Slab and trickle

It is ironic that the former West Malling fighter airfield in Kent, an old bastion of the RAF's defences, is now the location for a more welcome incursion. An otherwise innocuous two storey office building rising out of the wintry mud of Kings Hill business park marks the first UK appearance of the Swedish passive cooling technology, Termodeck.

Despite being mechanically ventilated, secondary ductwork is conspicuous by its absence. Instead, the hollow cores of the concrete floor slabs act as the ventilation paths, the thermal mass and heat transfer coefficient of the concrete – both conductive and radiant – obviating the need for mechanical cooling[1].

The client, Weidmuller (Klippon Microsystems), was keen to build a low energy headquarters building, and was receptive to the suggestion to use Termodeck by the business park's developer which had been introduced to the system by Sceboard.

Following extensive tests at the BRE[2] where Termodeck proved its worth in the UK climate, the client decided that being the first to use the system was a gamble worth taking.

The concept design was drawn up by design and build contractor Sunley Turriff and services consultant Waterfield Odam & Associates, although Termodeck's new UK arm Termodeck UK – headed up by sales and marketing director Derrick Braham – assumed some detailed design responsibilities for the passive Termodeck system.

From the client right down to the product suppliers, the project has forced a rethink of established construction methods, whereby the concept designers had to work much more closely with the construction team during the building's design development phase.

Design issues

As Termodeck relies on forced ventilation, the use of an air-to-air heat recovery system can reduce the reliance on the building's thermal mass which, while having a slow hysteresis, cannot by itself maintain stable supply temperatures at the seasonal extremes.

The solution here is almost identical to that used in Swedish Termodeck installations, where use of high efficiency heat recuperators can recover and pass upwards of 90% of waste heat from the extract air to the incoming fresh air supply. Modelling by Termodeck UK using the BRIS energy simulation tool shows that, with an outdoor temperature of -2·0°C, an internal dry resultant temperature of 20·2±2°C can be maintained with little conductive contribution from the Termodeck.

The consulting engineers adopted the constant volume system designed by the Swedish manufacturer Regenair, used extensively in Scandinavian Termodeck installations[1]. Rather than import complete units from Sweden, the Regenair damper packs and recuperators have in fact been assembled under licence by the Kent-based company Environmental Control Equipment (ECE).

The air handling system will be run continuously during weekdays to maintain the thermal stability of the Termodeck. In winter, the Termodeck may need to be 'charged' overnight, and the branch ducts are equipped with heater batteries for this purpose.

For the self-heating principle to work the building needs to be highly insulated, the U-value specifications being 0·2 W/m²K for the walls and roof, 0·3 W/m²K for the floor and 1·9 W/m²K for the triple glazed windows.

The Termodeck really comes into its own in summer, absorbing heat during the day which is then removed by the night-time ventilation process.

Figure 1 shows how the system will work. Here, the summertime diurnal supply air temperature is predicted to fluctuate by ±6°C during working hours, whereas the Termodeck slab temperature should only alter by 1-1·5°C. As supply air temperatures rise above 22°C, then the Termodeck begins to act as a peak-lopping device, ameliorating the temperature of the air as it passes through the hollow cores.

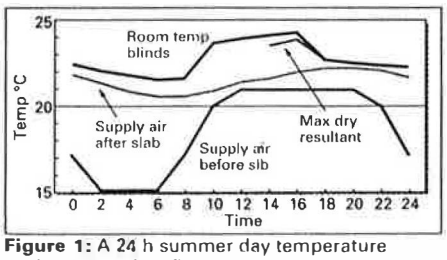


Figure 1: A 24 h summer day temperature profile for the first floor.

Termodeck UK carried out detailed simulations, providing system warranties for the client based on seasonal and diurnal loads. Although Termodeck UK has guaranteed a minimum internal temperature of 20°C at -4°C external ambient, the lack of mechanical cooling means that no guarantees have been given for maximum internal temperatures: the maximum summertime internal temperature is merely predicted at 26°C.

