Department of Building, School of Design and Environment,
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RESEARCH BRIEF 2005/002

Natural Ventilation of HDB Hawker Centres and Its Impact on Thermal Comfort

SUMMARY

This research project investigates the impact of different architectural layouts, landscaping, etc on the natural ventilation performance of the hawker centres in Singapore. The studies cover the examinations of thermal comfort in upgraded and non-upgraded hawker centres through field measurements and surveys. The impact of some key architectural layouts on natural ventilation is explored through a series of scaled model wind tunnel testing. The potential of using mechanically assisted ventilation to enhance thermal comfort in hawker centres is studied through Computational Fluid Dynamics (CFD) simulations. Also, the impact of roof construction on the thermal comfort of hawker centres is investigated through field measurements and computational simulations. Finally, a guideline on the design of hawker centres 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 centres. Some conclusions can be drawn from the study:

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

The study of the impact of the architectural layouts on natural ventilation in hawker centres was studied through 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 centre layout

It was found that:

- 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 stall height worsens the ventilation performance in hawker centres.
- 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 centre.
- The 1st storey performs better than the 2nd storey in terms of ventilation.

The CFD software was extensively used to simulate the air flow, wind speed and air temperature distribution of various mechanical ventilation design schemes in the hawker centres (Figure 2).

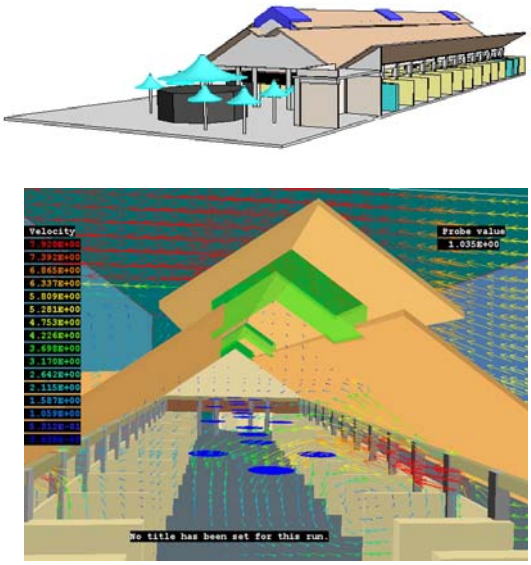

Figure 2. Hawker centre model in CFD software.

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

The effect of roof construction on the hawker centre's thermal environment was studied through field measurements and computational simulations.

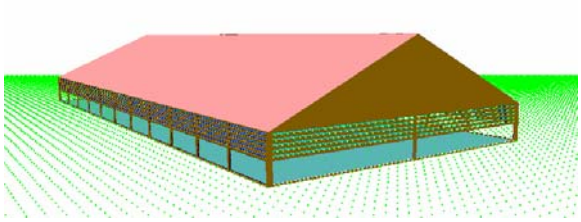

Figure 3. Hawker centre model in TAS software.

The field measurement results show that both indoor air temperature and mean radiant temperature in the upgraded hawker centres are lower than those in the old hawker centres with simple roof insulation. In the computational simulations (TAS software), the thermal performance of 4 types of roof construction with different U-values was tested (Figure 3).

The results reveal that the commonly used roof type (U = 0.7W/m^{2}C) in upgraded hawker centres 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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