The Institution of Structural Engineers

Internal environment and thermal mass

Thermal mass is a term that describes the ability of a material to store heat, but to be useful in the built environment they must also be able to absorb and release heat - at a rate roughly in step with a building's daily heating and cooling cycle.

Concrete and masonry products do this well and, being dense materials, can also store a lot of heat. Timber absorbs heat too slowly to offer much effective thermal mass, and steel conducts heat too rapidly to be in synch with a building's natural heat flows over the day.

Thermal mass in summer

On warm summer days, walls and floors with thermal mass will steadily absorb heat at their surface, conducting it inwardly, and storing it until exposed to the cooler air of the evening/night. At this point, heat will begin to migrate back to the surface and be released. In this way, heat moves in a wave-like motion alternately being absorbed and released in response to the change in day and night-time conditions.

This ability to respond naturally to changing conditions helps stabilise the internal temperature and provides a largely self-regulating environment, reducing the risk of overheating and the need for mechanical cooling.

Thermal mass in winter

Thermal Mass can reduce the energy needed to keep a heavyweight building warm during the heating season. This works through the ability of thermal mass to capture and recycle heat gains from south facing windows, along with those produced by lighting, people and appliances.

As the temperature drops overnight, this is slowly released back into the building, helping keep it warm and reducing the need for supplementary heating. Whilst lightweight buildings are also capable of doing this, the extent to which the heat gains can be utilised increases with the level of thermal mass; something that is now recognised in SAP - which is compliance tool for Part L1A of the Building Regulations dealing with new dwellings.

Does thermal mass have any disadvantages?

In summer, thermal mass is only beneficial if nighttime ventilation (or some other means) can be used to cool it down. Local issues such as pollution and security concerns can sometimes make this impracticable, although there are often ways to overcome these problems.

In winter, older heavyweight buildings with comparatively low levels of insulation and poor airtightness often required a relatively long pre-heat period to warm up the fabric, resulting in slightly more fuel being used than in a similar lightweight building. However, the greatly improved standard of fabric performance in new build means this is no longer the problem it once was, as the fabric retains much more of its warmth during periods when the heating is off. In practice, the ability of thermal mass to reduce the cooling load in many building types, particularly offices, is far more significant than the preheat issue.

In some types of intermittently occupied buildings, for example a weekend holiday cottage, thermally lightweight construction may still be the best option where heating is concerned, as it will enable a more rapid warm up period. For new mainstream housing, the preheat issue is negligible, and increasing the standard of insulation and airtightness ensures the passive benefits of thermal mass during the heating season are of more significance.

Impact / opportunities for structural engineers

Choice of structural system may be influenced by thermal mass requirements by others.
Specification of finishes for exposed surfaces. Typically surface specification by architect but this may impact on concrete mix design and hence structural engineer must have input.

Find out more:

http://www.concretecentre.com/Concrete-Design/Building-Regulations/Part-L1,-SAP-and-FEES.aspx