Night-time outside air temperatures in summer should be low enough to charge the slab to 20°C, but if daytime solar and internal loads exhaust the Termodeck's thermal capacity, two small evaporative coolers will kick-in to maintain comfort conditions. This is very much a safety-net measure, and it will be interesting to see how often they are used.

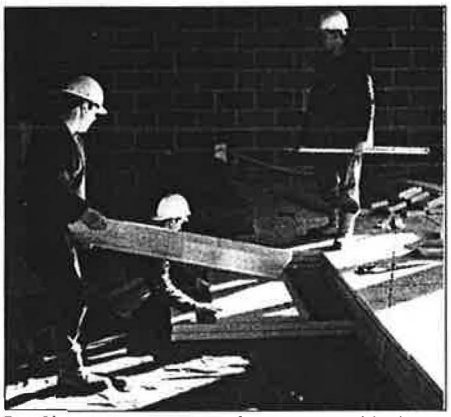
Supplementary heating for perimeter cellular offices will be provided by small 300 W panel radiators to prevent downdraughts, while

Paul Harmer

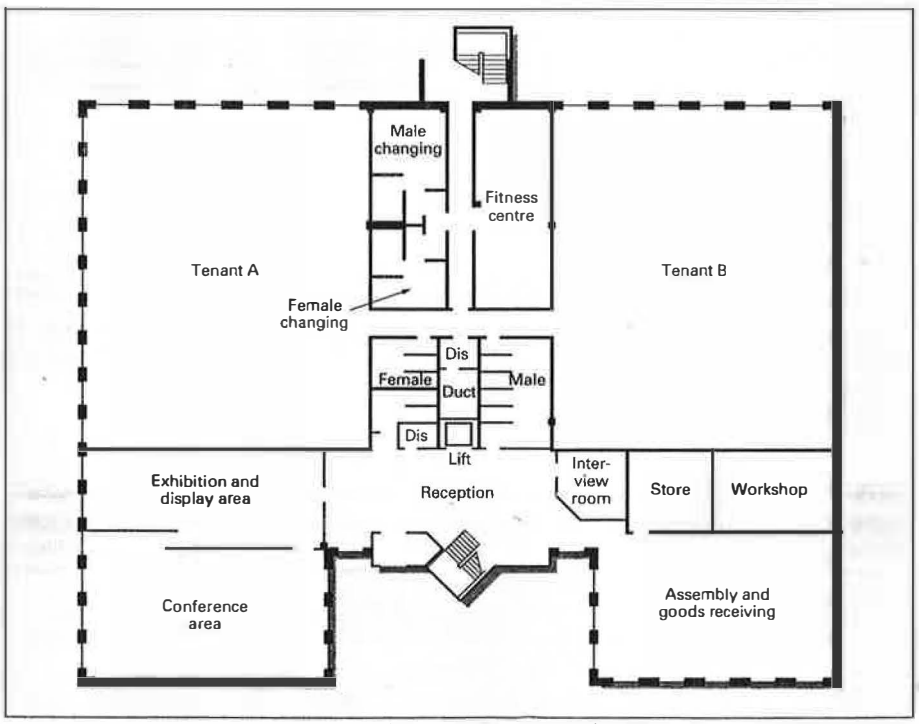
On-site report

● Weidmuller hq

Virtually every Termodeck bore has its own access for cleaning. Here, the first floor ceiling slabs have been drilled and fitted with steel spigots that are 300 mm-high to accommodate the roof insulation.



Roof insulation consists of polystyrene blocks laid on the top of the first floor slabs to a depth of 300 mm. The walls rely on mineral wool infill.



Ground floor schematic of the Weidmuller (Klippon Microsystems) hq.

in summer the openable windows (complete with internal solar blind assemblies) will provide additional ventilation.

Setting air change rates in a conventional mechanically ventilated building is usually a straightforward process. but here the Termodeck acts as the heat transfer mechanism as well as the ventilation system, so a balance had to be struck between the conductive heat transfer function of the Termodeck at seasonal extremes and prescribed ventilation rates for the occupants.

The calculation was aided by the low velocity displacement system. Instead of being injected into the space via a ceiling diffuser, supply air traverses the interstitial gap between internal walls, exiting from wall-mounted grilles into the 3 m high space (figure 2).

