Commercial Construction
Thermal Performance

Fabric Energy Storage

The energy efficiencies offered by concrete based materials are well known when applied to residential housing. There has been extensive research to model the performance of these high mass structures under local environmental conditions and these results have been well reported in the literature
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There have been fewer examples of high mass construction techniques being used in the commercial sector in New Zealand. The most often quoted example is the Maths and Science Building, Canterbury University. Overseas, the story is different. There are many examples of high mass structures being used to produce thermally efficient, comfortable work environments.

How does fabric energy storage work?

Concrete walls, columns and floors have a large capacity to store and release heat. This function has the effect of regulating the internal environment, by reducing and delaying the onset of peak temperatures. This effect is referred to in New Zealand as the thermal mass advantage. Overseas, the technique of utilizing the advantages of high mass in commercial structures is referred to as 'Fabric Energy Storage', or 'FES'. This technique has been widely used overseas for commercial offices to create comfortable working environments for the occupants, and reduced energy consumption costs for the owner-occupiers.

Maths and Sciences Building
University of Canterbury

The operational costs for heating, ventilation, air-conditioning and lighting are substantial. The trend in the UK has seen demand for air conditioning increasing simply to maintain thermal comfort. A developing trend in offices has been a substantial increase in cooling requirements brought about by the increasing use of computers, printers, photocopiers etc, together with uncontrolled solar gain. UK experience points to a significant increase in power usage for the refrigeration plant, pumps and fans necessary to maintain this "comfortable" environment. The energy consumed by these plants is second only to the energy used for lighting. Of more concern, is the fact that this portion of energy consumption is the fastest growing sector in the commercial and/or services market. This growth has been occurring at a time of increasing awareness of issues such as global warming, greenhouse gas emissions and climate change. Not included in any of these costs, are the substantial costs associated with the purchase and installation of air conditioning/heating plants, together with the ongoing maintenance costs over the life of the structure. As a consequence of these environmental pressures, many overseas designers are searching for innovative means of achieving a comfortable working environment. The thermal storage capacity of concrete comes into play in this regard, and as more structures are designed and built using this science, awareness of the advantages of this design philosophy spreads. Designers are now looking for low energy methods of achieving thermal comfort. Here, the inherent benefits of concrete as a material can come into play. There have been several notable structures built using this design philosophy in the UK, and the designs have been recognised in Industry Awards as a consequence of their performance. Three such examples are the Lloyd's Register of Shipping building in London, the Canon HQ building at Reigate and the Toyota Great Britain Headquarters at Epsom. In New Zealand, the use of FES design principles has been accepted in upper market residential houses and there are signs that this is a growing market segment. The commercial market is less developed however, with one or two notable exceptions i.e. the Maths and Science Building at Canterbury University.

Which parts of the structure can be used for FES?

Any section of the building can be used. The key point to remember is that it is important to keep the surfaces to be used free from isolating claddings or other coverings. This means that carpeted floors will not perform well, but exposed slab soffits will. These elements represent the largest volume and area within a typical structure and are usually well distributed throughout the building for maximum efficiency. Exposed columns and walls also act as good energy storage media. Hollow floor slabs can also be used overnight to reduce the concrete temperature by ducting cold evening air through the voids, thus removing the slowly accumulated heat generated by the daytime occupiers. Ducts cast into the concrete can also be used to act as enhanced heat sinks by lowering the temperature of the concrete and increasing the temperature difference between the air and the concrete. Careful design will remove the risk of condensation forming on these sections.

What can be expected from FES structures by way of thermal performance?

FES can reduce peak internal temperature by 5°C, shifting the peaks to later in the day often after the occupants have gone home. A passive FES building can contribute a cooling effect of 15-20W/mP^{2P}, which is sufficient to counteract the effects of computers and printers for an average office. A greater cooling effect of 25-35 W/mP^{2P} can be achieved with an active solution, (some papers have reported values as high as 40 W/mP^{2P}) allowing comfort to be maintained at higher levels of internal heat gain. If a significant area of concrete is to be exposed, then consideration should be given to the attainment of an appropriate surface consistency and colour consistency for the concrete. To achieve smooth, consistent surfaces on soffits it may be advisable to cast in custom-made high quality steel or glass fibre lined moulds. FES soffits in particular are most effective (for day lighting and lighting) if they have a white or pale coloured finish, which helps to reflect light onto workspaces. Special architectural concrete may be employed to achieve the desired finish, or normal structural concrete may be painted. The designer of a concrete FES building should also address the issue of coordination and integration of services. At the concept design stage, the servicing strategies for lighting, electrics, telecommunications, fire alarm and sprinklers, wet services and HVAC need to be considered. Early resolution of servicing runs is desirable so that precasting design work can be started in earnest early on. Pre-planning is the key to optimising both the construction efficiency and the operational longevity of an FES building.

Indicative performance guidelines

- Peak temperatures can be reduced by 5P^{oP}C or more
- Temperature peaks offset by up to 6 hours
- A 50% reduction in carbon dioxide emissions if you can leave concrete walls, floors or ceilings plain or painted
- A 25 W/mP^{2P} of passive cooling capacity, which is more than adequate to cater for heat loading of a typical commercial building
- Up to 40 W/mP^{2P} can be achieved by forced ventilation through a hollowcore precast concrete floor.

Thermal Performance Information courtesy of ***Cement & Concrete Association of New Zealand***.