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A Study on Balcony and Its Potential as an Element of Ventilation Control in Naturally Ventilated Apartment in Hot and Humid Climate

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ABSTRACT

Identified as one of the key issues towards achieving a sustainable building, natural ventilation in apartment buildings is at a primary importance especially in Malaysia, a tropical country with hot and humid climate. Apart from the normal window opening, a balcony is an alternative architectural element to allow for better ventilation in a naturally ventilated apartment. The incorporation of balconies at apartment buildings however, has been neglected mainly due to cost and space constraints, though knowing that it has many benefits especially in achieving better thermal comfort for its occupants through better ventilation, and subsequently in avoiding the need for active means such as air-conditioning. Apartment buildings are selected for the study due to the increasing demand for high-rise residential especially in metropolitan cities such as Kuala Lumpur, where land becomes more expensive and scarce. The main objective of this paper is to examine through literature review, the characteristics of a balcony and its potential in providing a better ventilated apartment. The outcome of the study proved that the balcony could be used as transitional space to control and induce the outdoor air flow into indoor spaces of an apartment. However, the study will require further detail analysis with various parameters to ensure that the ventilation benefit of balconies is optimized. This study however, which will be done on subsequent analysis.

Keywords: *Apartment, Balcony, Hot-humid, Natural Ventilation.*

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1. INTRODUCTION

In urbanization process, developments in the housing industry is very important and has becomes the focus in resolving the need of materialization for urban living. As land becomes more scarce and costly, the development of apartment buildings to fulfill the human basic needs, especially in urban settings is unavoidable.

The development of residential buildings such as apartments in urban setting uses large amount of energy and land area, which gives adverse impact on the natural environment. As a result, there is an urgent need for sustainable development. The needs for sustainable dwelling as thus become more crucial as dwellings such as apartments give direct impact to its inhabitants. It is a place where its inhabitants spend most of their time to live, rest and regenerate energy for next day work routine. Due to this, it is necessary for designers to look into the right match between housing solutions and the needs of the people and its environment.

Climatically responsive approach in architectural design has become essential in achieving sustainable development. Various approaches have been applied in the design to ensure that buildings are adapted to the local climate condition. One of the neglected elements in the design of apartments is the balcony which has various benefits contributing towards sustainable development. Among the benefits of balcony is that it can be used as an element of climatic control to achieve a better thermal comfort inside buildings by inducing natural ventilation into indoor spaces of apartments.

This paper looks into the concept of natural ventilation and characteristics of balcony. It also look into current studies available which contribute towards the understanding of the potential of balcony as an element of ventilation control in naturally ventilated apartment in hot and humid climate, with special reference to Malaysia.

2. NATURAL VENTILATION

Ventilation is “the process by which “clean” air (normally outdoor air) is intentionally provided to a space and stale air is removed” [1]. Natural ventilation for buildings is the process of ventilation through natural means, for examples through opening of windows and doors. Natural ventilation in buildings can basically be divided into two types, wind driven ventilation and buoyancy driven ventilation. Normally, for single storey unit in high-rise apartment, wind-driven ventilation plays a more important role in providing natural ventilation due to higher wind speed. Nevertheless, positive combination on both types of ventilation will provide a greater impact, as the role of buoyancy driven ventilation become greater as the vertical height of opening or vertical distance between openings is greater and as wind driven ventilation velocity is reducing.

Natural ventilation is very important to the health and comfort for occupants of buildings as it provides fresh air and maintains good indoor air quality. In a hot and humid climate, ventilation is crucial to achieve better indoor thermal comfort. Due to high humidity, ventilation speed is essential to allow for higher level of evaporation of sweat which avoids

discomfort due to skin moisture and providing better thermal sensation. According to Glanville et al [2], “as long as there is some air movement, most people will tolerate higher temperatures before they complain of discomfort”. Apart from the advantages of natural ventilation, it is also important to note that there are also the disadvantages of natural ventilation. These include difficulties to control indoor air quality and noise pollution, especially for apartment as it is most likely located in city.

