Improving the indoor environment in "*kampong*" house
(Case study: Siwalankerto Timur, Surabaya)

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Abstract

At a house, an opening is a requirement regarding the daylight penetration into the room, humidity and air temperature control, and maximizing room ventilation and air change. Thus, opening has important role to make a better indoor environment that bringing indoor activity comfort and healthy life. But in most of kampong house in urban area usually do not have enough opening. The aim of this study is to realize the society, that the opening of the room is important.

The case study took place at two kampong houses in Siwalankerto Timur. Both houses are approximately 70-100 m², with small open space in front of it. Both are brick walls plastered, cement floor tiled, wooden roof structured and genteng roof covered. Both houses do not have openings to outdoor except to the front open space. Several rooms in both house improved with addition some opening by jalousies or skylight.

The indoor environment aspects in this study are daylighting, ventilation, temperature and humidity. The daylight indicator is daylight illumination. The ventilation indicator is air velocity. Temperature, humidity (relative humidity) and air velocity are indicators of thermal comfort. Measurement of those aspects did at before and after the houses improved. Analyzed on each aspects showed that improvement on both houses had given a better indoor environment. The improvement of indoor environment can be an example to others kampong house occupants. They shall realize that they need to live in better indoor environment.

Key words: daylighting, ventilation, thermal comfort, indoor environment

Introduction

Building in warm humid climate requires enough outdoor space to allow air flow into the indoor room. Besides that, building should have enough opening for air flow and for daylight penetration. They are needed to make a comfortable and healthy indoor space.

Kampong house in urban area usually are crowded, even they do not have open space. The whole site is built with not enough openings to the outdoor space especially an opening to the front of the house. Their activity does in the darkness, dampness, still air, hot temperature and humid air. Such indoor condition, may bring discomfort for occupant's indoor activity and it's become unhealthy living area, but they do not realize. Most of them do not have knowledge about comfort for their activity and healthy living.

Good indoor environment requires daylight for healthy living environment and visual activity at day. It also need ventilation to control CO2 and odour, and to give thermal comfort. This study had improved two kampong houses by addition some openings, in order to bring more daylight, ventilation and better room thermal.

The Indoor Environment

In this study, the aspects of indoor environment of kampong houses studied are daylight, ventilation, indoor air temperature and indoor humidity.

Daylight. Daylight has effect on the human body (Evans, 1981). There are variations of normal growth development in both plants and animals, if they life in full spectrum of natural sunlight, or variation in the wavelength distribution by artificial light sources, or distribution of wavelength distribution of sunlight filtered through glass. Man also may find himself in trouble if he does not comprehend the secrets of sunlight and adapt them to his purpose in the establishment of his environments.

Daylighting is good if there is enough daylight into the building interior from 08.00 until 16.00; daylight distributions spread everywhere and no disturbs contras. (Departemen Pekerjaan Umum, 2004).

The daylight factor expresses the interior illumination as a fraction of that available outdoors, generally in horizontal plane. This fraction, usually written as a percentage, can be expressed as

$$DF = \frac{\text{Indoor illumination at given point}}{\text{Outdoor illumination}} \times 100\%$$

Recommended minimum level on ordinary seeing task is 1.5 – 2.5 %.

Natural Ventilation Natural ventilation use to achieve minimum ventilation for health or, air movement to improve indoor comfort in warm humid climates. (Ansley, 1977) Ventilation rates to reduce odours to an acceptable level vary from 25 to 90 m3 per hour depending on the volume and function of the space. Ventilation to improve thermal comfort depends on local air speeds in occupied portions of space.

The cooling effect of the airflow on the occupants is due to convection and evaporation of sweat from skin. The evaporative capacity of the air decreases with increase in relative humidity. Lippsmeier stated that cooling is increased by accelerated evaporation from the skin and not by lowering the temperature of the environment. If the air speed increased so the upper limit of the comfort zone is extended. In generally, the pleasant indoor air speed in warm humid is 0.5-1 m/second.

