preview

an introduction to

Designing comfortable homes

guidelines on the use of glass, mass and insulation for energy efficiency

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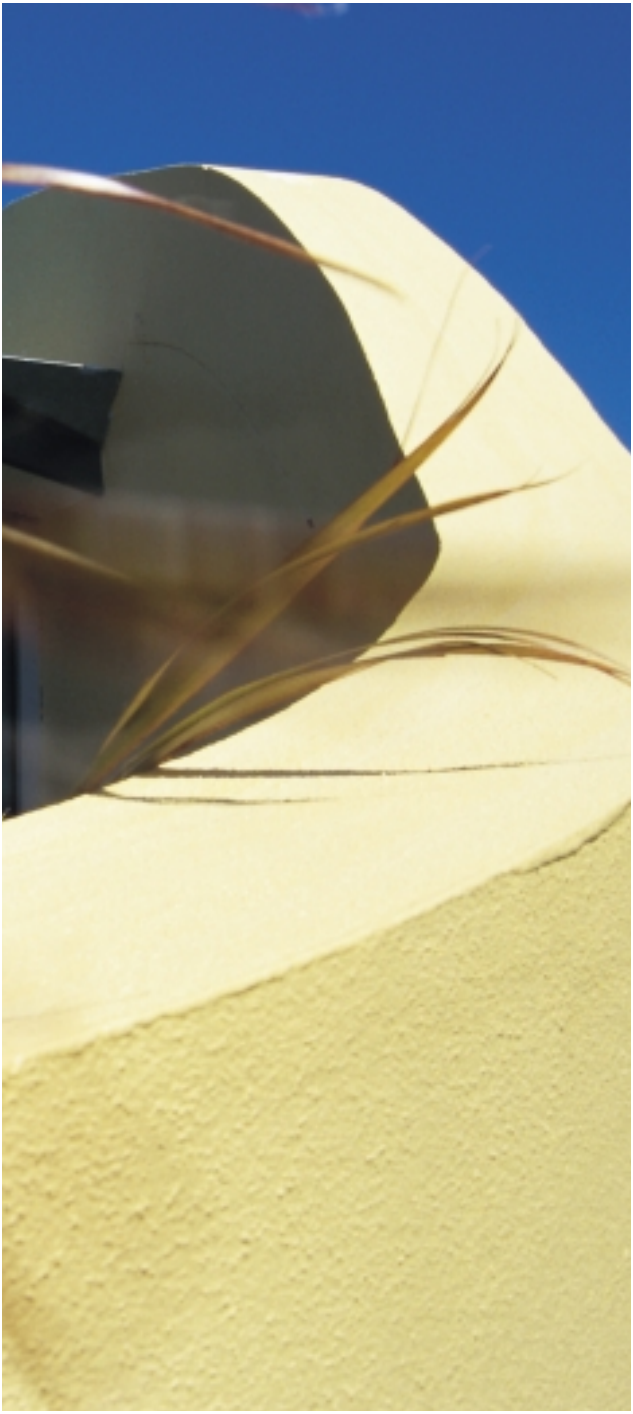

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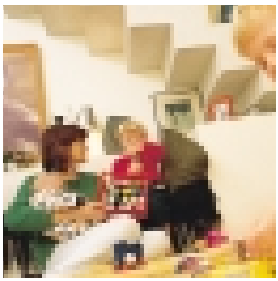
This booklet outlines the principles that are important to designing a home which is comfortable – both cool in summer and warm in winter.

It examines the three main factors which have the greatest impact on comfort and energy efficiency of homes:

- Glass – to collect the sun's heat
- Mass – to store heat
- Insulation – to keep the heat in

and explains the issues to be aware of when making your design decisions.



More detailed information on designing homes that are comfortable year round is found in **Designing Comfortable Homes**. *This 80-page handbook provides indepth information on comfort and energy efficiency of various design options, which are evaluated by computer studies. An order form is on the back of this booklet.*

Why is mass good?

Any high mass material can absorb, store and gradually release heat. This property is commonly referred to as thermal mass. One of the most important benefits of thermal mass is its ability to moderate temperature extremes. Homes designed to take advantage of thermal mass don't have the same extremes of temperature that can occur in lighter weight houses. Thermal mass keeps a home warm in the winter and cool in the summer and helps create an environment that is simply more comfortable to live in.

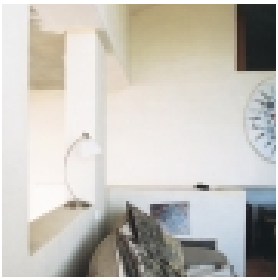
"Thermal mass keeps a home warm in winter and cool in summer... simply more comfortable to live in."

