Strategies for energy efficient building façade

A challenge building owners in Singapore face is the tremendous cost of keeping a building cool and comfortable for its occupants in the tropical climate here. Façade, or the exterior walls of a building, accounts for almost 50% of the thermal loads in buildings in the tropics[1]. The challenge of keeping buildings cool is made more apparent with the proliferation of glass-clad buildings today, with more in the pipelines for completion. With air conditioning accounting for about 40-50% of all energy used by buildings here[2], much can be done to increase their energy efficiency.

Much research and development has gone into technologies aimed at reducing solar heat gain of buildings, and thus the energy required by air conditioning systems. Here are some of the strategies that have found increased adoption due to their effectiveness in increasing building energy efficiency.

Double Skin Façade

Double skin façade consists of an inner and outer glass skin set 20cm to 2m apart, with an intermediate cavity that air flows through. In hot climates, the cavity between the inner and outer skins traps air which then absorbs solar thermal energy. This hot air is then vented out of the building, thus mitigating solar heat gain of the building interior, and reducing the cooling load of the building. Shading devices can be incorporated in the cavity to further reduce solar heat gain.

Air in the cavity is ventilated via the following means:

- Natural. This refers to ventilation driven by wind or thermal buoyancy (or stack effect) to draw in fresh air at a low level and exhaust air at a high level.
- Mechanical. Air flow is driven by mechanical fans to drive hot air out of the cavity and draw in cool air.
- Hybrid. This system combines mechanical ventilation system to supplement natural ventilation, to ensure optimum air flow.

To reap the maximum benefit of this feature, design considerations include the thickness of the inner and outer skins, the arrangement of the distance between the skins, and the ventilation strategy of the façade. Research done in Indonesia, with tropical climate similar to Singapore, has shown a 12% annual savings in annual total energy consumption.[3]

Glazing

Windows and glass panels have traditionally been a large source of heat gain for buildings here in the tropics. In recent years, though, technological leaps have been made in creating high performance, energy efficient windows and glass panels. Glazing systems are now available that can dramatically cut energy consumption. They reduce heat gain and air leakage, thus minimising cooling load, while improving comfort.
Window glazing minimise heat gain by altering these properties of a window:

- Reducing U-factor, or overall heat transfer coefficient. This refers to the rate of heat flow due to conduction, convection, and radiation through a window. These heat transfers are a result of temperature difference between the interior and exterior.
- Reducing Solar Heat Gain Coefficient (SGHC). This refers to how much of the sun’s energy striking the window is transmitted through the window as heat.

High performance, energy efficient windows and glass panels has the following features:

- Double or triple glazing
- Specialised transparent coatings
- Insulating gas sandwiched between panes
- Improved frames

Optimum window design and glazing specification can reduce energy consumption from 10-50% compared to typical practice in most climates.[4]

**Shading**

The principle behind shading is a simple one: mitigate solar heat gain by reducing the amount of sunlight transmitted into the building. Traditionally, this has been achieved through the use of blinds or curtains, though the efficacy of these might be limited by the manual control by building occupants, or their incompatibility with the aesthetics of the building.

Fortunately for building owners, shading can now be incorporated within the glass skin of the buildings themselves. Electrochromic glass, also called smart glass, is an electrically switchable glass which changes light transmission properties when a voltage is applied.

Light sensors in buildings detect the amount of sunlight received, and optimise for natural lighting and solar heat gain. As electrochromic glass allows for varying levels of opacity, the continuous balance between natural lighting and solar heat gain can be achieved as exterior conditions change.
Field studies done by the Lawrence Berkeley National Laboratory of the United States has demonstrated a 19-26% reduction in maximum peak demand power for cooling with the application of electrochromic glass windows in a room over one equipped with low-emissivity windows and manually controlled blinds and lighting controls.[5]

These are some of the common strategies employed by building owners to increase the energy efficiency of buildings in tropical climates. While the capital outlay for these features may be considerably more than those typically in use today, the energy savings gained by significantly reducing the energy consumption of the building air conditioning systems will be adequate to obtain a return on the higher investment.

The strategies presented here are not just stand-alone options for increasing building energy efficiency. The different strategies can be combined to maximise the potential for energy savings in a building.

To learn more about the featured energy efficient façade strategies, please visit:

Double Skin Façade: http://www.lth.se/fileadmin/energi_byggnadsdesign/images/Publikationer/Bok-EBD-R3-G5_alt_2_Harris.pdf
Glazing: http://www.wbdg.org/resources/windows.php?r=minimize_consumption

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[3]. “Study on naturally ventilated double-skin façade in hot and humid climate” http://repository.unhas.ac.id/bitstream/handle/123456789/2364/Thesis_Rosady.pdf?sequence=1