, are used for the experiments by changing their roof materials in comparison. Four types of roof materials, popular used in houses in Thailand, are selected for the experiments. Those types are a asbestos cement tile, a concrete tile, a adobe tile, and metal sheet. Temperatures in the middle of the boxes are recorded for analyses. The results showed that the temperature in the flat roof box is highest in the middle of the day. However, it released fastest in the nighttime. During the daytime, temperature in the box of the other three types of roof forms are not much different, while the gable roof release heat within the box a little bit faster than the rest. This study gives information for the users in considering roof forms for their house.

KEYWORDS: Roof, Material and Energy Saving

1. INTRODUCTION

A roof is a part of building that performs multi-functions. In the tropical climate the roof is protect building from rain and sun. So, the roof in this climate becomes an important element of the building especially a house. The roof is expected to provide a comfortable environment inside the house. An indoor temperature is one of the key factors in the comfortable situation that is used for this study.

For low-rise building, a roof is the building element that primarily intercepts solar radiation. So, in the hot tropical climate, the roof is designed to control the solar heat loads. It is necessary to reduce the heat transmitted through the roof as the roof is the most exposed to impacts of solar radiation, as it receives sunlight for practically the whole of the day, and in the tropics the angle of incidence is close to the normal in the hotter part of the day. (Kabre, 1999) First the radiation raises the temperature of the roof and the air above the roof surface. The heat is then transferred into the building, and the transferring rate is dependent upon the conductivity of the roof material.

In Thailand, mostly, the roof material has been selected in purpose to show a building's characteristic. So, to maintain suitable indoor temperature, insulation is largely added to help control heat gain from the roof. However, energy-efficient roof material can reduce roof temperatures significantly during the summer, and thus reduce the large amount of insulation and the energy requirements for air conditioning. The study of roof materials in term of thermal performing will be guiding to improvement of the indoor temperature in Thai houses.

2. ROOF MATERIALS IN THAILAND

Thai architecture, a roof is one of the most obvious characteristics. A configuration of roof selected for the house is relatively dependent upon the roofing material. A traditional Thai house had a gable roof with a slope of 50°-60°. This high slope solves a problem of water leak in rainy season as the roof was made of natural material such as grass, wood tiles and clay tiles. In 1970s, a new material for roofing, e.g. cement tiles, allowed the roof to be sloped as low as 15°-20°. With this roofing material, the low-sloped roof had become popular in that time. Nowadays, concrete tiles are a common choice for designers and owners because it is more durable and it has a various range of colors and forms. Cement roof tiles need a slope between 30° and 40° to avoid rain-leaking problems.

Nowadays, cement tile, concrete tile and metal sheet are widely used in houses all over the country. The tradition clay tile is still used in some parts. Thus, these materials are selected for this study.

3. METHODOLOGY

Models for the experiment are installed on the top of the building technology research building in faculty of architecture, Khon Kaen University, Khon Kaen, Thailand. It is located on latitude: 16-26 N and longitude: 102-50 E.

Boxes with 15 degree lean to roof facing south are used for experiment. The boxes are 0.80 x 0.80 x 0.80 m. sealed with foam and gypsum board. Data loggers are placed in the middle of the boxes for temperature measurement. The temperatures inside the boxes are recorded hourly for the comparison and analysis.

Four types of roof materials, cement tile, concrete tile, clay tile and metal sheet, are represented widely used materials for Thai Houses' roof. The colors of these materials are based on the original products. Moreover, these materials have difference thermal characteristic enough for the comparison study.

Figure 1. Models were installed on the top of the building in Khon Kaen, Thailand

4. RESULTS AND ANALYSIS

The results of the experiment are presented as shown in figure 2-3. Temperatures within the boxes were recorded hourly for 2 days. It has been found that the results of these two days are in the same direction.

