Study of natural ventilation on communal space in co-living at Setiabudi

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Abstract. Natural ventilation is the process of replacing air in the room with fresh air from outside the room without the help of mechanical equipment. The use of natural ventilation in a building in addition to producing healthier and more comfortable spaces can also increase energy efficiency. The shape of the building and the position of the openings determine the natural ventilation operation method. The principle of ventilation shows how the exterior and interior air flow is connected. Kleiven in his thesis entitled Natural Ventilation in Buildings (2003) revealed that there are 3 principles of natural ventilation. Those are single sided ventilation, cross ventilation, and stack ventilation. [10].

Setiabudi is a subdistrict in South Jakarta and located within Golden Triangle of Jakarta (SegitigaEmas Jakarta), a triangular area of business and commercial establishments in Jakarta. Setiabudi Subdistrict is bounded by Cideng River - MentengPulo Road - a water channel to the east, a flood channel to the north, JenderalSudirman main road to the west, and JenderalGatotSubroto main road to the south.

The latitude of Setiabudi, South Jakarta City, Jakarta, Indonesia is -6.213519, and the longitude is 106.822266. Setiabudi, South Jakarta City, Jakarta, Indonesia is located at Indonesia country in the Districts place category with the GPS coordinates of 6° 12' 48.6684'' S and 106° 49' 20.1576'' E.

Keywords: Co-living, affordable, natural ventilation, cross ventilation

1. Introduction

Living close to work is important for today people, as they want to minimise travel time to and from work to allow for more time with their families and friends and enjoying hobbies. But the problem is, houses in Jakarta are too expensive even for middle income society, so most of them choose to rent a house or apartment instead of buying one in the downtown area. As one of a solution, the concept of co-living housing is considered to have low consume energy so that they have low price of rent rate. In accordance with what Holly explained, in their article entitled Strategies for Designing Affordable Apartment Complexes [1], about strategies that can create affordable, comfortable, practical and attractive apartment dwellings. These include increasing shared space and increasing natural ventilation and using energy efficiently. With a more affordable cost, residents can still enjoy the facilities that are used together. By implementing a natural ventilation system in the building,
besides being able to reduce operational costs, the energy used can be more efficient, it can also create a more comfortable residence.

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Figure 1. Single sided ventilation

Figure 2. Cross ventilation

Figure 3. Stack ventilation

2. Research Method
The method used is quantitative method, where the data is obtained through comparative studies from the similar projects around the Southeast Asia (Table 1). Data collection through literature studies from books and journal is carried out to obtain data on concepts, theories and information that can support and become the basis in the design process of co-living with the application of a cross ventilation. And finally the study will be applied to the building and simulated with the software Autodesk FlowDesign which will produce the number of velocity rate inside the space. And it can be proven whether the number meets the criteria of windflow comfort that stated in the book of Heating, Cooling, Lighting: Sustainable Methods for Architects [2].
Table 1. Comparative Study

| Building                                      | Building Orientation | Wind   | Ventilation System          | Window Orientation | Window Types       | Fin-wall | Over-hang |
|-----------------------------------------------|----------------------|--------|-----------------------------|--------------------|--------------------|----------|-----------|
| SkyVille @ Dawson, Singapore (47 storeys)     | North-West           | North  | Cross-ventilation           | North-West         | Awning & Sliding   | No       | Yes       |
| SkyTerrace @ Dawson, Singapore (43 storeys)   | North-West           | North  | Cross-ventilation           | North-West         | Awning & Casement  | No       | No        |
| Via 31, Thailand (8 storeys)                  | North-West           | South  | Stack ventilation & Single sided ventilation | North-West     | Awning & Casement  | No       | Yes       |
| Green Heart Marina One, Singapura (34 storeys)| Northwest-Southwest  | North  | Cross-ventilation           | All sides          | Sliding & Casement | Yes      | Yes       |
| Pali Palms, Mumbai (12 storeys)               | East-West            | South  | Cross-ventilation           | All sides          | Sliding            | No       | Yes       |
| Avana Apartments, Indonesia (17 storeys)      | North-West           | North  | Cross-ventilation           | North-West         | Sliding            | Yes      | Yes       |

3. Results

3.1. Wind Respond Analysis

The research aspect of this project is focused on the context of wind, especially cross ventilation. From the data that has been obtained, there are several variables studied, namely building typology, corridor type and position and type of openings.

