The Energy Conservation With A Ventilated Roof of Joglo's House

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Abstract

The ventilation of buildings in hot and dry zones has to function differently from the warm and humid zones. When outside temperatures are rising higher than human body temperatures, cross ventilation through wide openings would not be useful; on the contrary, it would be a burden. To emphasize the sustainability of tropical homes, it is expected to maximize the use of the role of the roof opening in the building envelope in a passive manner. One passive cooling strategy is natural air. Circulation of natural ventilation in traditional Javanese built objects in humid tropical climates is used to achieve thermal comfort. Therefore, the problem that arises in this study is how far the Joglo-based roof element is in natural ventilation to form a comfortable space. This paper contains the elements of a Joglo-based house roof as a natural ventilation element. This study uses a computer simulation based on the program of CFD; the name is CFX-5, which is used to track the pattern and direction of air movement as well as the amount of air velocity and air direction in the Joglo-based roof ventilation object. The final value of these observations is between 0.389 to 0.489 m/s, which provides the majority cooling effect in the room, range between 0.489^{O}C - 0.589^{O}C. This was shown in the modified roof conditions, roof ventilation of the Joglo-Mangkurat-based roof is able to increase the speed of the air rate in the room.

Keywords: *energy conservation, ventilated roof, Joglo's house.*

Introduction

The flow of air should be aimed in the direction "living" or the zone of the building occupied. The airing naturally in buildings is intended to cool the body directly by convection across skin and body, and perspiration absorption. Air exchange is carried out with several air speeds. Generally, the design of low-speed mechanical systems has a little direct effect on the human physiological cooling system against transperspiration. The position and dimensions of the opening in the awakened object can be used to condition the movement of air that moves on the object. Often considered part of "bioclimatic design," natural ventilation is effective for cooling shady buildings and designed according to local climate conditions, such as air and earth temperature, relative humidity, daily wind and wind direction, and seasonal wind direction. In many locations and building types, these climate design elements can provide the main source of cooling comfort in buildings. Javanese traditional houses have special characteristics as identity. Based on the visual image can be used as a pause in planning simulations to obtain optimal thermal and ventilation performance. That should be done in that range, and that simulation planning cannot erase traditional images. According to learning in the traditional section, the part of a traditional house that is very likely to be able to maximize ventilation is on the roof of a building. Three sections affect the quantity of solar thermal radiation globally. Then, there are two parts that have an impact on the quantity of resistance to heat, the type of roof covering material and space planning on the roof without ventilation and ventilation. Based on the analysis of the time lag in making a type 45 house in a humid tropical climate, a ventilated

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roof is able to have an impact on the thermal balance and thermal performance of a building (Wonorahardjo 2000).

This effect is influenced by the roof's heat movement when the roof's construction fully receives heat from the sun's heat, so the quantity is determined by location, the principal orientation, and finally, the roof slope. Explanation of determining the object and basic history for this research is reinforced by research conducted by Lam et.al (2005) which reviews the basic understanding used and the potential of the object we will choose and the potential to be addressed, related to the flow of wind inside and outside the building impact on the thermal environment of buildings.

Review Of Theory

This study using a base object that represents all the types of roof overall *Joglo: Joglo Mangkurat*. Computer software used was CFX-5, CFD-based, as well as the types of variables that are used to detect how the effects of the use of ventilation on the Joglo roof against the change of the air in a building, and where the effective aperture in smooth circulation of air. In order to provide comfort in a low energy consumption building, it is preferable to use natural ventilation rather than HVAC systems (Grigoropoulos et al, 2017).

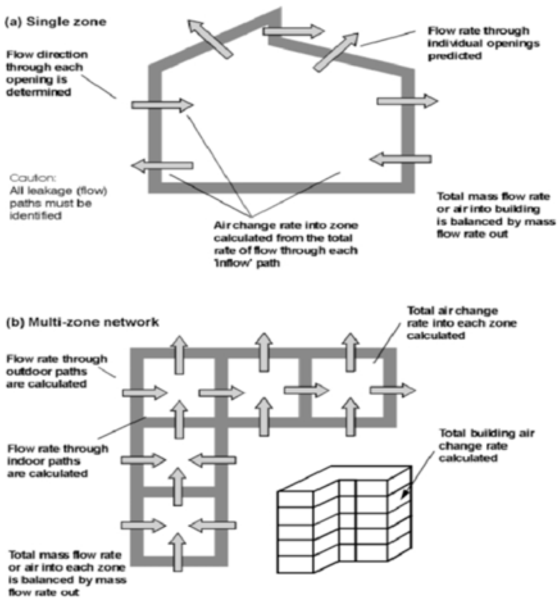
Liddament (1996) explains that to determine the opening scheme, variations in openings for natural ventilation are generally based on the use of wind power and temperature differences inside and outside the building, although in the form of variables, but have not made the design better, if not paying attention to:

a. The temperature of the air within the built-up area
b. The air shift is evenly distributed within 60 minutes
c. The right and a proportional amount of openings