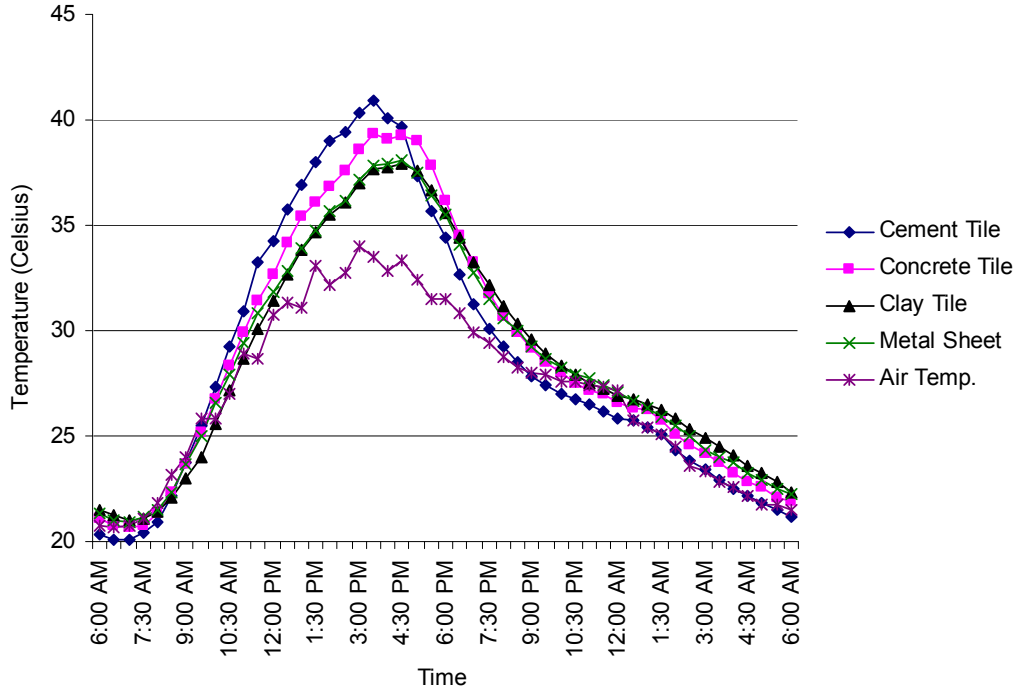

Figure 2. Result of the experiment on day 1

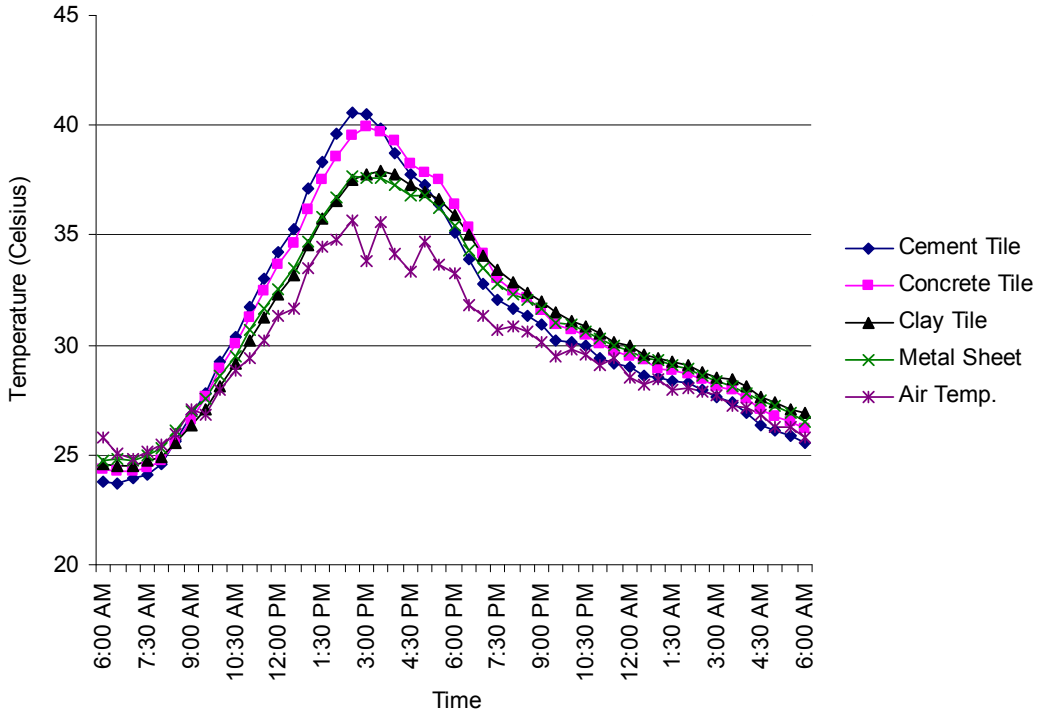

Figure 3. Result of the experiment on day 2

From the figure 2-3, in the day-time, the cement tile has the highest indoor temperatures, while the clay tile has the lowest indoor temperatures. The indoor temperatures of the metal sheet are close to the clay tile during the day-time but the temperatures drop quite slower than others during the night-time. The indoor temperatures of the cement tile rapidly drop after 6.00 am. and become lowest during the night-time. The indoor temperatures of the clay tile are mostly highest at night.

From the results, it has been found that the cement tile, which is widely used in a low budget house, allows very high indoor temperature. It absorbs more heat than other materials. This heat, mainly from solar radiation, then, transfers to the indoor space. However, at night, the cement tile can release heat from indoor to outdoor faster than other materials. This makes the indoor temperature of the cement tile lowest during the night-time.

The concrete tile has a high indoor temperature during the day-time. It releases the heat slow than the cement because the mass is thicker.

The indoor temperatures of the clay tile are lowest during the day-time. That means it allows less heat to the indoor space. By color, which is one of the main factors that influence the thermal performance (Givoni, 1976), the clay tile is in brown color, so it is not the best reflection color compare to others. Also the texture of materials is not as shiny as the concrete tile and the metal sheet. The insulating quality of clay is considering the benefit of this material. However, at night, it releases the indoor heat very slow. This can be because of its insulating quality as well. So, the heat gain during the day cannot release to outside as fast as other materials.

Among these 4 materials, the metal sheet, which gain attention to house's owner widely nowadays, has the best quality of reflection the heat radiation. By this quality, the indoor temperatures of the metal sheet prove to be very low, closed to the clay tile. At night, the heat in the indoor space release to outdoor as slow as the clay tile. It can be because its reflection quality.

5. CONCLUSIONS

For selecting the roof material, it is necessary to consider the benefit both during the day time and night time. The study shown that the clay tile and metal sheet help keeping the indoor temperatures lower than other two materials. However, at night when the temperature outside is lower than in the box, the clay tile and the metal sheet reverse their performances by keeping the heat inside making indoor temperatures of these materials highest during the night time. While the cement tile allows heat pass through the indoor space easily during the day time, it allows heat release out to the outdoor at night easily too. This makes the indoor temperature of the cement tile highest during the day time and lowest during the night time.

However, in a real building, roof system is much more complicate than the experimental boxes. There is layer of ceiling, insulation, etc. The roof material is just part of the system. To integrate roof material with other parts, it is necessary to understand the performance of each material. Then, the solutions can be applied to help improving each material.

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