In the traditional Malay house, incorporation of various passive design solutions such as plentiful full height window, ventilation grilles and panel as well as building raised on stilts contribute positively to the better thermal comfort to its occupants [3]. They allow for better natural airflow in the house by utilizing both wind and buoyancy driven ventilation. However, with development of technology, especially with the introduction of air-conditioning and ceiling fan, the need for natural ventilation elements such as verandah has not been considered of a primary importance. As a consequence, various traditional ways to provide thermal comfort in indoor environment have been ignored, which result in uncomfortable and unhealthy indoor environment and thus require the considerations for active means such as air-conditioning for indoor environmental control.

Nowadays, mechanical means of ventilation and thermal control such exhaust fan and air-conditioning system is widely used, not only in office buildings but also in residential buildings. This is the result of inappropriate building design and uncomfortable external environment resulted from the hot and humid climate. Whilst designing, building designers tend to isolate indoor building spaces from the natural environment surrounding it. This is an attempt to have better control over the quality of indoor spaces. The attempt to create an artificial internal environment has various negative impacts to its inhabitants and to the environment. For example, it could result in excessive use of energy and also generate Sick Building Syndrome. Thus, providing a better naturally ventilated building is crucial to improve indoor thermal comfort and consequently remove the need for active thermal control for buildings.

3. INTRODUCTION TO BALCONY

Balcony is defined as ‘a platform that is built on the upstairs outside wall of a building, with a wall or rail around it, you can get out onto a balcony from an upstairs room’ [4]. Based on this definition, the word balcony is very much similar with the word ‘skycourt’, a popular terms in bioclimatic architecture, introduced by Ken Yeang, a famous Malaysian architect.

Yeang [5] has defined skycourts as “large terraced areas that can be both private and communal and are located in the upper parts of the tall building”. The skycourts as explained by Yeang is based on his study on eco-skyscraper. Yeang [5] further explained that the skycourts features could effectively act as private communal spaces, wind-controlled zones as well as sun-receiving spaces, which could give benefits of better occupants’ satisfaction, better incorporation of natural ventilation, green landscaping opportunities as well as low-energy benefits. Even though balconies at apartment buildings are normally in smaller scale, the impacts of the balconies could be as much as the skycourt, or even more as the inhabitants normally spent much of their time in their home.

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Incorporation of natural ventilation is an integral part of the Malay traditional house design. Naturally ventilated 'anjung' or entrance porch found in front of Malay houses has similarity with the balcony which allows for an open comfortable space, where there is no enclosing wall. Besides providing comfortable space for rest and entertaining guests, the 'anjung' acts as a buffer space, help to avoid abrupt change in microclimatic condition and at the same time act as filter envelope for the indoor space from the hot and humid climate outside.

In Kuala Lumpur, balconies can only been seen in upper-end apartment buildings. There are various factors which influence the lack of incorporation of balconies in apartment buildings. The main reasons are associated with cost and space constraints, especially to middle cost apartments and below. The lack of understanding and awareness on the needs and benefits of balconies among designers and occupants also play an integral part contributing to the lack of overall acceptance of balconies as part of building configurations.

In Malaysia, the incorporation of balcony in apartment units is not made mandatory by authority. However, this is different with the state of New South Wales (NSW), Australia, where, the role and benefits of balconies are recognized and well understood. The NSW government plays a significant role in encouraging and enforcing the incorporation of balconies in apartment buildings. The Residential Flat Design Code by Department of Planning, NSW Government, which supports State Environmental Planning Policy No. 65 (SEPP 65): Design Quality of Residential Flat Development, states that it is compulsory to provide at least one primary balcony with minimum depth of 2.0 meters when private open space is not provided. The involvement of authorities is crucial in insuring successful implementation of sustainable development, and in this matter the incorporation of balcony in building configurations. In near future hopefully, the Malaysia government also will take a similar positive step to encourage sustainable development through incorporation of balconies.

The incorporation of balconies at apartment buildings is an attempt to respond to the local climate. Balconies become transitional areas where they receive direct flow of external wind and redirect it into indoor environment. At the same time, they act as a buffer from external weather such as functioning as a shading device to protect indoor spaces from the direct solar radiation and rainwater. This is also very important for buildings in hot and humid countries like Malaysia. Balconies also contribute towards better relationship between human and nature by promoting an outdoor private open space. Balconies give an enhanced amenity and lifestyle to apartment occupants by taking advantage of great outdoor environment. In the architectural perspective, balconies contribute towards the form and articulation of apartment buildings. With various design approach consideration, balconies could become great architectural element. Balconies can also contribute towards better security and liveliness of spaces around apartment buildings by allowing for informal overlooking. Besides the above, balconies also can enhance monetary value of highrise residential properties, regardless of the view outside [6].

