Research Finds Masonry Homes Can Have Lowest Whole Life CO_2 Impact

New research by independent consulting engineer Arup shows that when it comes to reducing the operational CO_2 emissions the utilisation of thermal mass is paramount. Andrew Minson, Head of Framed Buildings at The Concrete Centre, explains

Over the life of a home, the operational CO_2 emissions have far more environmental impact than the embodied CO_2 of the materials used to build it. Some 50% of the UK's carbon emissions are due to the energy used to heat, cool and light buildings. It is essential, therefore, that the energy which is likely to be consumed during a building's lifecycle is taken into account when evaluating construction materials. A building's environmental impact does not stop once it has been built.

New research from Arup Research + Development shows that modern masonry houses that take advantage of their inherent thermal mass of concrete can save a significant amount of energy over their lifetime compared to lightweight timber frame housing. The research is the most comprehensive study to date to examine both embodied and operational CO_2 emissions from dwellings in a warming climate. It provides strong evidence that lightweight timber homes may not be as comfortable or as sustainable in the long term as heavyweight masonry construction.

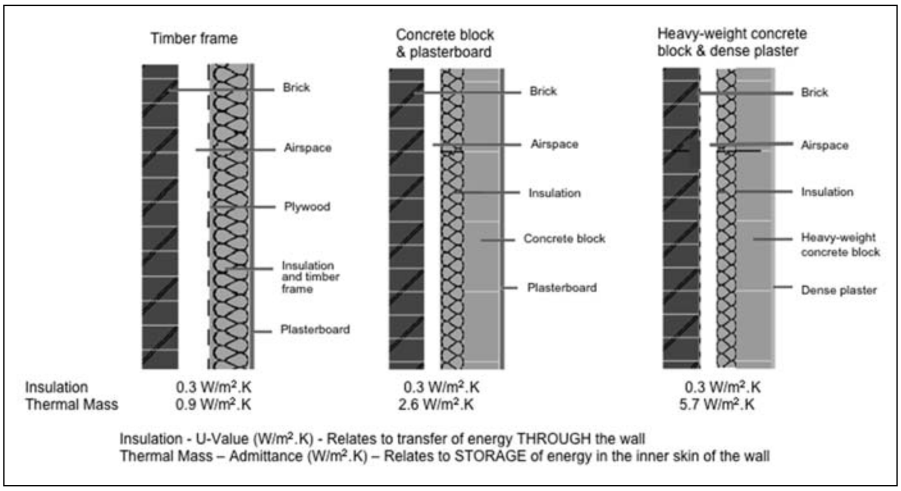
The research takes account of experts' predictions for climate change and demonstrates that the thermal mass in masonry homes can reduce the likely need for air conditioning in the coming years. It also highlights the additional savings that can be achieved by using thermal mass to capture solar and internal gains thereby reducing the consumption of fuel during the heating season. These savings can offset the slightly higher level of embodied CO_2 in a masonry house in as little as 11 years and can ultimately lead to the lowest CO_2 emissions over the life of the house

The research compares lightweight timber homes with medium weight and heavyweight masonry homes and found that the latter can have the lowest total energy consumption and CO_2 emissions over their life. This was achieved through using the thermal mass in blockwork internal walls. It was also found that the addition of concrete floors increased the operational CO_2 savings still further over the life of the house. Beyond this, additional increases in thermal mass are beneficial but the offset period obviously becomes longer.

Lightweight homes were found to overheat more frequently during the predicted hotter summers of the 21st century which could in turn lead to an increase in the use of air conditioning resulting in greater energy use and CO_2 emissions. Homes built using heavyweight construction materials with their inherent thermal mass will be cooler in the summer and so will not suffer overheating to such a degree.

The energy savings are not restricted to eliminating the need for air conditioning. Thermal mass can also be used to capture solar and internal gains during the heating season and re-radiate the heat into the room as the temperature begins to fall in the late afternoon. Otherwise known as passive solar design, this energy saving technique is very simple and basically requires little more than glazing that is orientated to the south and adequate thermal mass in the floors and/or walls to capture and store heat from the low winter sun. It is applicable to standard house designs and its ability to reduce the load on conventional heating systems enables worthwhile savings in heating fuel and CO_2 emissions to be realised over the life of a house. Straightforward guidance on passive solar design (PSD) is available to download from the Carbon Trust website, www.thecarbontrust.co.uk

Tom de Saulles, Senior Manager for Building Sustainability for the British Cement Association, explains that the research was based on the



