# Natural Ventilation of HDB Hawker Centers and Its Impact on Thermal Comfort

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**SUMMARY**

This research project investigates the impact of different architectural layouts, landscaping, etc on the natural ventilation performance of the hawker centers in Singapore. The studies cover the examinations of the thermal comfort in upgraded and non-upgraded hawker centers through the field measurements and surveys. The impact of some key architectural layouts on natural ventilation is explored through series of scaled model wind tunnel testing. The potential of using mechanical assisted ventilation to enhance thermal comfort in hawker centers is studied through CFD simulations. Also, the impact of roof construction on the thermal comfort of hawker centers is investigated through field measurements and computational simulations. Finally, a guideline on the design of hawker center with good natural ventilation and thermal comfort is developed.

**KEY RESEARCH FINDINGS**

The field measurements and surveys were conducted in 6 upgraded and 5 non-upgraded hawker centers. Some conclusion can be drawn as below:

- The thermal environment in upgraded hawker center is slightly better than those non-upgraded.
- The thermal environment in upgraded hawker centers is found to be satisfactory by more people than in the non-upgraded hawker centers.
- The operative temperature is beyond the upper limit of the ASHRAE thermal comfort standard in all investigated hawker centers.
- People feel slightly warm in all investigated hawker centers and they prefer cooler environment.
- The air freshness and air flow are satisfied by most people but they prefer more air movement.

The study of the impact of the architectural layouts on natural ventilation in hawker center was studied through the wind tunnel testing. (Figure 1).

***Figure 1. Wind tunnel and scaled model***

The tested architectural design parameters include:

- Roof Form
- Roof Height
- Stall Gap

- Stall Height
- Courtyard
- Number of storeys
- Hawker Center Layout

It was found:

- The provision of openings at the hipped-ends of the roof helps to improve ventilation.
- The optimum roof height is 5.0-5.5m.
- An increment in stalls height worsens the ventilation performance in hawker centers.
- The ventilation is improved when the stall spacing is increased from 0.5m to 1.5m, and 3m is the suitable stall gap.
- There is significant improvement in ventilation when an additional courtyard is present in the hawker center.
- The 1st storey performs better than 2nd storey in terms of ventilation.

The Computational Fluid Dynamics (CFD) software was extensively utilized to simulate the air flow, wind speed and air temperature distribution of various mechanical ventilation design scheme in hawker centers. (Figure 2).

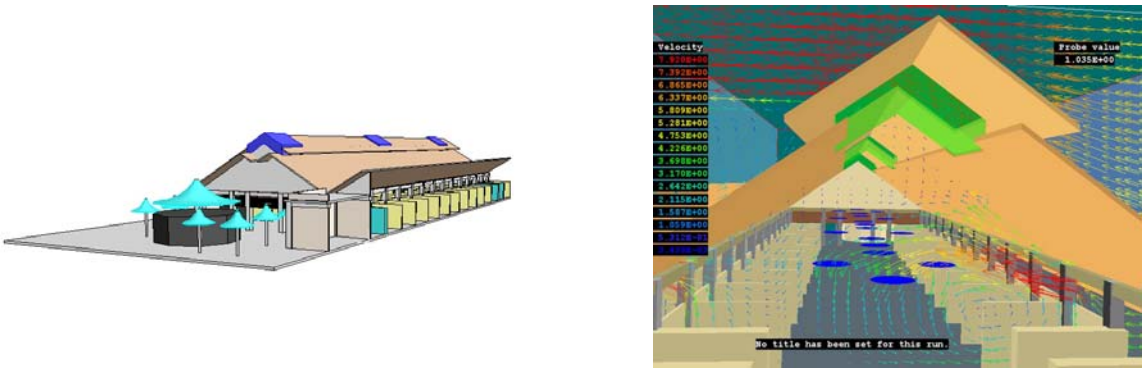


***Figure 2. Hawker Center model in CFD software***

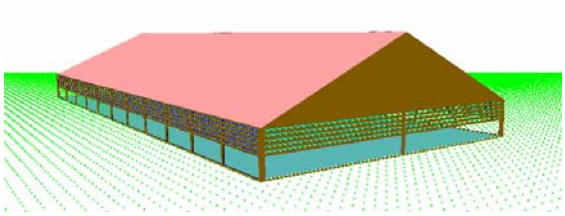

***Figure 3. Hawker Center model in TAS software***

The CFD simulation results show that the installation of the fans should help the hot air flow outside in addition to increasing the air velocity. Installing exhaust fan can improve the stack ventilation in the hawker center and installing the wall fans could provide a higher air movement closer to the occupants, which make people feel comfortable.

The effect of roof construction on the hawker center thermal environment was studied through the field measurements and computational simulations. The field measurement results show both indoor air temperature and

mean radiant temperature in the upgraded hawker centers are lower than that in the old hawker centers with the simple roof insulation. In the computational simulations (TAS software), the thermal performance of 4 types of roof construction with different U-value was tested (Figure 3).

The results reveal that the commonly used roof type (U= 0.7W/$m^2$C) in upgraded hawker centers has good thermal performance. Actually, the roof with 2 W/$m^2$C U-value can provide suitable prevention of solar radiation and heat.


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