The most common high mass material used in house construction is concrete. It is readily available, relatively inexpensive, and can be used for the structure of the house as well as providing the thermal mass. Other forms of mass used in house construction are rammed earth, mud bricks, and concrete or clay bricks.

Lighter weight homes can also be comfortable and energy efficient. They can have advantages if the home has been allowed to get cold, as they will heat up more quickly when the heaters are switched on.

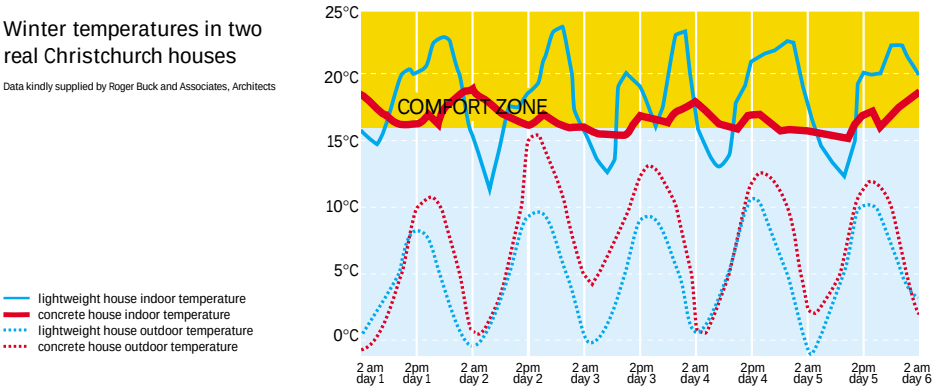
It keeps you warm in winter

When the climate is cold, heat from the sun (and also from heaters) can be stored in high mass floors, walls or ceilings. This heat is gradually released into the home once the heat source is no longer available. In this way the mass is effectively acting as a heater, long after the original source of heat is gone. Nightstore heaters are a familiar example of the ability of mass to store low cost energy for later use. However, if you use the sun as your source of energy, it costs you nothing!



Winter temperatures in two real Christchurch houses

Data kindly supplied by Roger Buck and Associates, Architects



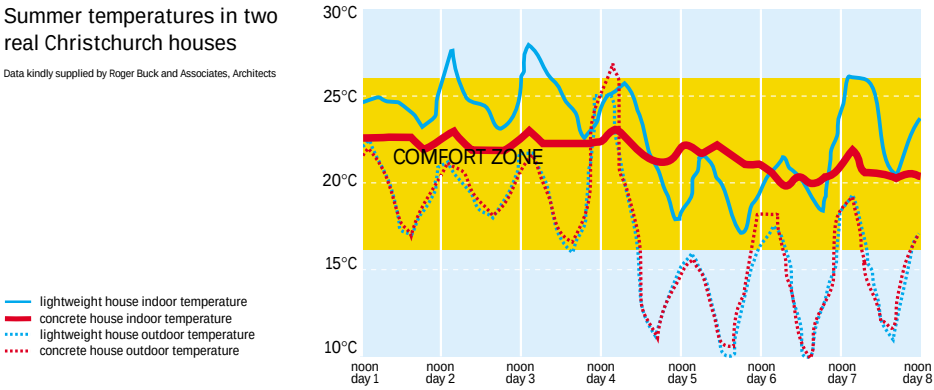
. . . and cool in summer

When the climate is hot, the heat from the sun can cause homes to overheat. Air-conditioning can reduce temperatures, but air-conditioners are expensive to install and run. Normally in New Zealand we simply open the windows to get rid of excess heat, and may also close curtains to reduce the heating effect of the sun.

Thermal mass can help reduce overheating – the mass absorbs heat from the sun and stores it. This reduces the room temperatures during the hot parts of the day. The heat stored within the mass is only released back into the room when the room temperature drops.

Summer temperatures in two real Christchurch houses

Data kindly supplied by Roger Buck and Associates, Architects

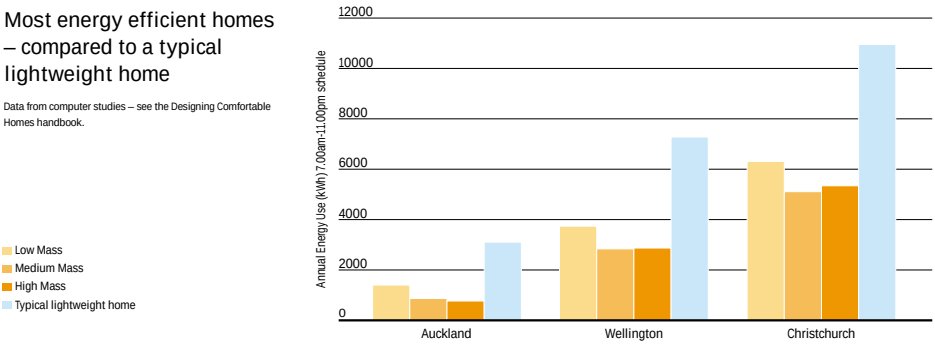


It's energy efficient

Capturing free energy from the sun means that high mass homes can be more energy efficient than lighter weight homes. But this is only as long as other factors effecting energy efficiency – glass, insulation and orientation – are well considered when designing the home.