This convective element should reduce the effects of the ventilation/heat transfer conflict, whereby a 25°C internal temperature could easily be 1°C lower in practice. Even so, much work was done in the final two weeks of detailed design to optimise the ventilation rates against the varying heat transfer requirements of the Termodeck.

Erring on the side of caution, this Termodeck installation is not expected to cope

with the higher air changes required in areas like the shower rooms, toilets and print rooms, so dedicated mechanical extract – running on the peak tariff – will be provided for those areas. The downside of this strategy is that the hot extract air will not be available for heat recovery by the main recuperators.

Experience on site

So how easy has it been to construct a Termodeck building? Essentially, the build phase has been little different to a conventional building; if anything it has been easier and faster due to the modularity of the Termodeck and the low complexity of the services.

The total build phase is over 39 weeks. The steel frame was erected first, after which the design and build contractor, Sunley Turriff, quickly craned in the 16 m (max) long, 440 mm thick and 1200 mm wide Termodeck floor slabs onto L-shaped support sections of the frame (see contract programme).

The narrow hollow core slabs were extruded under licence by concrete prefabrication specialist Bison, and trucked down from Shropshire to West Malling. They were delivered with the active bores (those through which supply air will pass) capped-off with a lean mix, and the non-active bores sealed with a short length of expanded polystyrene inserted while the concrete was still green.

Much of the internal partitioning is of heavyweight block construction to prevent noise breakout, particularly from the tenanted areas. The consultants do not anticipate any cross talk problems created by the hollow cores.

As the lower (ceiling) surface of the Termodeck will only have a thin plaster finish so as not to compromise the radiant contribution, care had to be taken during the extrusion process and during site assembly.

Although tests at the BRE[3] demonstrate that keeping the active Termodeck bores clean is no more difficult than with a normal ducted system installation, the consultants have not taken any risks.

"As it is a relatively new system, no-one really knows how much contamination there is going to be," says consulting engineer Simon Odam. "If you have the worse case situation where a filter bank collapses and contaminates the whole building's ductwork system, it would have to be cleaned out. With ductwork it is not so bad, but these horizontal bores do not allow access for rodding, so we have provided extra cleaning holes for backward-projecting air lances."

After deciding on their specific positioning, the on-site drilling of the supply, extract and cleaning holes were monitored by Termodeck UK. The cleaning holes are fitted with circular steel spigots which will be capped.

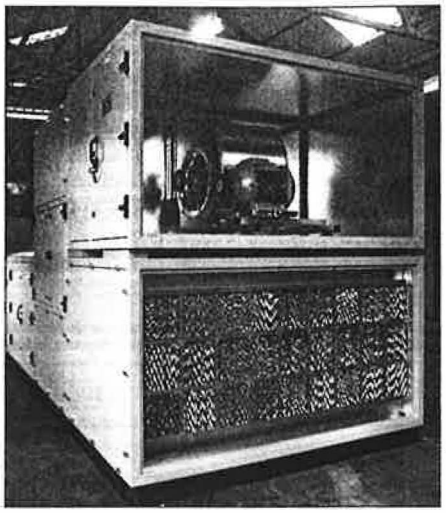
During the second week of January, the Regenair air handling units were being tested in the factory ready for delivery to site. Being a new unit to the UK, a full range of high and low voltage tests were undertaken, along with tests to ensure that the recuperator actuators were working properly.

According to ECE managing director Fred Hull, the only problem was sizing the supply and extract fans against the system resistance of the Termodeck as determined by the m&e contractor, Rotary Southern.

"The rather tortuous ventilation route made that assessment difficult," said Hull. "However, we have sized the centrifugal fans for the worse case resistance, and any adjustments can be made on the pulley selection."

The building is due to be completed in May 1994, and will then be pressure tested and commissioned over a two week period. *Building Services* will return to the project later in the year to provide more detail on the services, and assess the building's performance.

References
[1]Bunn R, "Termodeck: the thermal flywheel", *Building Services*, May 1991
[2]Willis S and Wilkins J, "Mass appeal", *Building Services*, January 1993.
[3]Wiech C and Smith J T, "A concrete solution", *Building Services*, March 1993



Dennis Molyneux

The Regenair RG units will operate continuously during weekdays so that the slabs can either be preheated or cooled during night-time operation.