According to the power source to drive (Liddament, 1996), openings for natural ventilation are also regulated by the hot wind, and then shift pressure. The design of openings for natural ventilation is influenced by this source, which is related to the dimensions and location of the opening. Sources of energy to move, are influenced by several parts, namely:

a. Massive pressure on the wind: the air moves into the awakened object and causes positive pressure in the front and negative pressure in the opposite direction in the area of the object being built.
b. Accumulation of pressure or air temperature: created as an effect of temperature difference, hence the solidity of water and air, outside and in the effect of the object being built, is giving inconsistencies in the level of massive pressure outside and inside the air mass which gives massive pressure perpendicular to the outside where the result of perpendicular pressure differences. Where the temperature of the air inside the area is greater than the outside area.

Figure 1. Single and multi-zone flow network (Source: Liddament, 1996)



Specific problems in humid tropical climates besides the potential for high humidity and high air temperatures, are also temperatures above human comfort levels [Figure 1]. The non-active cooling solution provided to overcome this problem is to reduce the heat as much as possible to enter the area in the building. To be able to achieve these conditions means reducing as much as possible the adverse effects of climate performance. Things that need to be considered:

a. Reducing as much as possible heat entering the area in the building: in the direction of the heat zone.
b. According to Szokolay (1980), optimize the flow of wind into the building to reduce the

maximum available heat. Based on the plan above, the focus of this research is on the opening system of the area of awakening / optimizing the wind rate into the awakened object that occurs on the moon, where the air temperature reaches its hottest point in a period. This arrangement is a non-active, most functional cooling planning step in humid tropical regions, where humidity and air temperatures are relatively high.

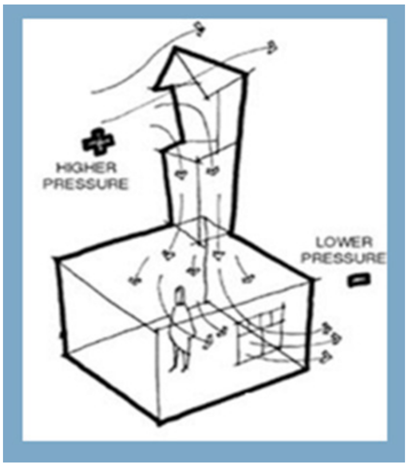
The speed and movement of the air have a big effect on the user's cooling process. The velocity of air is directly proportional to the amount of water vapor and heat that comes from the body (evaporation). The greatest air velocity is in the inlet with dimensions for smaller inlets and relatively larger opposite outlets. A comparison of dimensions between the inlet to the exit is very influential in the movement of air. If the inlet opening is small, 0.09 square meters, and a large outlet, 1.1 square meters, This can produce relatively fast wind speeds. And if a means to enjoy comfort is placed on the side of a relatively small hole, then it will produce a relatively comfortable wind motion to be enjoyed. Then behind the awakened object (which is close to the exit), the wind movement will be slow, and it is not suitable to be a comfortable place. What is recommended in order to produce the recommended airspeed for all inner spaces is that the exit path is somewhat larger than the dimensions/size of the inlet. Apart from the quantity of air being shifted through the inner area is the most important factor, the air movement also plays a role like that, it is obtained by the same method (the entry and exit paths have almost the same dimensions). The movement of air clearly functions for cooling (in the evaporation method). And if it cannot cover thoroughly, then the cooling is not able to run properly.

Discussion and Results

The fact that the object is built rectangular with openings between moving airways, the wind has the potential to move using open channels. When the inlet position is on the edge of the area, the air has the potential to enter the open channel and move to another area. At the opening location, the air pressure in the outer centering area is smaller above the smaller wall area and will become larger in the larger wall area. "Surface vectors" or flowing currents along the surface are the result of different pressures in the concentration of outer space or currents that move along the surface. The shelter column and lattice are able to revise these different pressures in more detail as well as revise the wind potential towards the inlet direction, and this will have an impact on the wind inlet flow.