Most energy efficient homes – compared to a typical lightweight home

Data from computer studies – see the Designing Comfortable Homes handbook.



There are many possible combinations of glass, mass and insulation that result in both energy efficiency and comfortable temperatures. Also the relative importance of energy efficiency and comfort vary from person to person. For details of the energy efficiency of various design alternatives, see the *Designing Comfortable Homes* handbook.

The main benefits of energy efficiency are lower heating costs and lower environmental impact. Another benefit is that less heaters are required. The cost of installing expensive central heating systems can therefore be eliminated by good design.

It's healthy

"A moderate temperature makes for a healthier living environment."

Keeping a moderate temperature also makes for a healthier living environment. The World Health Organisation recommends that minimum indoor temperature should not be below 16ºC. High mass construction can help maintain temperatures above this level. The surface temperatures of high mass walls also tend to be more stable therefore condensation is less likely to occur. Condensation can lead to mould and fungi growth. Low temperatures also encourage dust mite growth.

. . . quiet

Because of its high density, high mass construction naturally reduces airborne noise transmission more than lighter weight construction. This is particularly valuable for reducing noise from the external environment and to provide sound separation between rooms. Also, concrete floors don't creak!

. . . durable

Well designed, well built concrete homes are extremely durable. Periodic maintenance, particularly of the external coating (often paint), ensures the home continues to perform well and look good.

. . . earthquake resistant

Concrete homes are designed to the earthquake requirements of the New Zealand structural design Standards. All homes, concrete or timber, are designed to withstand the same strength earthquakes.

. . . and fire resistant

Concrete is non-flammable and will not contribute to the fuel load in a building fire.

Design principles

As stated in the introduction, the key factors that influence the comfort and energy efficiency of homes are glass, mass and insulation. How and where you use these materials is critical to the planning of a new home or renovation. Here are some general guidelines to consider. For specific guidance on how to incorporate these design principles, see the *Designing Comfortable Homes* handbook.

GLASS – COLLECTING THE SUN'S HEAT

Windows are generally the best collectors of the sun's heat, but they can also allow large heat loss.

Orientation

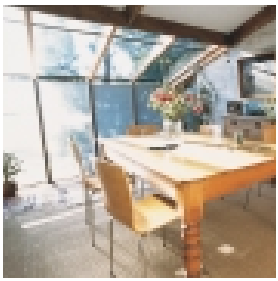
The placement of windows is critical to a house's ability to collect heat from the sun – north facing windows are best, east and west facing windows can lead to glare and overheating, while south facing windows receive very little direct sun.

Heat loss from glass

Heat loss from glass can be reduced by double glazing and insulating frames, and, of course, good-fitting curtains.

How much glass should there be?

The ideal area of glass to use in a home depends on many factors such as insulation, mass and orientation. See the *Designing Comfortable Homes* handbook for guidance.



MASS – FOR HEAT STORAGE

Where should the mass be?

Mass can be in the ground floor slab, external walls, internal walls, suspended intermediate floors and ceilings. In order to absorb heat, the mass should not be covered with insulating material, such as carpets. Relying on the ground floor slab alone is therefore risky as it may be covered with carpet at some stage in the building's life

How much mass?

There is no general 'ideal' amount of mass for a home – it depends on many variables, such as the house's orientation, and its use of glass and insulation. See the *Designing*

Comfortable Homes handbook for more detailed discussion of this issue, and to get an idea of what is right for *your* home.

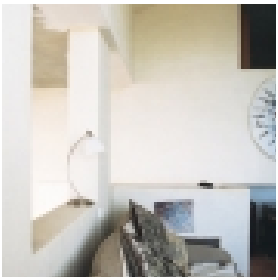
"Insulation is one of the key factors that determines both energy efficiency and comfort."

INSULATION – FOR REDUCING HEAT LOSS

Insulation is one of the key factors that determines both energy efficiency and comfort in homes.

Insulating concrete floors

While insulation for concrete floors is not necessarily required, edge insulation is recommended. Under-slab insulation is also recommended for wet sites or cold climates (Christchurch or colder), or if heating systems are installed in-slab.