Thermal Comfort. The most important factors affecting the standard of comfort in an enclosed space are the air temperature, the humidity, the movement of air, the general degree of lightness and distribution of light within the field of vision, the average temperature of radiation from walls and ceilings (Lippsmeier,1969). In warm humid climate, average dry bulb temperature often more than 26°C. Temperature diurnal and temperature annual are not significant. Relative humidity range is 60-100 %. Wind speed is less than 2 m2. With high temperature and high relative humidity, the basic thermal problem is needed air speeds for physiological cooling.

The temperature. Lippsmeier stated the temperature comfort in warm humid tropical region mainly between 22-29 °C. Olgyay found the comfort air temperature is 23-30 °C. Temperature comfort in Indonesia in the research result of Santoso (1986) is 25,4 -28,9°C. But it was corrected at 1988 to become 26-29.1 C (Santoso, 1988).

The humidity. Relative humidity (RH) is the amount of water vapor in the air expressed as a percentage of total water vapor which can be held in the air given temperature. RH less than 20 % are likely to cause discomfort due to the excessive dryness of the air; this may cause lips to crack, eyes to become easily irritated and the throat to become sore. RH above 90 % fell clammy and damp.

The air movement. The reference of thermal comfort in warm humid climate, air speeds necessary to restore comfort in environment with high dry bulb temperatures and relative humidity can be determined form Fig.1.

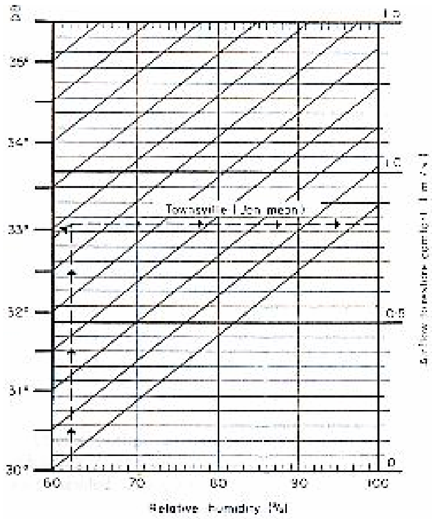
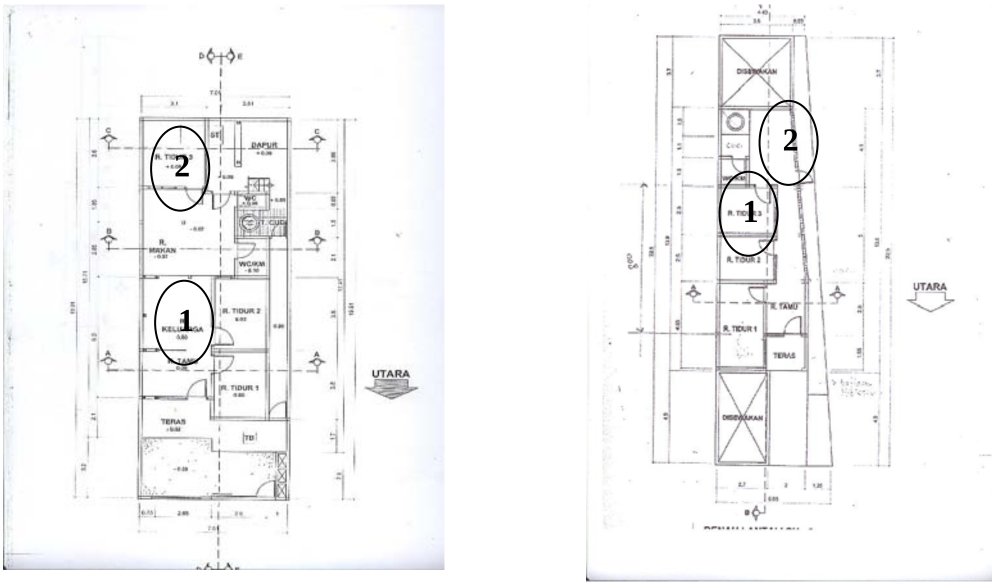


