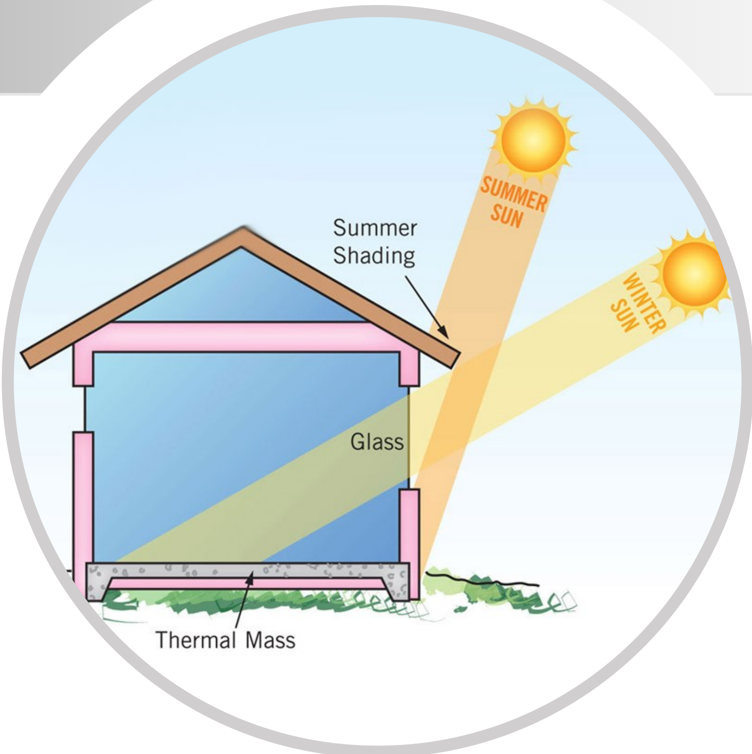

FACTSHEET #02

Walling materials, energy efficiency and passive design

Good passive design uses free heat from the sun and natural night time cooling to keep a home at a comfortable temperature year round. It can significantly reduce the need for expensive mechanical heating and cooling.

TECHNICAL CONTRIBUTOR

Think Brick Australia
WWW.THINKBRICK.COM.AU

Executive Summary

Passive design is "energy efficient design" that makes harnesses free heat from the sun and natural night time cooling to make a home more comfortable, while reducing heating and cooling bills. Passive design does not add to construction costs, as long as it is considered during the design and planning stages.

Good passive design uses natural heat from the sun and natural night time cooling to keep a home at a comfortable temperature year round. It can significantly reduce the need for expensive mechanical heating and cooling.

Passive design for the Southern Hemisphere considers:

- Orientation and solar access.
- North facing shaded glass.
- Sealing and ventilation.
- Insulation.
- Thermal mass.

Principles of Passive Solar design for summer and winter

Tailoring the passive design features to each climate zone is important. As shown in the Figures 1 and 2 above, prominent north facing shaded windows together with eaves that overhang importantly permit the entry of the winter sun and strict summer sun.

Also important are well designed properly sealed doors and windows that allow cross ventilation in summer and restrict air and heat leakage in winter.

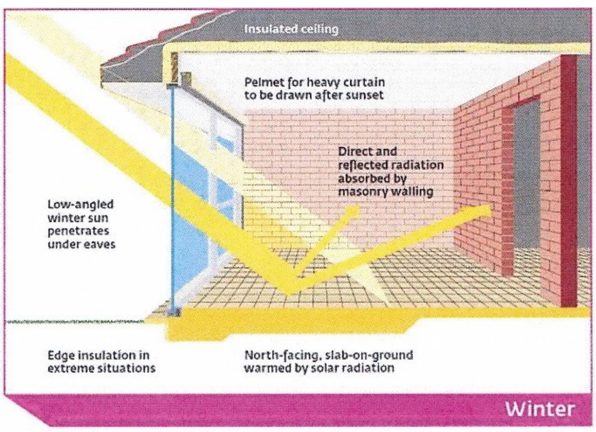

Figure 1 Principles of passive solar design – Winter

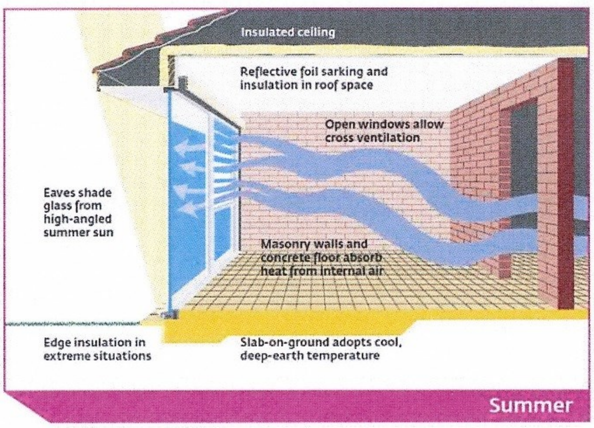

Figure 2 Principles of passive solar design – Summer

The Importance of Thermal Mass in Building Design

Thermal mass is the ability of a material to retain heat energy when subjected to thermal temperature differentials. Clay brick and concrete floors have relatively high thermal mass.