On the other hand, the incorporation of balconies in apartment buildings does have it disadvantages which can give negative impact if not been tackled. Large opening at balcony could lead towards excessive velocity of air flow which could cause draught nuisance; however, this can be controlled by limiting the opening size. For air conditioned buildings, it could result in leakage of indoor cool air and allowing outdoor heat to pass through glass

closure at the balconies. Security also is a main concern for balconies especially for apartment units at lower floors.

Balconies as element to promote natural ventilation also lead to disadvantages in controlling indoor air quality and noise pollution, especially for apartments located in cities such as Kuala Lumpur. However, these disadvantages could be reduced by various means such as providing sufficient greenery at balconies and providing proper geometries of balconies to avoid reflection of noise into indoor environment. For example, in the research done by El Dien et al [7], it states that balconies projections depths with inclined parapets can provide reduction of noise between 4.5 and 12.0 dB (A).

With all the advantages and disadvantages discussed, it is essential to note that the exact impacts of balconies are also depending on the social, economy and environmental factors. For example, in temperate climate such as Sydney, Australia, the benefit of balcony in inducing natural ventilation is limited to summer time, while it result in heat leakage during winter time, whereas, in Malaysia, the need for balcony to induce indoor natural ventilation is pertinent whole year round.

4. BALCONY AS ELEMENT TO INDUCE NATURAL VENTILATION IN AN APARTMENT.

Design of a sustainable residential development is influenced by various factors. According to Oktay [8], “when deciding how to make an environmentally responsible intervention with a new building within the site, two major site factors must be addressed, which are the local climate and the environmental impact of the building on the site”.

Utilization of local natural wind for indoor natural ventilation is one of building adaptations to its local environment. Window is the commonly used means of natural ventilation. A certain amount of air will pass through windows from outdoor to indoor or vice versa, depending on various factors. According to Larsen et al [9], the amount of air passing through window opening will depend on the wind speed, temperature inside and outside of room, wind direction; turbulence characteristics in the wind, the pressure variations caused by e.g. wind gust, as well as the size, type and location of the opening.

Openings at balconies have similar characteristics with windows in which it allow passage of light, air and sound. The openings could be only a door or combination of a door and other types of opening. Balconies have protruding elements which give impact on air flow. Having similarities with windows, but with a door and possible larger opening, balconies are great alternative to induce natural ventilation into indoor environment. However, the incorporation of balconies shall come with proper design and detailing. It shall response to the local climate and context to ensure that it usefulness is optimized.

Apartment buildings have huge opportunity to incorporate natural ventilation as it has the advantage of height which could receive greater wind speed compared to lower level building. This can be seen in the graph of mean wind speed ratio against height in Power-law model [10]. However, with higher air speed, it will require better control, as excessive wind speed

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could cause draught and movement of indoor properties such as paper. Incorporation of balconies, however, could give better flexibility on control of indoor natural air flow.

Balcony, being at the façade of apartment buildings, it capable of influencing the external air flow by causing turbulence. For example, the study done by Chand et al [11] indicates that the wind pressure distribution and turbulence on windward wall is subjected to variations due to provision of balconies on building facade. If properly designed, the balcony can create turbulence and generate wind pressure which contributes positively towards indoor airflow.

Openings at the balconies play an important role to control the indoor natural ventilation. The size of opening influence the air pressure developed on the external surface of the wall. With similar external wind velocity, smaller opening develop higher pressure on the surface which result in higher indoor airflow velocity. As a result of this, inducing indoor air flow through control of opening size helps to achieve an appropriate indoor wind speed. Besides that, the adjustable large opening at balcony also can psychologically make the occupants to be more tolerable to level of discomfort as they are capable of controlling the amount of ventilation.

In addition to the above, the configurations of balconies also play an important role to optimize the natural ventilation indoor. For example, incorporation of wing wall in balcony configurations can lead to effective natural ventilation. According to Givoni [12] and Mak et al [13], an addition of wind wall at openings in single sided ventilated square cell could induce the wind flow from outdoor into indoor. Mak et al [13] also found that the best performance of wing wall is at the wind angle of around 45 degree. In the research done by Prianto et al [14,15], it states that opening and balcony designs and configurations are to be useful in increasing natural indoor air movement, and they must be taken into consideration on designing dwelling especially in tropical humid region. In other words, balcony has a function as a wind scoop for scooping the air into building.