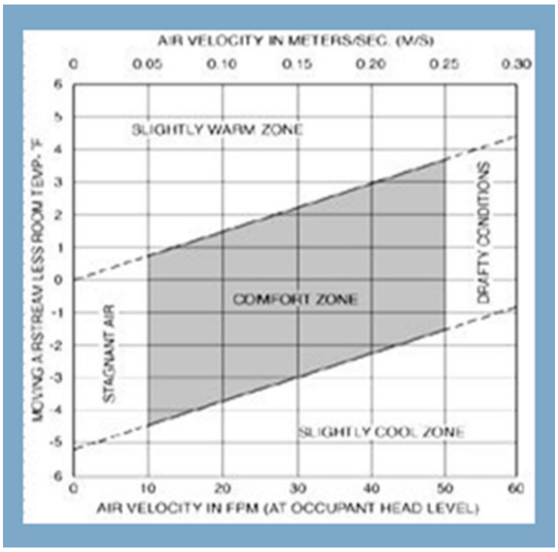
A wind scoop is a method to encourage air to enter the building naturally (similar with Joglo's opening roof) [Figure 2.], in other words, there is upward pressure on the roof of an object built to create an area that has the potential to have air pressure into the rooms (when the air moves from one direction), or enter in openings and out of the scoop when the air comes from a different direction from the original direction. As explained in Bernoulli's theory, the movement of air into deep space is triggered by different pressures created from moving air that is above the wind spoon, and building objects are built up (Roaf et al, 2007). The same structural framework that is also functionally used in the tropics to incorporate natural ventilation patterns and materials is the "Tower of Venting" (see Figure 2). The tower on the roof of a building to influence air patterns and moving material and produce relatively low air pressure areas. This is what causes the air to move/be attracted to the built-up object. This composition requires a lower opening area towards the opening, which has the potential to produce relatively higher air pressure.

Figure 2. Middle east's object built's winscoop (Source: Roaf et.al, 2007)



Openings in natural ventilation can reduce the level of air temperatures that are relatively high in tropical climates [Figure 3], especially humid tropical. "Solar ovens," or unprotected windows or uninsulated roofs will collect more heat than is needed, and this is the need for a non-active (passive) cooling solution. The west-oriented glass wall is the effect that needs the solution. This is what underlies a design that is not in context with the climate will make buildings that are not energy friendly (Allard and Giaus, 2006). Top-down or balanced-stack natural ventilation systems use high-level supply inlets to access less contaminated air and to place both the inlets and the outlets in higher wind velocity exposures Evaporative cooling towers are important elements of a potential energy home that cools indoor air temperatures (Babich et.al, 2017).

Figure 3. Zone of comfort modified to consider the movement of air (Source: Roaf e. al, 2007)



The pattern of air motion in the area inside a traditional Joglo house, indicates the presence of an airway moving outside the roof of Joglo, with a speed of 0.189 to 0.289 m/s, so that the difference is 0.589 to 0.689 m/s from the initial speed. The movement of air entering the Joglo building through the opening on the roof, starting from 0.489-0.589 m/s, then decreases with the speed of 0.389 - 0.448 m/s, with a value of 27.489% of the percentage of the speed of air that moves in the Joglo building [Figure 4]. When complex building structures are erected, the difference in pressure and the created airflow pattern will not be easy to target. The appropriate method is to test targeted planning based on a scaled model, then grafted in a stable moving air rate and then observation using smoke media in a vessel. For this reason, the results that have been produced will have an impact on the formation of a comfort zone in the built object based on the Joglo house.

Figure 4. Joglo's house with opening's wind speed

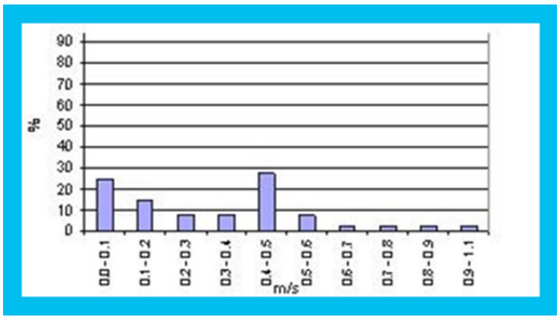
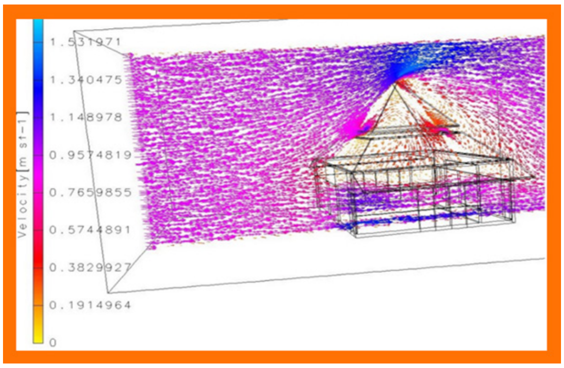