Fig.1. Minimum air flow to restore comfort for a range of dry bulb temperatures and relative humidity.
(Ansley, 1977)

The Case Study

The houses which studied are on Siwalankerto Timur, at north of Petra Christian University. The buildings type is in approximately 70-100 m², with small open space in front of it. The first house is about 70 m² that built on 140 m² land area. This house consists of a sitting room with window and door to the front terrace, a dining room which is open to the washing place, three small bed rooms with small window opened toward the side open passage, a kitchen which only has a door to the side way, a small maid room without window, bath room, and open washing place with well. In front of this house there is a small open space with plants and terrace, next to the two bed rooms there are small open side way to the kitchen. See Fig.2.

The second house is 55 m² that built on about 100 m² land area. This house consists of a sitting room with door and window to the terrace, a dining table set in indoor passage with small window which never open, three small bedrooms without window, a bath room without ventilation, and a small kitchen open to washing space and well. In front of it, there is a terrace uses to sell groceries and open space, which half of it they rented out to other person. See Fig.2.



Frist House Second House

Fig.2. Plan of Houses

Building Improvement

The improvements were

1. A window opening and ventilation for each room, because there were none.
2. Changing the window position to be better ventilation and daylight
3. Changing the room position, with reason to get better window position to the limited outdoor space.
4. Opening skylight to bring better daylight in the rooms, to avoid darkness and dampness.

Measurement

The indoor environment aspects those measured were luminous intensity of daylight (lux), speeds of airflow (m/s), dry bulb temperature (°C) and relative humidity (%). Measurements are taken in two times. The first did on February, 13th until 17th, 2006. This measured the existing condition before the improvement done. The second, measured after improvement, did on 1st until 8th of August 2006.

Measurements of both houses did in terrace (outdoor) and in every room (except a bathroom), at the middle of the room, because the rooms were small, not bigger than 9 m². Those rooms were measured three times per day: at seven am when the sun rises and the air is still cool and become warm, at twelve am when sun is on the top, and at five pm when sun starts to down, and the air starts to cool. But in two rooms of both houses, measurement temperature and humidity by data logger, taken in whole day.

Daylight luminous intensity was measured by light meters. Air speed was measured by thermo-anemometer. Four units HOBO data logger measured room temperature, room humidity and room intensity of daylight of two rooms in first house and two rooms of second house. Thermo-hygrometer used to measure outdoor (terrace) relative humidity and outdoor (terrace) temperature. Temperature of others rooms measured by manual thermometer.

Result: Indoor Environment Before And After The House Improved

The result below is condition of only two rooms in each house, which have significant improvement, and its air temperature measured a whole day by data logger. Those rooms are living room (room 1) in first house, bedroom (room2) in first house, middle bedroom (room 1) in second house and back bedroom (room 2) in second house. (See figure 2.)

The result describe by charts of daylight, air speed, temperature and thermal comfort. Each chart describes indoor environment condition of existing buildings and after the house improved, so both condition is easier to compare.

Daylight

Daylight condition was described by percentage indoor illumination of each room from outdoor illumination. But outdoor illumination measured not on a real open space, so the number of percentage is bigger than exact daylight factor. The result is in figure 3.

Room 1 first house. After the house improved, there was no effect at the morning, but at noon there was increasing daylight illumination at 3 times the condition before and at afternoon at 6 times. This condition was caused by direct sunlight that penetrate into the room from window at noon and afternoon on August.

Room 2 first house. After the house improved, there was increasing daylight illumination in the morning at approximately 2.5 times the condition before, 1.5 times at noon, but only a little at afternoon. This condition was caused by addition the skylight that allow direct sunlight in the morning until at noon.