However, an accurate effect on air turbulence required a thorough study on the balconies and buildings configuration as well as its contextual. Therefore, experimental or numerical studies such as wind tunnel test and computer simulation studies are essential, before they could be incorporated in building design to ensure that the objective of the incorporation of balconies are accurately materialized.

Based on the completed literature review, there is no specific study done on the impact of balconies on the outdoor and indoor airflow of apartment buildings in Malaysia context. Studies on ventilation in local context are important to provide proof and give better awareness and understanding on the benefits of balconies. This will ensure that the concept of balconies as element of ventilation control is accepted and at the same time, properly applied to apartment buildings, in particular to cities such as Kuala Lumpur.

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the study, it could be concluded that a balcony can act as an element of inducing and controlling the natural ventilation in apartments through various factors such as larger and flexible opening, ability to act as wind scoop and has capabilities in controlling indoor and outdoor turbulence characteristics. However, it is important to ensure that the benefits of incorporating balconies in apartment buildings are optimized and the incorporation of balconies is feasible in comparison to the initial cost invested. Due to lack of study in the Malaysia context on the impact of balconies on outdoor and indoor air flow, it is necessary to have further scientific studies on this area. As a subsequent study, the author will look into the numerical and experimental studies to demonstrate the ventilation benefit of balconies in apartments.

REFERENCES

- [1]. Liddament M W (1996), A Guide to Energy Efficient Ventilation, Air Infiltration and Ventilation Centre, Coventry, Great Britain.
- [2]. Glanville M, King S and Bourke P (2008), Natural Ventilation of Residential Apartments, Building Construction Materials and Equipment (BCME), Volume 48-No.1, Issue 1. Autumn 2008, pp 34-35.
- [3]. Yuan L J (1987), The Malay House: Rediscovering Malaysia's Indigenous Shelter System, Institut Masyarakat, Pulau Pinang, Malaysia.
- [4]. Oxford Advanced Learner's Dictionary (2000), Oxford University Press, Oxford.
- [5]. Yeang K (1996), The Skyscraper Bioclimatically Considered: A Design Primer; Wiley-Academy, Great Britain.
- [6]. Chow K W, Wong S K and Yiu C Y (2004), The Value of the Provision of a Balcony in Apartment in Hong Kong, Emerald Journal, Volume 22 No. 3, pp 250-264.
- [7]. El Dien H H & Woloszyn P (2005), The Acoustical Influence of Balcony Depth and Parapet Form: Experiments and Simulations, Applied Acoustics, (66), pp 533-551.
- [8]. Oktay D (2002), Design with the Climate in Housing Environments: An Analysis in Northern Cyprus, Journal of Built and Environment, 37, pp 1003-1012.
- [9]. Larsen T S & Heiselberg P (2008), Single-sided Natural Ventilation Driven by Wind Pressure and Temperature Difference, Energy and Buildings (40), pp 1031-1040.
- [10]. Cook N J (1985), The Designer's Guide to Wind Loading of Building Structure, Part 1: background, Damage Survey, Wind Data and Structural Classification, Butterworths, London.
- [11]. Chand I, Bhargava P.K. and Krishak N. L. V. (1998), Effect of Balconies in ventilation Inducing Aeromotive Force on Low-rise Buildings, Building and Environment, Vol. 33, No. 6, pp 385-396.
- [12]. B. Givoni (1976), Man, Climate and Architecture; Applied Science Publishers Ltd, London.
- [13]. Mak C M, Niu J L, Lee C T and Chan K F (2007), A Numerical Simulation of Wing Walls Using Computational Fluid Dynamics, Energy and Buildings, (39), pp 995-1002.
- [14]. Prianto E and Depecker P (2002), Characteristic of Airflow as the Effect of Balcony, Opening Design and Internal Division on Indoor Velocity: A Case Study of Traditional Dwelling in Urban Living quarter in Tropical Humid Region, Energy and Building, (34), pp 401-409.

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- [15]. Prianto E and Depecker P (2003), Optimization of Architectural Design Elements in Tropical Humid Region with Thermal Comfort Approach, *Energy and Building*, (34), pp 401-409.