Termodeck: in-use performance

As part of a long-term investigation into fabric energy storage systems, EA Technology has been monitoring the headquarters of Weidmuller Interface, the first UK application of Termodeck, since the building was occupied in July 1994. Has the system lived up to expectations?

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References

[1]Winwood R, 'What's in store for Termodeck?', *Building Services Journal*, 6/96.

[2]Assuming an annual energy consumption of 50 kWh/m² for Termodeck and 120 kWh/m² for a conventional building.

Further reading

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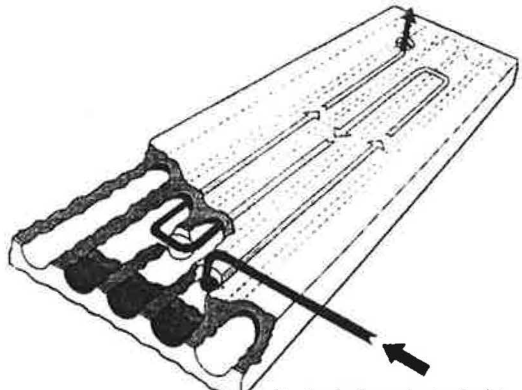
Fabric energy storage systems offer tremendous potential for reducing building energy loads while improving internal comfort conditions.

Research agency EA Technology has been investigating one particular approach to fabric energy storage: the Termodeck active thermal storage slab.

Termodeck has been used in continental Europe for over 20 years, achieving popularity in Sweden where the system was invented. While Scandinavian experience shows that Termodeck is an environmentally-friendly method of cooling commercial buildings, the system has been slow to take off in the more conservative UK market.

Termodeck uses the thermal storage capacity of a given building's structural mass to regulate the building's internal temperatures. By using hollow core concrete slabs, the building's 'effective' thermal mass is enhanced by passing ventilation air through the centre of the slab before it enters the room. Properly controlled, Termodeck can provide a comfortable working environment.



The basic Termodeck principle.

In-use performance monitoring

Monitoring results are now available from the first UK office building to apply Termodeck, the Weidmuller Interface offices located on the site of an old airfield at the Kings Hill Business Park in West Malling, Kent. The building has been studied by EA Technology as part of a long-term commitment to research into fabric energy storage.

The first year's monitoring data indicated that while the building was conceptually sound, providing comfortable temperatures with a low energy consumption (109 kWh/m² for ventilation, heating and cooling[1]), there was room for considerable improvement.

This was subsequently achieved by optimising the control strategy and upgrading the electric heaters, thereby increasing the proportion of heating energy supplied during the cheap, off-peak tariff.

Based on available data, figures 1 and 2 show the building's comfort levels and energy consumption for each of the last three years.

During 1995 the building was operated automatically, using the original control schedule. In 1996, as problems became apparent, manual control was adopted until a refit (corresponding to the missing data for weeks 32 to 48) allowed the implementation of a new control schedule.

Apart from a few weeks in high summer, all three control methods have resulted in similar comfort levels (figure 1).