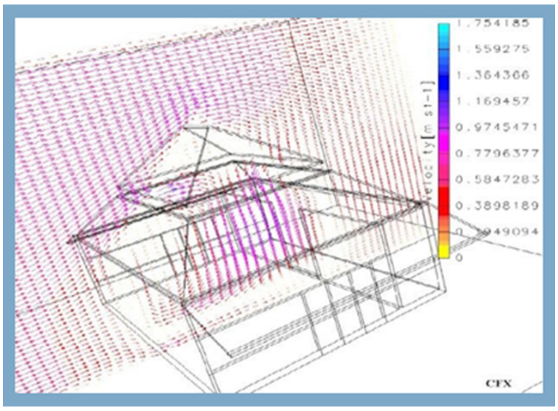
Figure 5. Joglo's house with the opening's in the flow picture



Streamlines represent the wind velocity (the yellow until blue line) [Figure 5]. The streamlines were compared so as to roughly consider the flow field affected by the location of devices (Allard and Giaus, 2006). Wind flowing above the units was an upward flow, although it was a frontward flow into the opening of the roof. On the other hand, apply airing or other types of ventilation such as open exhaustion or natural ventilation due to tradition, national legislation, climatic conditions, and/or cost reasons can make an alternative of low energy residence (Sugahara et.al, 2017) [Figure 6]. The rates of computed ventilation under various fixed conditions depend mainly on the opening cross-section, but also strongly on the location of openings and their geometry, which is not reflected by available design tools (Zukowska et.al, 2020). In some passive methods, traditional architecture has raised the potential of the region including the climate, and this also has an impact on energy savings in the building (Aghlmand, 2011).

Indeed, this program has a few weaknesses in the display conditions of air temperature of an object and should be compared with the other similar programs to produce the maximum result. With a roof opening design with consideration or air, movement behaviour is expected to be the better opening design in natural ventilation. The influence of building elements that is more detailed or wider leads advanced research along with the CFD software development so that computation study transmits with another CFD software research result like FLOVENT and FLUENT can be conducted.

Figure 6. The wind-speed and air-flow pattern of opening's roof's built object



Conclusion

The function of the ventilation is to flow air from outside into the room and vice versa so that a healthy change of air occurs to be inhaled. Along with the release of air from the inside, ventilation is also a channel for pollution from the building. This air circulation aims to create a clean air availability that is low in pollution with the intention of keeping the humidity and temperature comfortable for the occupants in the building. Building ventilation is an important factor that can have an impact, not only on the productivity and activities of its inhabitants. Thus the potential spread of respiratory infections can also be reduced. Cross ventilation and chimney supported natural ventilation result in high air exchange rates (Schulz and Eiker, 2013).

Building envelope that affects many conditions of comfort in buildings, one of which is the roof. The shape of the roof is important to transfer the heat out of the room. Also, the main objective of building ventilation is also used to cool indoor air (Larsson & Moshfegh, 2017). Only a holistic approach, including a wide range of passive cooling methods, tools, and technologies, can significantly reduce the environmental impact of cooling systems. Passive and hybrid solutions for reducing 'sol-air' increments, mitigating internal gains, and dissipate heat are able, in fact, to provide comfort conditions without consuming fossil fuel energy, or at least reducing this consumption (Chiesa & Grosso, 2017).

Several ventilation strategies have been described in several approaches to choose the right strategy, such as the right balance of air flow, local climate control in the room and the use of ventilation for night cooling, so indoor air quality can be maintained or improved while reducing energy consumption (SeppĘnen, 2008).

The roof has the potential to drain air out through the ventilation holes contained in between. Reduction of air temperature in areas in built objects such as the Joglo house with a ventilated roof can increase the level of effectiveness and efficiency in the use of energy in the building. This is because the openings on the roof of Joglo are able to provide the air supply to enter the building so as to reduce the temperature of the air inside the awakened object despite all openings under the roof in the closed position. It also refers to Koenigsberger et.al (1973), that the pressure of moving air flowing in an area that has a high air pressure towards an area that has a lower air pressure. And last but not least is the relationship between indoor air quality and energy efficiency created by outdoor air ventilation which is the main link to sustainable buildings, and most importantly that indoor air quality is very important to achieve energy-efficient buildings with indoor environments (Persily & Emmerich, 2012).

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