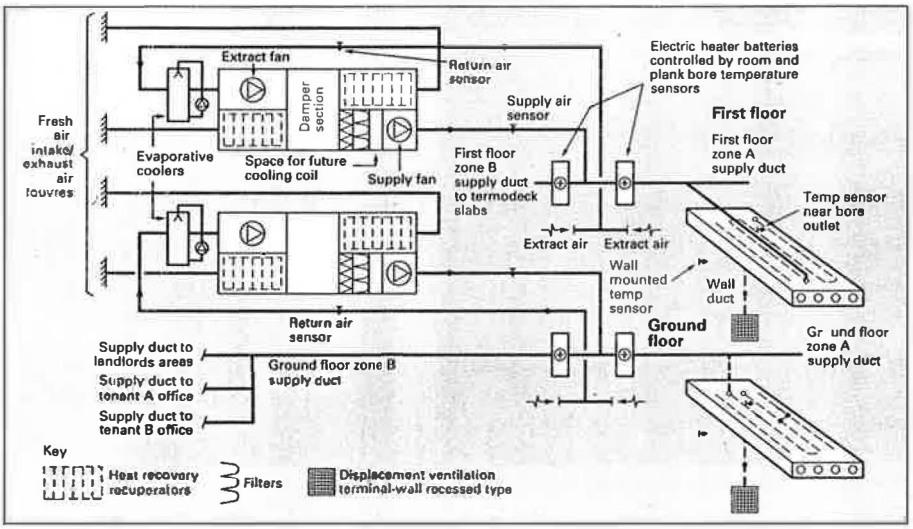
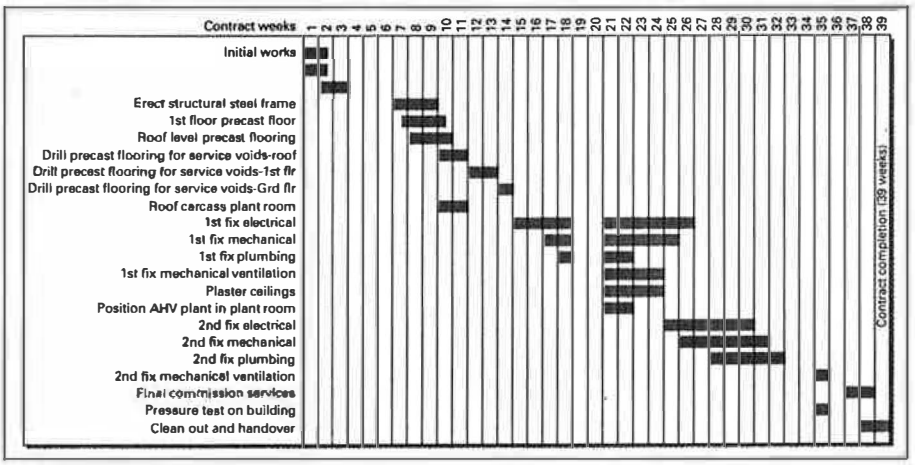


Figure 2: Schematic showing the relationship of the Termodeck to the air-side heat recovery system.



Weidmuller (Klippon Microsystems) Headquarters, Kings Hill Business Park, West Malling, Kent

Design & build contractor
Sunley Turriff
Project manager
Cox & Partners
Consultants
Services consultant: Waterfield Odam & Associates
Structural engineer: Shepherd Gilmour
Quantity surveyor: Kensalls

Main contractor's design team
Termodeck: Termodeck UK
Architects: Sunley Turriff (AEW)
Structural engineers: Cundall Johnson & Partners
Principal sub-contractors
M&E services contractor: Rotary Southern
Pre-cast concrete/structural steel: Bison/Tetbury Structures
Key suppliers
Air handling units: Environmental Control Equipment (0474 814432)
Precast Termodeck slabs: Termodeck UK (0293 520232)
Displacement terminals and evaporative coolers: ABB Fläkt Products (0926 430403)