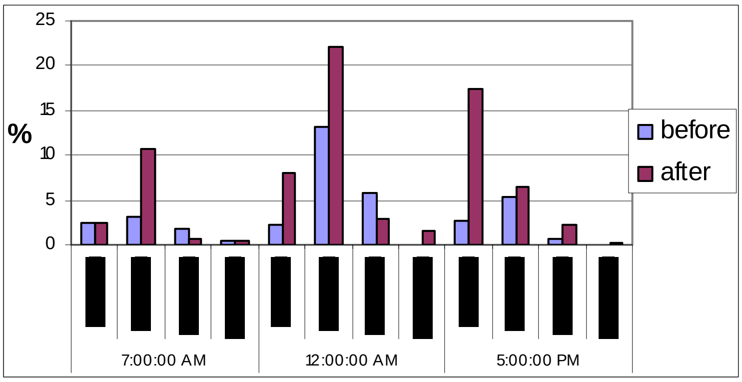


Fig.3. Daylight Diagram

Room 1 second house. After the house improved, there was decreasing daylight illumination to be a half of condition before at the morning and at noon, but at the afternoon there was increasing daylight illumination, 3 times. This condition was caused by wrong position of the addition skylight where was at shaded area since morning until noon.

Room 2 second house. After improved the house, there was no effect at the morning, but at noon there was increasing daylight illumination 6 times the condition before and 2 times at afternoon. This condition was caused by the additional skylight which allow more daylight penetration only at noon.

Natural ventilation

Natural ventilation condition before and after house improved was described in percentage of indoor air speed divide by the outdoor air speed . The result can be seen in figure 4.

Both Room in First house. After improved the house, there was increasing air speed caused by addition opening that allowed the wind through into the room. The increased air speed were 1.1 times at the morning, 2 times at noon, and 2.3 times at afternoon from the condition before.

Room 1 second house. Addition a skylight in this room as opening for ventilation can increase indoor air speed only at noon and at afternoon, because the hole of the skylight was in wrong orientation.

Room 2 second house. Addition an opening gave bad impact for natural ventilation in whole day, because the air speed got decreased. This condition was caused by wrong position of opening where face toward the passage with no wind flowing.

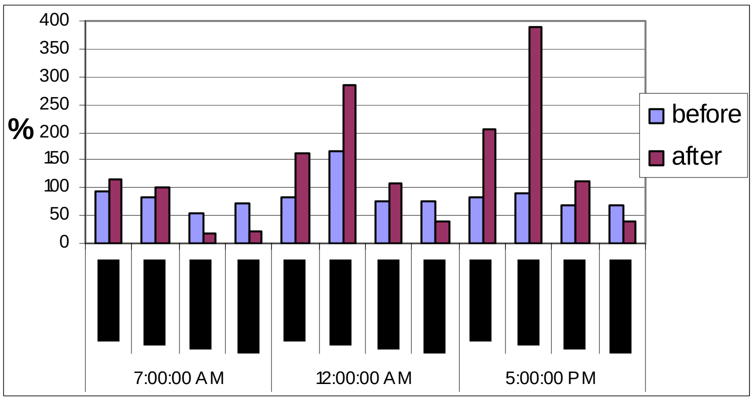
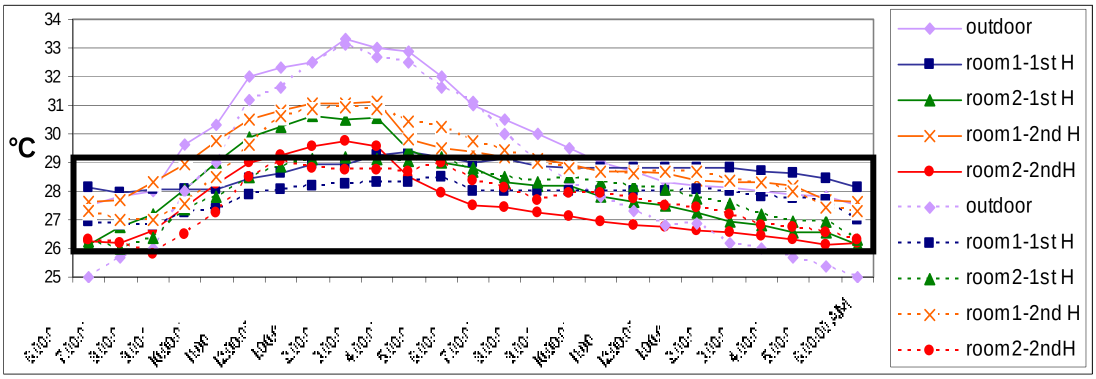


