THERMAL MASS ON TIMBER FRAME CONSTRUCTION

The ability of a property to maintain a constant habitable temperature is essential, and depends not only on the ability of a construction to keep its heat through correct insulation, but its ability not to absorb or lose heat to the environment. This is mainly linked to the ability of a material to absorb and release heat, and is known as its thermal mass

Definition of thermal mass

As defined by Wikipedia**, thermal mass** (C_{th}, also called **heat capacity**) is the capacity of a body to store heat, and is calculated as the product of mass the body *m* and the specific heat capacity for the material c_p, and typically is measured in units of J/°C or J/K (which are equivalent).

All materials that have mass will have some thermal mass. A common misconception is that only concrete or earth soil has thermal mass; even air has thermal mass (although very little). So the issue of "timber frame has no thermal mass" is not strictly true, it has less thermal mass than traditional masonry build.

Thermal performance of buildings

The interior of a construction needs to be maintained at a comfortable temperature of around 20^{o}C, whereas outside temperatures may vary considerably (Figure 1).

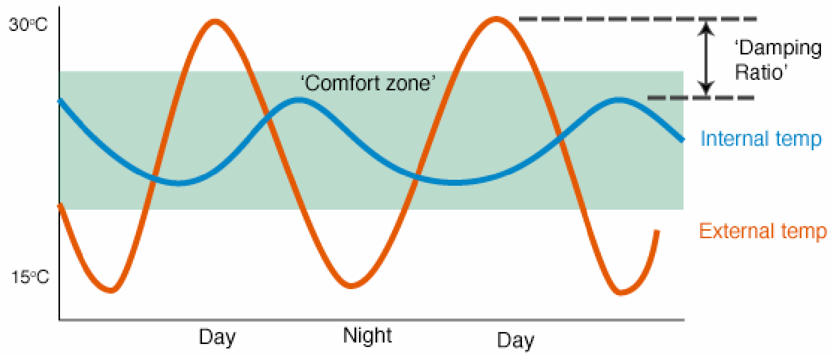

Figure 1: Temperature variations experienced by a construction

This temperature variation is more exaggerated in the summer. High thermal mass materials will take longer to warm but will then retain that heat for longer. It is argued that this delay time to reaching ambient conditions favours masonry build over timber build during hot summers, and will do so more in the future when warmer summers are predicted.

Is thermal mass right or wrong?

For thermal mass to have a significant effect there has to be prolonged exposure to high external temperatures. There is an argument that only the outer 50mm of a building (Figure 2) is affected by the daily variations shown in Figure 1.

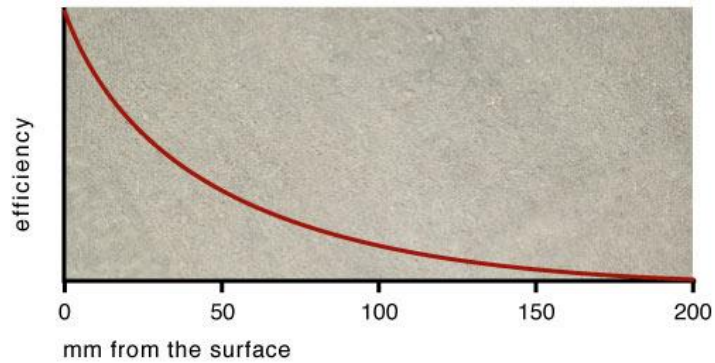

Figure 2: Thermal transmission efficiency from surface of built component

A study by Arup[i] compared heavy, medium and lightweight versions of a detached 4 bedroom house in three emission scenarios. The findings showed that whilst the heavyweight building overheated least in every scenario, by 2080 *all* three of the housing formats overheated beyond 28˚C for significantly more than 1% of their occupied time. A more recent joint study[ii] suggests that air conditioning units will be required even in the most heavyweight dwellings by 2061 under a medium high emissions scenario[iii]. These findings suggest that thermal comfort cannot be maintained by relying upon conventional thermal mass strategies alone.

Gilbert's (2005) MSc thesis *'Thermal Mass and the Effects of Dynamic Heat Flow'* suggests that lightweight structures in the 'cold-humid' UK climate may actually require significantly *less* heating input than their heavyweight counterparts when intermittently occupied[iv]. In 'cold humid' conditions (with limited solar gain), Gilbert found that both the lightweight and Phase Change Materials (PCM) performed equally well, requiring *17% less* energy input than the heavyweight wall[v]. In 'hot humid' conditions, the lightweight and PCM structures performed no worse than heavyweight structures.

Timber frame is used in many countries where these elevated temperatures are prevalent (e.g. Australia) as well as countries with hot and humid conditions (e.g. Malaysia). Many groups use these facts in arguing that Timber frame may be effective the UK in the future. KLH (Austria) produce cross-laminated timber products, and their web-site (www.klh.at) refers to good insulation in both summer and winter. The summer performance is based on the heat conductance of wood (0.14 W/mK), giving good insulating effects, whilst winter performance is also linked to the secondary insulation within the cosntruction.

Mark Brinkley writes in his web blog (http://markbrinkley.blogspot.com)of flaws to the thermal mass where passive solar gain has been proposed. The high levels of glazing necessary in the UK (especially in winters) provide significant heat loss sites during night time. This may be reduced through the use of insulated shutters, but not logical for large glazed areas. Hence the argument for solar gain in insular walls is limited. Daily conditions vary considerably between maxima and minima (as shown in Figure 1), and there is insufficient time for the whole wall to achieve temperature equilibrium with the outside atmosphere (as shown in Figure 2).

The use of brick cladding on timber frame may also prove to be flawed as this provides a heat sink on the outside of a building. This can increase the potential of overheating. It is suggested that thermal mass should be within the core of a building, not on the outside. This would allow heat absorption/release as and when required (given the interior does not suffer the same temperature fluctuations as the exterior of a building).

Despite the predictions being issued over the inability of timber frame to cope with future climate changes, it would appear that it can perform within the modelling parameters used.

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[i] Hacker, J and Twinn, C. *UK Housing and Climate Change- Heavyweight versus Lightweight Construction*. Ove Arup and Partners Ltd. 2004

[ii] Hacker, J et al. *Embodied and Operational Carbon Dioxide emissions from housing: a case study on the effects of thermal mass and climate change.* Unpublished Report 2006 [available] www.arup.com [accessed 21 Oct 06]

[iii] Ibid p25

[iv] Gilbert, B. *Thermal Mass and the Effects of Dynamic Heat Flow.* MSc Thesis. University of East London. 2005, p 60

[v] Ibid pp60-61