

Natural ventilation design for houses in tropical region

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Tropical region shares almost the same climate hot and humid throughout the year which has the advantages of the prevailing winds In assisting the flow of air. Natural ventilation has served as an effective passive cooling strategy in vernacular houses for the past decades. Unfortunately these passive cooling design elements have been mostly ignored in contemporary house designs where the effectiveness of natural ventilation has become an issue.

This paper presents the characteristic of past and present house design and their performance In providing comfort for residents. Findings In this paper present the recommendations to enhance the natural ventilation in contemporary house design through lessons from the past. Keywords:

Natural Ventilation, Thermal Comfort, Tropical Climate 1. Introduction

Ventilation in buildings is important as it provides air for human to breathe and live a healthy life where it removes any undesirable odors and contaminants as well as replace the carbon dioxide by supplying an adequate amount of oxygen [1].

Generally, there are 2 mechanisms of ventilation which are natural ventilation and mechanical ventilation. This paper focused only to natural ventilation. According to Bawl [2], natural ventilation Is the term describing alarm flow to/or from a building through specific openings In the building envelope which caused by naturally produced pressure due to wind and stack effects. It has served as an effective passive cooling design strategy to reduce energy consumption and dependency of air conditioning. Almost 68% of the energy is used for Heating, Ventilating and Air Conditioning Systems (HVAC's) [3].

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In a favorable climates and building types, natural ventilation can be used as an alternative to alarm conditioning plants, saving up of total energy consumption [4]. According to Gluon [5], building components that affect natural ventilation include shape of the building, geometrical configuration, orientation of opening, window size and type and subdivision of interior space. On the other hand, outdoor environment such as landscape elements (trees and water bodies) also affect the natural ventilation. 2. Vernacular & Contemporary House vernacular meaning domestic (not foreign) or indigenous.

Therefore, the terms gives more emphasis on 'place' rather than time or 'chronological continuity [6]. Vernacular house were built with respect to the nature and environment. It uses vicinity materials that abundance in the equatorial rainforest's like palm, wood and bamboo as rudimentary materials in constructing a house. In ventilation perspective, these traditional materials contain low thermal capacity to holds little heat and cools adequately at night [7]. Houses were built on stilts to avoid from wild animal attack and prevention from flooding where settlements were usually located near to the forest and river.

The vernacular architecture element such as large window and openings was designed to take advantage of the prevailing winds. The roof usually as overhangs and pitched to facilitate the flow of rain water. In ventilation point of view, overhangs can decrease the amount of solar radiation entering into the house and pitched roof and large openings helps to increase air flow acceleration to eliminate heat accumulation in room and make it comfortable

for occupants [8]. This roof design can easily be found in most vernacular architectural in Malaysia, Indonesia and Thailand.

There is also art element in the vernacular architecture where the panels were embellished with decorative carved and fitted as external and internal walls. Decorative carving is not only meant for aesthetically value only but it plays more important role in ventilation as it allows wind to penetrate and blow inside the house. Each house design in each state is different. There are significant differences in the vernacular house in each country. Many studies have been done to classify the vernacular house in each country. Thailand is located near to the northern part of Peninsular Malaysia.

Some of the architecture in Malaysia is inherited by the influence of Patina [6]. Antiquarian's [9] grouped the house in Thailand into 3 region which are south region, north region ND north-east region which are shown in Figure 1 . The characteristic of house selected include the construction material which constructed almost entirely with wood, with no ceilings and clay tiled roves. In addition, the house selected has no glass in the window apertures representation of the vernacular architecture. Figure 1a: South region Figure b: Central region Figure LLC: North-East region Source: Antiquarian's (2005) [22].

In Malaysia, Mohammad. Arras [6] has classified the Traditional Malay House (TEM) are namely the Mammalian, Appear, Asked and East Coast styles which was illustrated in Figure 2. Their binding features are distinctive 'Malay Roof form and construction system, but there are also other various variables to distinguish the differences between these regional styles (such <https://assignbuster.com/natural-ventilation-design-for-houses-in-tropical-region/>

as arrangement of balcony (male guest), roof detail and orientation and composition of units). ABA Wabash [10] also classified the TEM into 4 zone area referred to the feature of the house due to the historical ties especially migrant effects.

However, Wan Abiding [11] state that based on the different groups of people who had immigrated and settled in the different states in Peninsular Malaysia, the Malay house may be derived into three types which are Malice - Niger Assemble, Skeletal - Termagant, and Juror - Clangor - Appear. The classification of TEM has been simplified in Figure 3. Figure AAA: Appear house Figure c: Asked house Source: Mohammad Arras (2005) [6] Figure b: Malice house Figure ad: Skeletal house Figure 3: Classification of traditional Malay house Generally, there are 33 major houses of provinces in Indonesia.