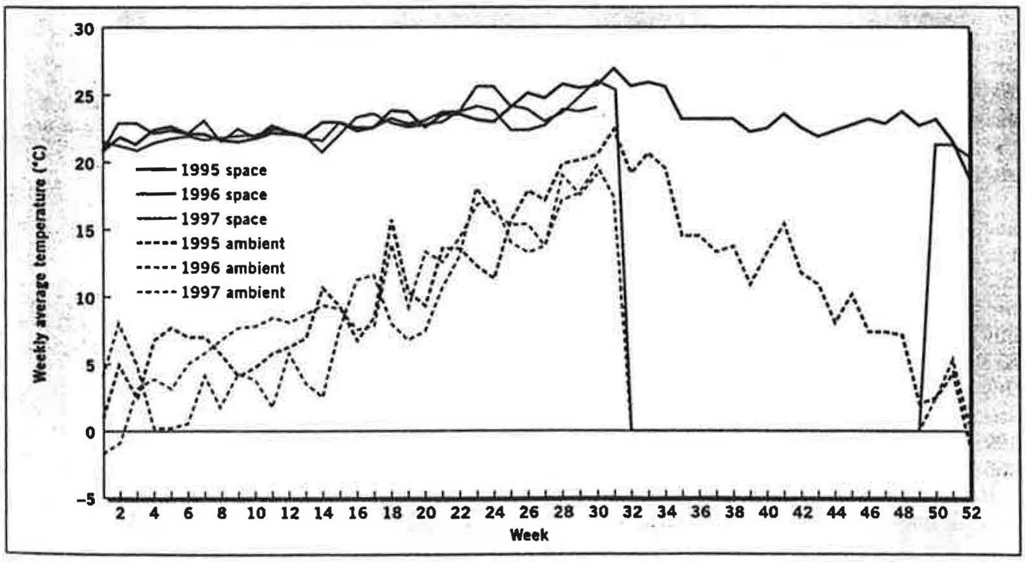


FIGURE 1: Monitored thermal performance at the Weidmuller Interface offices for the period 1995-1997.

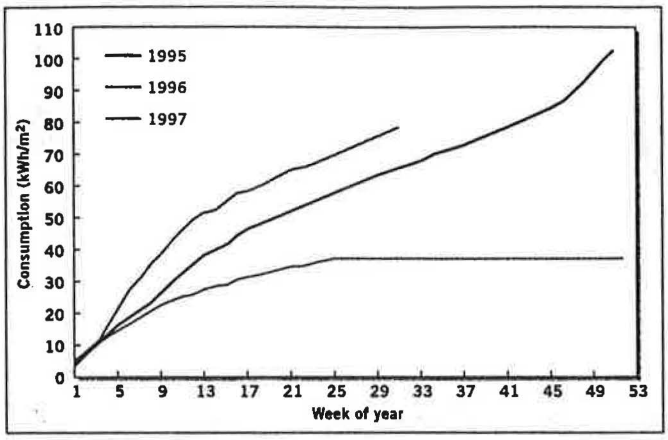


FIGURE 2: Cumulative energy consumption for the first floor (1995-1997).

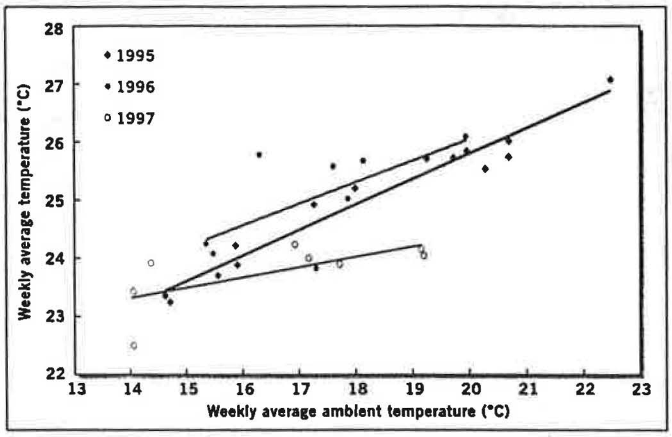


FIGURE 3: The building's free cooling performance during summer months.

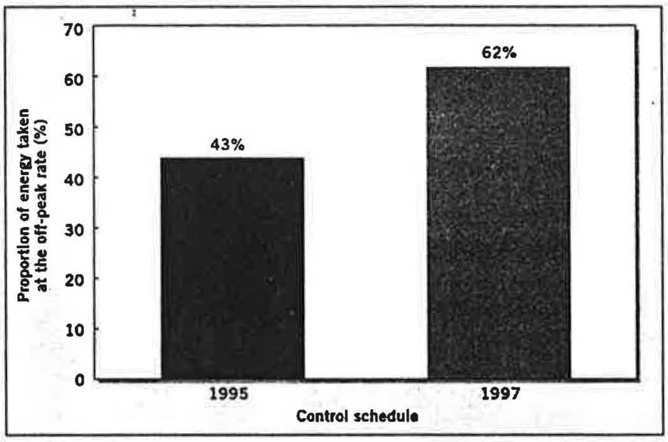


FIGURE 4: Off-peak energy consumption at the Weidmuller Interface hq building.

