Through the mechanism of its heat storage capacity (thermal mass), concrete slab-on-ground construction helps make a house cool in summer and warm in winter. Since the slab is constructed directly on the ground and the earth temperature is almost constant, thermal stability is achieved. Concrete slab-on-ground is critical to delivering a sustainable home, by reducing the energy required for heating and cooling. This saves money and improves the thermal comfort of homes, delivering a truly sustainable housing solution across environmental, social and economic dimensions. Concrete slab-on-ground is the responsible choice for house floors in Australia.

The ground floor of roughly ninety per cent of Australian homes is of concrete slab-on-ground construction. However, the intrinsic thermal advantages of concrete slab-on-ground construction, and the consequential energy efficiency it delivers, are often not understood by designers, builders or home owners.

Concrete Slab-on-ground and Energy Efficiency

Through the mechanism of its heat storage capacity (thermal mass), concrete slab-on-ground construction helps make a house cool in summer and warm in winter. Since the slab is constructed directly on the ground and the earth temperature is almost constant, thermal stability is achieved. Concrete slab-on-ground is critical to delivering a sustainable home, by reducing the energy required for heating and cooling. This saves money and improves the thermal comfort of homes, delivering a truly sustainable housing solution across environmental, social and economic dimensions. Concrete slab-on-ground is the responsible choice for house floors in Australia.

Concrete Thermal Mass for Greater Energy Efficiency

Thermal mass (also called thermal capacitance or heat capacity) is the capacity of a body to store heat. It is designated by $C$, and typically measured in units of MJ/m$^3$.K or MJ/t.K, or the Celsius equivalent MJ/m$^3$.°C or MJ/t.°C. Dwellings of medium to high thermal mass are characterised by their inherent ability to store thermal energy, and then release it several hours later. Concrete slab-on-ground has a natural advantage in heat storage capacity, resulting from a combination of the nature of the material and the volume of concrete required. When used in passive solar design, the thermal mass makes a significant
contribution to reducing energy consumption, while maintaining the occupancy comfort.

In summer, concrete slab-on-ground acts as a giant cooling element. The floor slab benefits from the earth’s near-constant low temperature, and can improve thermal comfort by absorbing radiant heat from the occupants and appliances. When concrete internal walls and insulated concrete external walls are also used, the heat storage capacity of the house is enhanced, so that it reacts slowly to outside temperature fluctuations, reducing dependence on energy for cooling to produce a comfortable internal temperature. Provided that the climate is such that the nights are cooler than the comfort level, the cool night air can ventilate the building and purge the accumulated heat that is emitted from the building fabric.

During winter, when heating is required, the thermal mass will help keep a dwelling warm and reduce heating energy consumption. When the outside temperature is higher than the comfort level, heat is absorbed by the thermal mass during the day and then slowly released at night. During such winter days, the windows and openings should be kept shut to minimise heat loss.

To take the full advantage of the thermal mass of concrete slab-on-ground construction, house orientation, glazing and other building elements should be carefully balanced. Ideally, concrete floor slabs in living areas should receive sunlight in the cooler months, but be shaded from direct sunlight in summer by eaves, awnings and the like. The local climate pattern and the change in sun angles over the year must be clearly understood and reflected in the building design. So too, the designer should account for the future growth of trees and the possible effect of additional shading. Detailed information can be found in CCAAs publication Climate-responsive house design with concrete.

**CONCRETE FLOOR FINISH TO MAXIMISE THERMAL MASS ADVANTAGE**

Concrete slab-on-ground can be used with or without additional flooring materials. When flooring materials are chosen for aesthetic reasons, heat conducting materials such as quarry tiles, slate or vinyl should be used to allow heat from the incident sunlight to reach the slab. Ideally, timber flooring and carpets should not be laid in these locations, since their relatively high thermal resistance reduces the quantity of heat absorbed by the slab from winter sunlight. There has been increasing use of uncovered concrete slab-on-ground, which is the most efficient way to get the full benefit of concrete’s thermal mass. Various colouring and surface finishes can be adopted to simultaneously achieve absorption of solar heat and stunning visual effects.

**Integrally-coloured concrete slab**

Integrally-coloured concrete involves the addition of pigments to the entire volume of premixed concrete, thus providing colour on any exposed surfaces. Over time, the concrete colour may sometimes appear to become paler, due to the carbonation of calcium hydroxide at the surface. However, the use of a clear surface sealant can minimise this effect and facilitate cleaning.

Local climate patterns and the change in sun angles over the year must be clearly understood and reflected in the building design.
**Stained concrete**
The surface of concrete can be coloured using chemical stains. Chemical stains react with the calcium hydroxide in the concrete to permanently colour it. Various colours are available, and patterns can be created using different colours.

**Honed/polished concrete**
The surface of grey, off-white or coloured concrete can be honed or polished. This involves grinding the concrete to produce a smooth, durable and low-maintenance surface. Sealants are applied to minimise discoloration.

**Epoxy or polyurethane coating**
Low-VOC epoxy or polyurethane coatings (those which emit only low quantities of potentially toxic volatile organic compounds) are now available from many construction-chemical suppliers. A smooth or matt finish can be produced, while various colours are available.

**CONCRETE FLOOR HEATING**
Concrete slabs can be heated by embedding either electric elements or hot water pipes (known as hydronic systems) within the slab or a topping screed. The thermal mass of the concrete slab is used to store the heat generated by these systems. This method of heating provides a warm floor and unobtrusive space heating, through which a higher level of thermal comfort, safety and indoor air quality can be achieved. Designers should also be aware of edge-insulation requirements of the Building Code of Australia. Guidance on designing and sizing under floor heating systems can be found in CCAA’s Briefing Concrete Floor Heating.

**Concrete – the responsible choice**
Sustainable houses must cater for occupancy comfort, energy efficiency and overall cost. Concrete slab-on-ground construction reflects the three pillars of sustainability – Social, Environmental and Economic; and is the responsible choice for sustainable housing.

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