Department of Building, School of Design and Environment,
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RESEARCH BRIEF

2004/016

Thermal Performance of Façade Materials and Design and the Impacts on Indoor and Outdoor Environments

SUMMARY

This research project investigated the thermal performance of the façade and the impacts of façade material and façade design on the indoor and outdoor environments in naturally ventilated (NV) buildings in Singapore. The studies covered the examinations of the thermal performance of façade and indoor thermal environments in the existing NV buildings through a series of field measurements. Some thermal properties of commonly used façade material were tested in the laboratory. The potential of using suitable façade U-value and the adoption of window shading device to achieve good indoor thermal comfort were studied through the simulation exercises as well. Finally, an attempt was made to develop a design guideline on the acceptable U-value of an NV building façade.

KEY RESEARCH FINDINGS

The field measurements were conducted in 4 school buildings and 2 Housing Development Board (HDB) buildings. Some conclusions could be drawn and they are as follows:

- Orientation and building height had an impact on façade thermal performance.
- The thermal protection of a secondary roof system in HDB buildings was proven wonderful in the field measurement.
- The current façade systems in most selected buildings had good thermal performance.
- The indoor thermal environment in the selected measurement rooms was good.
- The façade design was good in most selected buildings. The thermal buffer and window shading device were widely used in these buildings.

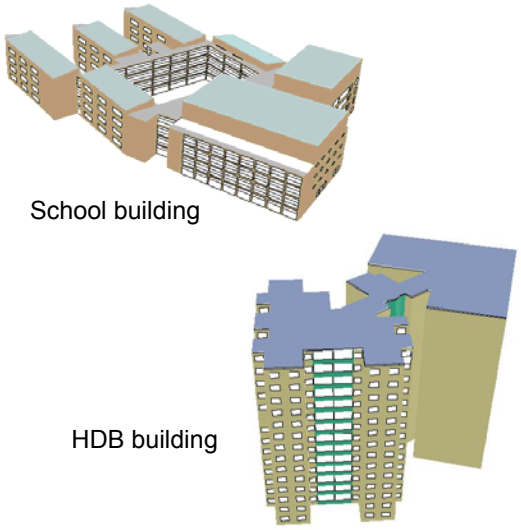

Figure 1. Building models in the TAS program.

The study of the acceptable U-value and the impact of the adoption of a window shading device were processed through an energy simulation program called TAS (Figure 1).

By setting the indoor thermal comfort as the criterion, and considering the effect of façade orientation, Window to Wall Ratio (WWR) and adoption of window shading device, a set of acceptable U-values for the NV building façade was developed through the iterative rapid prototyping simulations. The results are shown in Table 1.

The spectrophotometer was used to test the reflectance and transmittance of the commonly used façade materials in the laboratory (Figure 2). It was found that the reflectance of light-coloured façade material was higher than that of dark-coloured material. The high reflectance of façade material was helpful in decreasing the surface temperature.

Table 1. Acceptable U values and the window shading device for naturally ventilated buildings in Singapore

	East	West	North	South
WWR=0	U=3W/K·m2	U=3W/K·m2	U=3.5W/K·m2	U=3.5W/K·m2
WWR=0.1	U=2W/K·m2 300mm horizontal shading	U=2W/K·m2 300mm horizontal shading	U=2.5W/K·m2	U=2.5W/K·m2
WWR=0.2	U=2W/K·m2 300mm horizontal shading	U=2W/K·m2 300mm horizontal shading	U=2.5W/K·m2 300mm horizontal shading	U=2.5W/K·m2 300mm horizontal shading
WWR=0.3	U=2W/K·m2 450mm horizontal shading	U=2W/K·m2 450mm horizontal shading	U=2.5W/K·m2 300mm horizontal shading	U=2.5W/K·m2 300mm horizontal shading
WWR=0.4	U=2W/K·m2 600mm horizontal shading	U=2W/K·m2 900mm horizontal shading	U=2.5W/K·m2 300mm horizontal shading	U=2.5W/K·m2 300mm horizontal shading
WWR=0.5	U=2W/K·m2 600mm horizontal shading	U=2W/K·m2 900mm horizontal shading	U=2.5W/K·m2 600mm horizontal shading	U=2.5W/K·m2 600mm horizontal shading

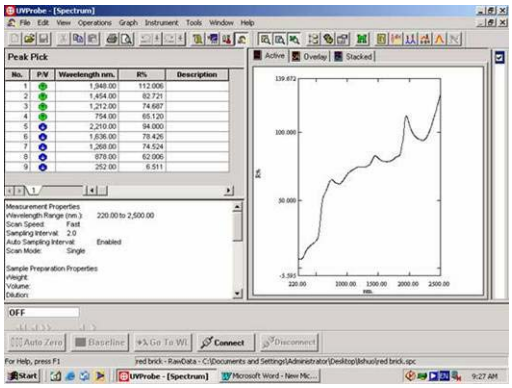

Figure 1. TAS, the energy simulation program.

Figure 2. The spectrophotometer in the laboratory.

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