Reducing CO_2 emissions and the potential for fuel poverty

Thermal mass, particularly when used as part of a passive solar design strategy, is increasingly being used to reduce heating and air conditioning energy consumption and bills. Both benefits are of interest to housing associations wanting to build sustainable homes that reduce both their environmental impact and the potential for fuel poverty, writes Guy Thompson, Head of Architecture and Housing, The Concrete Centre

The ability of thermal mass to reduce overheating problems is increasingly recognised. Perhaps less appreciated is its ability to save heating energy when used in passive solar design (PSD). Consequently, it is possible for concrete, masonry and other heavyweight dwellings to exploit their inherent thermal mass on a year-round basis.

During the summer, heat is absorbed on hot days, helping to cool the internal temperature and prevent overheating problems. The stored heat is then removed by night ventilation. During the winter, the thermal mass will absorb solar gains through south facing windows, and slowly release the heat at night. This process is effectively the same as that which occurs on summer nights, the only difference being that during the winter the stored heat is beneficial, so windows and openings are kept shut to minimise heat loss. Shutters and blinds used to prevent overheating in the summer can also help minimise heat loss during the winter.

Useful levels of thermal mass are found in medium and heavyweight construction, which in practice is most easily provided by concrete in the form of blocks and precast or in-situ floors and panels.

The use of concrete often raises questions regarding its embodied CO_2, which can be slightly higher than that associated with alternative materials, but in reality the difference is relatively small when compared to lightweight systems. And, when you evaluate this in whole-life terms, the operational CO_2 savings provided by the heavyweight solution is actually much more significant over the long-term.

This point can sometimes be overlooked in the drive to specify the greenest materials available, but should to some extent be redressed in the forthcoming revisions to Part L1 of the Building Regulations, which will take greater account of thermal mass in the Standard Assessment Procedure (SAP) calculation.

To establish the facts of embodied versus operational CO_2, The Concrete Centre commissioned research to examine the embodied and operational CO_2 emissions of a simple semidetached house built using a typical lightweight frame, with that of several heavyweight versions built using varying levels of thermal mass.

The embodied CO_2 for each option was calculated and thermal modelling was undertaken to see how each performed across the 21st century, taking account of the likely impacts of climate change. The results showed that a typical masonry house with a medium level of thermal mass, has around 4% more embodied CO_2 than an equivalent lightweight frame construction, but that this could be offset in as little as 11 years due to the energy savings provided by its thermal mass.

Increasing the mass through additional concrete elements, such as precast upper floors, resulted in a longer offset period, but ultimately led to the lowest whole life CO_2 emissions of all the options, with a saving in CO_2 over the 21st century approximately six times greater than the difference in its embodied CO_2 when compared to the lightweight frame solution.

"DURING THE WINTER, THE THERMAL MASS WILL ABSORB SOLAR GAINS THROUGH SOUTH FACING WINDOWS, AND SLOWLY RELEASE THE HEAT AT NIGHT"

Due to the predicted increase in summer temperatures resulting from climate change, the lightweight home was found to need air-conditioning by 2021. This compared with 2041 for the medium-weight home and 2061 for the medium-heavy and heavyweight homes.

Thermal mass is of course only one of the steps needed to adapt homes to a warming climate. Effective ventilation and shading are also of great importance in all types of housing, particularly in the south of the UK where overheating is likely to be greatest. Traditionally, shading has not been a major feature of UK housing. However, this is likely to change, particularly if tougher overheating rules appear in the Building Regulations. There are many shading options, but the most effective at minimising solar gains are externally located, such as overhangs and louvered shutters. The latter has the advantage of also providing secure night time ventilation in the summer.

Incorporating these design features can help to maximise a home's year-round passive thermal performance, thereby reducing both CO_2 emissions and energy bills.

For more information, visit The Concrete Centre website (www.concretecentre.com) and download 'Thermal Mass for Housing'.