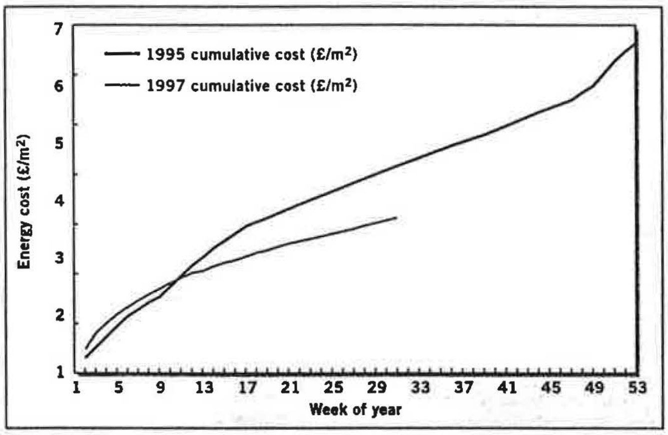


FIGURE 5: Calculated energy costs for 1995 and 1997.

However, at the same time the 1997 control schedule has so far consumed much less energy while producing more comfortable summertime temperatures (figures 2 and 3).

Figure 2 outlines the building's cumulative energy consumption for each of the monitored years. Energy consumption in the first 30 weeks has been reduced by 9% in 1997 compared to the 1995 figure, and is considerably below the consumption achieved with manual control.

Figure 3 details the building's free cooling performance during the summer months, showing the average weekly temperatures maintained inside the building plotted against the corresponding average ambient temperature (for summer weeks defined as those with an average ambient temperature >14°C). The improved performance with the 1997 control schedule is evident.

Summer overheating in 1995 was mostly due to warm nights when the time switch initiation of free cooling sometimes resulted in the introduction of warm air into the building, increasing the slab temperature.

The inclusion of some simple intelligence in the 1997 control schedule has solved this problem and improved summer comfort, as shown by the data.

A secondary problem with the 1995 schedule was short-circuiting between the ahus of the ground and first floors, where one unit would exhaust warm air into the intake stream of the other unit. This problem has since been resolved by making the units work synchronously.

The net effect of these two problems was to supply around 9 kW of heat to the incoming air, equivalent to running one of the heater batteries while attempting to cool the building.

Energy consumption

Extrapolation of the energy consumption data indicates that the Weidmuller Interface building should use around 85 kWh/m² in 1997. Although this represents a saving of around 20% compared with 1995, this consumption rate is still disappointingly high.

However, analysis shows that, if the designed fan efficiency of 2 W/l/s had been achieved, the energy consumption figure would have been much closer to its target of 50 kWh/m².

Subsequent Termodeck buildings have benefited from the lessons learned at the Weidmuller Interface offices, achieving better annual energy consumptions than the target of 50 kWh/m².

The latest examples are being specified with fan efficiencies of 1 W/l/s, which should help these buildings to achieve an energy consumption of around 40 kWh/m² or less.

Although energy consumption at the Weidmuller building is still higher than the desired level, figure 4 shows that the new control schedule has resulted in a much greater proportion of the consumed energy being shifted to the cheap night-time tariff. This has led to cost savings which are far in excess of the energy savings.

The estimated costs for heating, ventilating and cooling energy are shown in figure 5. For the first 30 weeks of 1997, a 25% improvement in running costs is shown compared to the previous control schedule (based upon an assumed 3p/9p tariff and seven hours of off-peak availability).

Design lessons

Overall, the opportunity for extended and detailed monitoring of the Weidmuller Interface building has revealed several important lessons about the design and control of buildings which rely on advanced fabric energy storage.

A simple analysis shows that increased application of Termodeck-type construction would be environmentally beneficial. A construction rate of 30 000 m²/y would produce an incremental reduction of around 2 GWh/y in the UK's national energy consumption[2].

The monetary incentives are also significant. How many financial directors would love to slash a fixed cost by more than half? The peak reduction and load shifting provided by advanced fabric energy storage results in cost savings even greater than the system's energy savings.

It is fair to say that the product development phase involving advanced fabric energy storage systems is complete. It is now up to practising engineers to seize upon the benefits of these systems and to exploit them.