In summer, a high thermal mass wall can reduce the transfer of heat by absorbing the heat energy flowing in from the outside. This process is slow resulting in a delay called "thermal lag".

The capacity to absorb a large quantity of heat energy for a small rise in temperature combined with the thermal lag, effectively increases the R-value performance over a complete day night cycle.

Maximum external air temperature is usually reached between noon and 2pm. A lag of 6 hours, which is typical for brick construction, means the maximum heat flow would not each the interior until 6 hours later, by then external air temperature will usually have dropped and thermal flow will reverse, allowing the building to cool for the following day.

- A concrete slab is an essential part of the equation as it increases the mass significantly.
- Solid partition walls, as opposed to lightweight system walls also add to the mass and were found to significantly improve internal thermal comfort.
- The density of double leaf clay brick with a cavity (with or without insulation) is particularly successful at absorbing the effect of solar radiation reducing the net heat flux entering through the wall.

  In summer, heat energy on the surface of a west wall is 700-900W/m^2 . This figure falls to about 200W/m^2 entering the external wall. The heat reduces still further to just 50W/m^2 passing across the cavity with finally only 5-6W/m^2 of heat energy on average passing into the internal space.

Lightweight Construction

A lightweight construction (often called an Alternative Building Technology or ABT) consists of a light steel frame, externally clad with 9mm fibre cement board (nominally 145 mm thick with 0.2mm polymer vapour membrane, 20mm orientated strand board and 0.8mm steel studs. There is an internal wall of 15mm gypsum board with 75/100mm fibre sound insulation.

An insulated lightweight test building often has a high thermal resistance (R-value) but it has no thermal mass in the walls. There is usually a concrete slab providing thermal mass in the floor.

South African and international research has found that the insulated lightweight module exhibits the greater variations in internal temperature and little thermal lag. It has an internal daily temperature swing of more than twice of that of insulated cavity brick during hot conditions. The important observation was that although insulated lightweight walls reduce the amplitude of heat entering the building, they do not provide any thermal lag.

Applying similar R-value materials to the external skins of the different modules, the lightweight module was subject to greater temperature variations inside than insulated cavity brick modules over the same period. This variance can only be attributed to the behaviour of the thermal mass of the cavity brick module.

Figure 8 shows the lightweight module was subjected to greater temperature variations.

- The lightweight walls immediately transmitted heat into the module when solar radiation was incident on the external surfaces.
- The lightweight modules exhibited no properties with the potential to assist in maintaining adequate comfort.

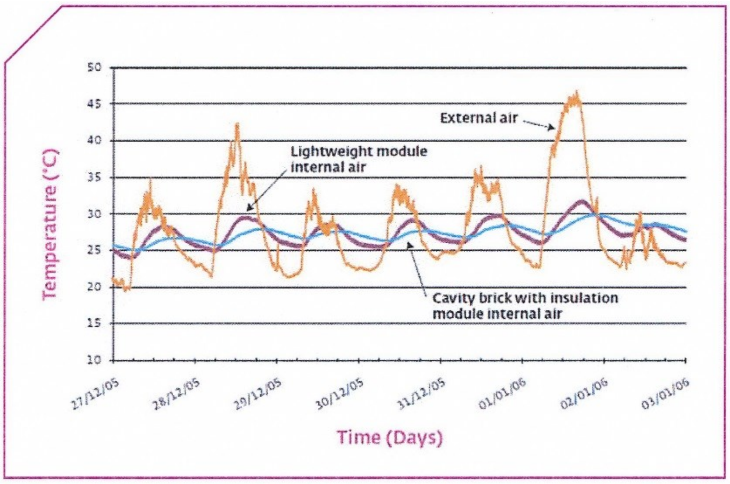

Figure 8 External and internal air temperatures for lightweight and insulated cavity brick modules, January 2006

- The lightweight module had the highest temperature during the day and the daily swing was also consistently the highest.
- The energy consumption in the lightweight module needs to be high to counter the large daily temperature swing. When clay brick was applied to the internal skin of the lightweight walling module, the thermal performance improved considerably due to the thermal mass the internal brickwork skin provided.
- However, while this internal brickwork skin improved the performance of the lightweight test building, the lack of thermal mass in the external skin meant that the insulated cavity brick system performed better.

For further information:
The Clay Brick Association of South Africa
Website: www.claybrick.org