![Figure 4. Building Massing](image)

The building mass responds to the wind direction at the site so that the building can be exposed to more wind and avoid wind shadows. With a typology of buildings in the form of I which are arranged parallel (Figure 4). This building mass was selected after previously simulating 3 alternative building masses, until finally the building mass with the optimal wind flow was chosen, as the simulation below (Figures 5-7).
Figure 5. I Shaped Massing, height of 2 floors

Figure 6. I Shaped Massing, height of 8 floors

Figure 7. I Shaped Massing, height of 16 floors

As the massing has chosen, the building developed by implementing a single loaded system and openings in the opposite position on each residential unit to maximize cross ventilation. So that the wind can flow throughout the building (Figure 8).

Figure 8. Cross Ventilation with Single Loaded Corridor

3.2. Cross Ventilation Analysis

Based on the results of comparative studies of precedent studies, it was concluded that for site locations with humid tropical climates, the type of openings that are often used is awning types for rooms and sliding for living & dining rooms (Figure 9). Living and dining rooms that use a sliding opening type, allow more air to enter without any obstructions. So the air can enter smoothly. Or as another option, ventilation blocks can be used as well to replace the window (Figure 10).

Figure 9. Types of openings

Figure 10. Ventilation Blocks

Based on Heating, Cooling, Lighting: Sustainable Methods for Architects [2] there is a criteria of the windflow comfort. In hot and humid climates (in this case tropical climates) require between 1-4.5 m/s wind speed in the room to be comfortable for the occupants (Table 2).
Table 2. Air Velocity / Windflow Comfort (Source: Heating, Cooling, Lighting: Sustainable Methods for Architects[2])

| Air Velocity (m/s) | Equivalent Reduction* | Effect on Comfort |
|--------------------|------------------------|-------------------|
| 0.1                | 0.2                    | Stagnant; not slightly uncomfortable |
| 0.2                | 0.3                    | Barely noticeable but uncomfortable |
| 0.5                | 0.6                    | Design velocity for air outlets that are near occupants |
| 0.8                | 0.9                    | Not noticeable and comfortable |
| 1.1                | 1.2                    | Very noticeable but acceptable in certain high-activity areas |
| 1.4                | 1.5                    | Upper limit for air-conditioned spaces |
| 1.6                | 1.7                    | Good air velocity for natural ventilation in hot and dry climates |
| 1.8                | 1.9                    | Considered a gentle breeze when hot outdoors |

*The value in this column are the number of degrees that the temperature would have to drop to create the same cooling effect as the given air velocity.

From the simulation, with the chosen opening types applied to all of the units at the typical floor 3rd to 16th, which is awning for the bedroom and sliding for the communal area, also using ventilation blocks in the area that facing the corridor, it is proved that the wind can flow inside the unit with a comfortable speed with the velocity rate in between 1-3 m/s (Figures 11-14).

**Figure 11.** Simulation at the 3rd floor  
**Figure 12.** Simulation at the 10th floor  
**Figure 13.** Simulation at the 16th floor  
**Figure 14.** Velocity Rate

From those analysis, thus type of openings and position will be applied to the building unit since it has proven that the wind will flow optimally to the typical units which ultimately resulted in the following final design (Figures 15-16).

**Figure 15.** Ventilation Blocks on the side that facing the corridor  
**Figure 16.** Sliding door at the balcony side and awning window on the bedroom
4. Conclusion
Co-living is a solution that can be used as an alternative rental housing for millennials. With facilities such as apartments, co-living can reduce the cost of rent because it applies the concept of sharing facilities for its residents. In addition, in the effort of cost reduction, energy efficiency in buildings must be improved. One of them is by applying natural ventilation to the building so that the use of AC in the shared space in the co-living building can be reduced. From the results of the analysis that has been done, it was found that natural ventilation on the site can work optimally when massing the building is made thinner with a single loaded system, so that cross ventilation can occur in the building. The massing shape of a building also has a significant effect. From the analysis that the author has done, the best massing of buildings that can be used on the site is the I or L-shaped massing. In addition, the building orientation factor also influences the effectiveness of natural ventilation in buildings. In this case, the orientation of the building faces north and south. With the long side exposed to direct gusts of wind. For the opening in the unit, cross ventilation placement is the best choice compared to the single sided opening. This is because with cross ventilation, air can more easily enter and exit the room so that the air change in the room is maximized. In this case, cross ventilation is applied by placing the opening points at opposite points, not just one side. The communal space is also placed in the center of the cluster unit with more openings so as to get maximum natural ventilation with airflow rates ranging from 1 ~ 3 m/s. In each unit in living & dining rooms, the best window type to use is the sliding type. Apart from the fact that more air can enter, the openings can also be adjusted as needed so that it is more flexible. Meanwhile, for rooms that do not require a lot of air to enter, awning or casement type windows can be used so that the room can still have air change. On the side of the unit facing the corridor, it was chosen to use a rooster with additional glass windows on the inside, to maximize the privacy of the coliving occupants. Air can enter the building, and privacy is maintained.

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