Fig.4. Air speed Diagram

Temperature

Indoor air temperature before and after improved the house as in figure 5. The before and after measurement were not taken in the hot season, so the indoor temperature tend to the comfort temperature (in the range of 26 – 29 °C).

After the house improved, the fluctuations of temperature tends to lower than the condition before improvement. At noon, in Room 2 of the 1st house and Both rooms in the 2nd house; after improvement indoor temperature was higher caused by the sun radiation which penetrate into through the added skylight.



Note : Straight lines indicated the condition before improvement, dust lines indicated the condition after improvement.

Fig.5. Temperature Graph

Thermal comfort

Indoor temperature range before improvement was 26.15-31.12 °C, after improvement was 25.82-30.92°C. Indoor relative humidity range before improvement was 43.14-89.8 %, after improvement was 42.75-79.70%.

Before improvement, some times there were higher indoor temperature and RH so they need 0.36-0.44 m/s airspeed. Indoor air speed from the measurement was less than 0.1 m/s, so can not fulfill the indoor thermal comfort. After the improvement, the temperature were lower than 30 C and the relative humidity were lower than 60%, these indicated from the chart below that the conditions need not air flow to fulfill the comfort zone.

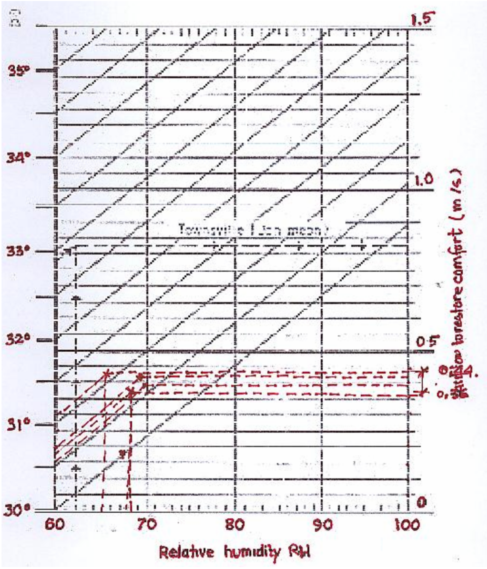


Fig. 6. Temperature and Humidity from 4 rooms applied into Chart of Minimum air flow to restore comfort for a range of dry bulb temperatures and relative humidity by Ansley.

Conclusions and Suggestion

Conclusion

In generally, these kampong houses improvement had a good impact to their indoor environment on:

- Increasing daylight intensity
- Increasing air speed
- Decreasing humidity
- Minimizing indoor temperature fluctuation

There were some failures caused by the opening orientation to the sun path or to the wind direction. The failures are:

- In the 1st house
  - Room 2 (bedroom), after the improvement the daylight intensity are lower, because the daylight only come from skylight in the dining room.
- In the 2nd house
  - Room 1 (bedroom), after the improvement, the indoor temperature become higher because the sun radiation into the room through the skylight.

- Room 2 (bedroom), after the improvement, the air speed is too low to the human comfort, because the outdoor air come from the open air upper the well.
- Room 1, and 2 (bedrooms), after the improvement, the indoor daylight intensity are not comfortable to the visual activity in certain time when the sunlight directly penetrate into the room through the sky light.

Suggestion

This physical kampong house improvement, by renovation the house opening could be a purpose to a better indoor environment in kampong houses.

– Further research should be more attention to the opening design, size and orientation to the sun path and wind direction.
– The size and position of skylight, will impact to unstable indoor daylight intensity.

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