However, Variant [9] has classified Indonesia architecture focused in Java Island into 3 types of houses which are traditional, colonial and contemporary architecture, as shown in Figure 4. It represents from the strong influence of Islamic culture right up to the influence of European architecture to the modernization of the local architecture. However, colonial building in hot and humid climate especially in Java Island is slightly different from the European classic style where it emphasis the perception of wind, sun and rainfall influence [9].

Figure AAA: Traditional Javanese Figure b: Colonial house Figure c: Contemporary house house Vernacular house were built without modern technology and the skills of master elders were passed from generation to generations. This skill is more vanishing in line with time elapsed. When the <https://assignbuster.com/natural-ventilation-design-for-houses-in-tropical-region/>

architects came back from study abroad, they bring back the idea of modernization. Brick, concrete and asbestos has been introduced to replace the traditional materials. Fan and air-conditioner has been equipped in a contemporary house to provide thermal comfort to the occupants.

This has resulted in high energy consumption. 3. Climate analysis Malaysia is located between 10 and 70 North latitude and 1000 and 1200 East longitudes where the hot and humid climate can be characterized by high relative humidity and air temperature. The yearly mean temperature of between ICC - ICC and has high daytime temperatures of ICC - ICC. Relative humidity of this country is 70%-90% throughout the year [12]. Though the wind over the country is generally light and variable, there are, however, some uniform periodic changes in the wind flow patterns.

Based on these changes, four seasons can be distinguished, namely, the southwest monsoon, northeast monsoon and two shorter periods of inter-monsoon seasons. The southwest monsoon season is usually established in the later half of May or early June and ends in September. The northeast monsoon season usually commences in early November and ends in March [13]. Indonesia is situated between latitude 80 of north and 130 of south, which is a tropic region in Southeast Asia and passed by equator line. It has two seasons which are dry season (April - October) and rainy season (November - March).

The average daily temperature is ICC along the year and the range of maximum and minimum temperature is about ICC. In certain areas, the temperature reaches ICC in dry season. There are two provincial capitals in <https://assignbuster.com/natural-ventilation-design-for-houses-in-tropical-region/>

Java island, Smearing (the capital of entrap Java province) has temperature between 23 - ICC with humidity between 30% - 95%, and Curably (the capital of East Java province) has temperature between 24 - ICC with humidity between 40% - 98%. The relative humidity varies between Thailand lies between 60 and 200 North latitude has a typical tropical climate.

Generally, it has 3 seasons which are not completely distinct. The hot summer months from March to June are characterized by a high sun angle, high temperature, and moderate south wind. The rainy season from July to October has a lower temperature but a higher humidity than the summer months. The remaining months, November to February, are the winter months, where the sun angle is the lowest and the temperature is moderate. The air temperature for the year ranges from 21 to ICC, while the relative humidity varies from 45 to 95% [14].

The study of Administrative [14] recommends that winter period are the most suitable month to apply natural ventilation. 4. Thermal comfort environment [15]. It achieves when the occupants does not feel that temperature is neither too cold nor too warm. American Society of Heating, Refrigerating and Air- conditioning Engineers (ASHRAM) has developed standard 55 as reference in determining thermal comfort. The ASHRAM Standard AAA 1995 on 'Thermal Environmental Conditions For Human Occupancy gives the upper limit of comfortable temperature as ICC [16].

A summary of the neutral temperatures and comfort ranges of subjects in tropical region with hot-humid climate is shown in Table 1. There is so far no study conducted to give a specific measurable scale of Of the temperature in <https://assignbuster.com/natural-ventilation-design-for-houses-in-tropical-region/>

tropical region. The measurable scale also refers to the study of Abdul Raman [19] where the most comfortable indoor temperature in Malaysia ranges from 25. ICC - ICC which refers to scale No. 2 in Table 2. Table 3 refers to the relative humidity (%) in which the amount of water vapor content in the air.

The commended level of indoor humidity is in the range of 30% - 60% by Wolff and Gerhard, 2007 [20]. Table 2: The scale of measurement for Table 3: The scale of measurement for relative Humidity [20] 5. Discussion temperature [19]. A study from Dietitians [14] on natural ventilation design for houses in Thailand has proposed some recommendation designs for contemporary house through lesson from the past. A passive system of natural ventilation only suitable in the cool months and the house should have a large envelope and an irregular shape. Sustainable building design should consider the prevalence in vernacular architecture.

Properly-sized of overhangs that can shade the building from excessive solar heat gain should be used in contemporary house design. Other studies by Kamala [7] suggested that new design to meet the requirement of modern living according to Fee [21] must follow a few concepts. The basic concept demands that direct sunshine and heat to be keep out and facilitate rain drainage by steeply pitched roof design. It also offers large ventilated space that allows warm air to dissipate. It cools the building as gaps between the roof eaves and wooden slats enable air to enter.