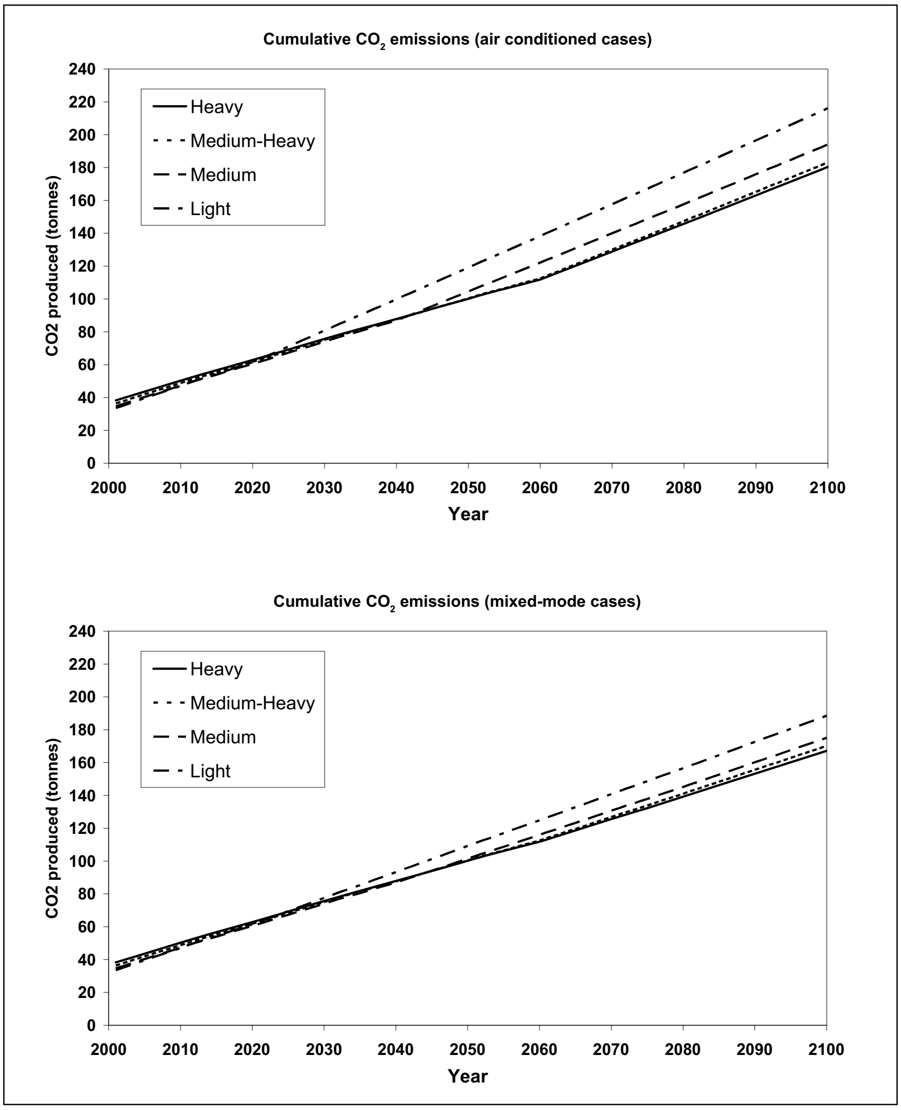
study of a two-bedroom semi-detached house in the south east of England, typical of the type of "starter home" envisaged by the Government for major areas of housing development such as the Thames Gateway. Analysis of lifecycle CO_2 emissions was carried out on four "weights" of construction: light, medium, medium-heavy and heavy. The lightweight class was a timber-frame home with timber floors, exterior brick and internal plasterboard finish. Medium weight was the same but with brick and block cavity walls. The medium-heavyweight house had a pre-cast concrete first floor and ground floor partitions of medium-weight concrete blocks with a plasterboard finish. Finally, the heavyweight house had the highest level of thermal mass with heavyweight blocks used for the external walls and internal partitions, together with a pre-cast concrete first floor and loft floor.

Occupancy was assumed to be continuous, with a family of two adults, one of whom was at home during the day with a pre-school age child. In all house types, gas-fired central heating with radiators was assumed and had a set point of 19ºC for the bedrooms, 21ºC for the living room and 22ºC for the bathroom. In the summer, three operating modes were considered: natural ventilation, conventional air conditioning and mixed-mode, which was air conditioning combined with natural ventilation so the benefits of passive cooling are realised whenever possible. In line with guidance from the Chartered Institution of Building Services Engineers (CIBSE), a house was judged to have overheated if 1% of the occupied hours in the living room were over 28ºC or 26ºC in one or more of the bedrooms. The research also included the caveat that this must occur in at least 3 in 5 consecutive years before it was assumed that air conditioning would be installed. From the outset, all the houses had solar shading and an appropriate ventilation strategy to help mitigate the effects of climate change.

Weather data representative of the climate of suburban London was used as the basis of the lifecycle analysis. The data covered the 20-year period (1976-1995) and was repeated in sequence to cover the 100-year period of 1996-2100. This was then modified using a continuously ramped morphing factor which takes account of the UKCIP02 medium-high emission scenario for climate change in the 21st century.

The lightweight home was found to need air conditioning by 2021. This compared to 2041 for the medium-weight home and 2061 for the medium-heavy and heavyweight homes.

The better winter performance due to PSD of the masonry house was found to negate its marginally higher level of embodied CO_2 compared with the lightweight house in just 11 years. The medium-weight masonry home was calculated to have around 1.25 tonnes more embodied CO_2 than the equivalent timber house, yet over a 60-year period the timber framed home was found to emit 9 to 15 tonnes more CO_2. Whilst recognising that there are many variables that can influence thermal performance, the research highlights the ability of masonry and concrete construction to provide the best long-term sustainable building option through energy efficient design.



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