SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

The objective of this study was to examine the effects of naturally ventilated facades on energy consumption in air-conditioned buildings.

Effects of doubled glazed facade on energy consumption, thermal comfort and condensation for a typical office building in Singapore

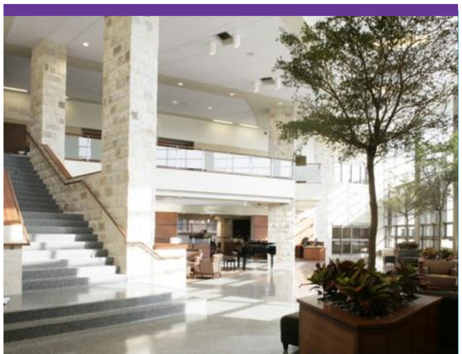
Hien, W. N., Liping, W. , Chandra, A. N. , Pandey, A. R., Xiaolin, W., 2005 | *Energy and Buildings. Volume 37, Issue 6, Pages 563-572*

Key Concepts/Context

Buildings in Singapore use fully glazed-façade systems because of their daylight advantages of low consumption of lighting energy and the aesthetic satisfaction of full external views. High energy consumption, thermal discomfort, and issues with noise control are some of the disadvantages associated with single-glazed façade systems. Double-glazed façade ventilation systems are believed to address these issues. The intent of this simulation study was to examine the energy efficiency of natural ventilation in two double-façade and one single-façade building models in Singapore. The authors concluded that the double-glazed façade model with stack effect ventilation and mechanical fans was most effective in reducing energy consumption and maintaining thermal comfort.

Methods

Simulation software was used to conduct this study. The two software applications used were TAS, designed to assess energy consumption, thermal comfort, and condensation, and CFD, designed to calculate the airflow field of the double façade. For this study three building models were used: the first was a six-floor building with a single-glazed façade system, the second and third models both had nine floors with a double-glazed façade system. The second included a stack effect ventilation and an external heat absorption layer; the third was ventilated by mechanical fans placed at the top of the double-façade space. For the simulations mean vertical solar radiation intensities on clear days in Singapore were taken into consideration. Annual consumption of energy, cooling loads, thermal comfort, and condensation were examined. The material for all three facades was clear glass with blinds on the internal side. The double-glazed facades had a 6mm heat absorption glass on the outside. The roof for all three facades was a concrete slab.



The Center for Health Design: Moving Healthcare Forward

The Center for Health Design advances best practices and empowers healthcare leaders with quality research that demonstrates the value of design to improve health outcomes, patient experience of care, and provider/staff satisfaction and performance.

Learn more at www.healthdesign.org

Findings

In connection with the annual consumption of energy, it was seen that the cooling load increased from a lower level to a higher level following the pattern of the solar heat gains. It was also seen that east-west orientations had a higher solar gain and this contributed to increased cooling load. The two double-glazed models showed a decreased cooling load (by about 120MWh per year) as compared to the single-glazed façade. This was attributed to the lower solar heat gains in the double-glazed models and ventilation which helped remove heat and cooled the internal surface temperature. There was no difference in the energy consumption between the different ventilation types of the two double-glazed models. The mechanical fan contributed to an improvement in the air change rate in addition to a very slight reduction in cooling load. The simulation showed that the cooling load would potentially reduce by 100MWh/year in a double-glazed façade building having no ventilation and by an additional 23MWh/year if naturally ventilated with stack effect.

Ventilation inside the double façade helped remove heat and lower the surface temperature. External surface temperatures in all three models remained high, the highest being that of a double façade with no ventilation and the lowest being that of the single façade. However, internal surface temperatures were lower in all models having double façades than the one with single façade. The double-façade model with mechanical fans recorded a slightly lower internal surface temperature than the double façade with stack effect.

Thermal comfort in the double-façade models was better than in the single-façade model as depicted by the low PPD indices of the former. The double façade with mechanical fan had a slightly higher satisfaction than the one with the stack effect. Season-wise, the northern zone on the second floor in December had the highest thermal comfort level, while the sixth floor on the eastern and western zones in June had the lowest thermal comfort levels – for all three models.

Temperature differences between the outside and the glass surface on highly humid nights led to condensation. The mechanical fans were found to be very effective in preventing moisture condensation.

Limitations

The authors did not identify any limitations. However, it may be noted that the findings of this study may be specific to buildings located in cities with a climate similar to Singapore.

Design Implications

The authors recommend the double-glazed façade with stack effect ventilation and mechanical fans for buildings in Singapore.