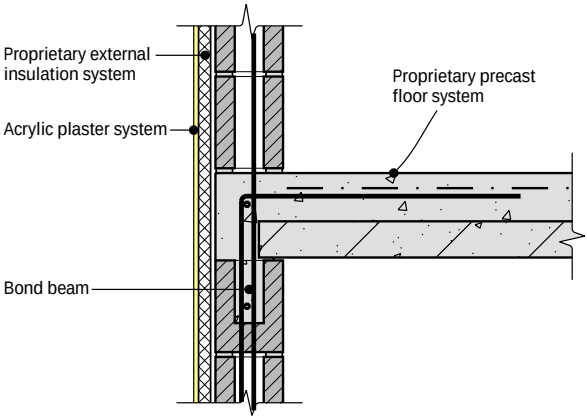
Insulating timber framed walls

Fibreglass insulation is the most common method of insulating timber framed walls, although there are several other commercially available alternatives.

Insulating concrete walls

External insulation

To gain the most benefit from a concrete wall's thermal mass, insulate its external face.



Common methods of external insulation include:

- Fixing polystyrene to the exterior of concrete masonry or precast concrete walls – all standard finishing systems can be used, including: masonry veneers, weatherboards and plaster finishing systems.
- Casting polystyrene sheeting into a precast wall (near the exterior surface).
- Using masonry blocks which have a polystyrene biscuit pre-fitted near the exterior surface.
- Insulating concrete formwork (ICF) blocks with the interior polystyrene face of the block removed and the surface plastered.
- Masonry blocks with insulating plaster applied to the exterior.

Internal insulation

Concrete walls can be insulated internally if there is enough mass elsewhere in the house to store heat.

Common methods of internal insulation include:

- Masonry and precast walls strapped with timber and lined with plasterboard – insulation can be placed between the strapping.
- Masonry or precast walls with polystyrene board directly fixed (usually glued) – finishing can be with plasterboard or applied plaster systems.

Insulation on both sides

To achieve a high level of insulation, concrete walls can be insulated on both sides. Again there must be enough mass elsewhere for heat storage. The use of insulating concrete formwork is the most practical method of insulating both sides.

Roof Insulation

The most common way of insulating roofs is the use of fibreglass or other insulating material within the cavities of the timber frame of the ceiling.

Concrete roofs/ceilings usually use external polystyrene insulation and a weatherproofing system. A concrete roof may also have a timber frame ceiling which can be insulated in the same way as standard roofs, however this isolates the thermal mass.

How much insulation?

Generally, the more insulation the better. If you are using concrete for its thermal qualities, insulation must be used in a way that enhances these qualities. For more details, see the *Designing Comfortable Homes* handbook.

HEAT DISTRIBUTION

Heat can be distributed around a house by movement of air and by heat transfer through high mass walls. Large openings between rooms greatly help the circulation of air, as does the use of fans.

GETTING RID OF EXCESS HEAT

Thermal mass

Thermal mass (such as concrete walls or floors) absorbs and stores excess heat, and thereby reduces overheating.

Shading

Shading can block the sun when it is not wanted. Overhangs above north facing windows are the most effective. Moveable shades are good for east and west facing windows. Deciduous trees can be effective but even without leaves can block some sun in winter.

Ventilation

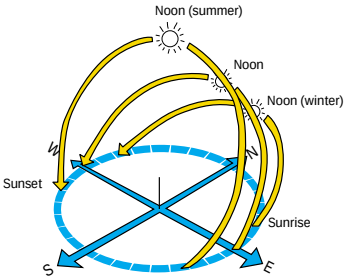
Ventilate the house to get rid of excess heat. Opening windows and doors works well. Vents also work well, particularly in the roof as they remove the rising hot air.

It is important to ventilate to get rid of water vapour, especially from kitchen and bathrooms.

SITE CONSIDERATIONS

Orientation

The orientation of a house is critical for both comfort and energy efficiency. Orientating the house on the east-west axis will maximise north facing exposure, as will staggering or stacking the house's layout. Living areas should be located on this north face, garage and service rooms on the south.



The sun's azimuth

Sun

Ideally, you should aim for unrestricted sun on solar collecting windows between 9am and 3pm in winter (as a minimum).

By mapping the path of the sun across the sky you can determine shading on your site – sunpath diagrams are available in the *Designing Comfortable Homes* handbook.

Topography

Typically air flows uphill during the day and downhill at night, contributing to frosts in the valleys. North facing slopes receive more solar gain than south facing slopes.

Ground surface cover around the house

Dark coloured paving heats up – this may be unwanted in summer. Grass cover and other vegetation such as trees and shrubs have cooling effect in summer.

Water

Water moderates air temperatures. Near the sea, air temperatures are cooler in summer and warmer in winter. There is a similar but lesser effect with lakes.

Wind

Wind can cause high heat loss. Houses must be well sealed, both in construction joints and weather stripping of windows and doors.

Wind barriers can reduce the wind that impacts on the house (these have the added advantage of making outdoor areas usable more often) – perforated wind breaks are best.

"The orientation of the house is critical – for both comfort and energy efficiency."

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