SLAB HAPPY

BUILDING SERVICES JOURNAL, JANUARY 2000

When Post Office Counters decided to upgrade its national centre in Chesterfield, environmental friendliness was high on the agenda. The designers opted for an unusual combination of services: Termodeck and fan coils. How did the two fit together?
By Alison Luke

Designers on the Chetwynd House project had a tough brief - loose, but tough. PO Counters wanted to demolish its existing ten-storey, gas heated building and replace it with a more environmentally-friendly version. This, the company hoped, would satisfy its 850 staff and comply with the company's Green book environmental policy. The brief simply specified the building size, staff numbers and jobs, the requirement to gain a 'very good' BREEAM rating and the need to "design an environmentally friendly building".
An initial microclimate study carried out by consulting engineer IBSEC ruled out the use of natural ventilation due to local noise and traffic pollution. When IBSEC then suggested the ventilated hollowcore system Termodeck, PO Counters needed to be convinced of the product's performance. However, after witnessing Termodeck's use in other buildings, PO Counters agreed to the system for the office areas, with conventional fan coils for the rest of the building. This unusual combination required some interesting engineering.

The design process itself proved long and complicated. In the early stages the client was in full control of the construction process. However, this changed when it was asked to construct under the PFI scheme, at which point the construction team backed down and the Termodeck system was abandoned. The PFI reached its own advanced stage before that too collapsed, leaving the original POPH team back in control.

Consultant engineer IBSEC was involved throughout the debacle. Having won the contract through tendering, the company acted as an advisor during the pre-PFI stages and was well placed to advise the PO after this agreement collapsed. The winning architect, Edinburgh firm Cochrane McGregor, was originally invited to tender on the strength of its work in the Scottish PO system. Close working relationships were maintained throughout the construction process. They still are - six months after handover.

Land was not a problem. The plan was to demolish the existing 1960's building and reuse the site. The PO owns the five acre plot the previous building stood on and this provided ample space for a broader low-level building - a desire of the client and cost-cutting exercise.

BREEAM points were gained for reusing the land, which consists mainly of filled ground and previously housed a railway goods yard. An archaeological survey was necessary as it lies on the site of the old city wall, however it was decided that the current ground level is high enough to prevent disturbance to any ruins. One thing did however cause slight consternation at groundworks stage. An underground structure not listed on any plans was found. With reinforced concrete walls one metre thick, construction workers thought they has uncovered the council's nuclear shelter. The truth was less dramatic: it turned out to be the boilerhouse for the town's defunct district heating scheme. Too big to break out, it was tested for structural safety and left.

Building structure and layout

The resulting building is an attractive, three-storey red brick structure which fits well with the facing town hall. It lies on an east-west orientation and consists of two main wings cantilevered off a central zone.

The building facade sits a pavement-width from the main road that runs though the town. This was a planning constraint as planning officers thought it would improve the sightline from the town centre.

An open passageway through the central zone separates the two wings. More significantly it accommodates a public right of way from the Town Hall and main shopping area to the town's Queen's Park. During construction, permission to divert this route had to be reapplied for twice annually, with a final reopening date of December 1999 easily met. On the east side of the passage resides the building's reception area, on the other, general offices. Drives at the side of either wing lead to a landscaped carpark behind the building.

With the quest to gain a 'very good' BREEAM rating and get maximum efficiency from the Termodeck, the building fabric had to be airtight. The services engineers worked closely with the architects throughout the detailed design and construction stages, and even specified items such as window reveals and headers. All window sills are positioned on timber grounds which lie on a base of silicone mastic. This mastic has been used on every conceivable area of the building where a risk of air leakage exists: notably around plasterboard joints, windows and doors.

This care was well rewarded. The resulting BSRIA airtightness test in June 1999 gave an overall value of 5 m3/m2/h, the target. The east wing achieved 3·6, the west 4·7. This is despite faulty seals on fire doors in both wings.

The wall cavities are 75% filled with polystyrene board to help achieve a U-value of 0·2 W/m2K. 200 mm insulation on the ground and second floor Termodeck slabs help the floor and roof achieve U-values of 0·1 W/m2K.

Pilkington K low emissivity glass has been installed throughout the building. Triple glazing was considered but double glazing installed for cost reasons. Brise soleil and blinds were installed on all South-facing windows and latterly on the first two working bays of the north elevation where low-level glare problems were being experienced. This may be due to a low window to wall ratio in the offices and the existence of the perimeter bulkheads, which combine to limit the even spread of daylighting into the offices.

In glazing also, energy efficiency and building airtightness have been considered down to the smallest detail. In a system specified by Cochrane McGregor, the blinds are sealed between the two layers of window glass. To avoid penetrating the window frames with winding mechanisms, the blinds are magnetically controlled. This involves a magnet on the outside of the frame being connected with one on the inside of the window cell. Moving the magnet up and down then operates the blinds. The windows are openable for cleaning and maintenance purposes only.

Inside the building

From the moment of entering the glazed reception area it is evident that security is a priority. Extensive, high-tech systems abound, of which more anon.

The two wings are basically identical. The first two floors consist of deep, open plan offices, colour-coded into departments "so you don't get lost", according to the engineers. The PO's recently approved policy of open plan offices is fully adhered to in this building and no-one has a personal office.

The open plan areas are dominated by the imposing batwing central and perimeter bulkheads, which make the 3·3 m floor to ceiling height appear much lower. Desked working bays run either side of a central passageway the full length of the room.

Each office area has a separate restroom - installed as part of a no drinks policy in the main working areas. Structured cabling stretches into these and laptop computer plug-in points are provided for peripatetic workers.

The central part of the building houses core facilities such as lift shafts, stairwells and a variety of meeting rooms. This area is serviced conventionally by a fan coil system on minimum fresh air supply and extract. Structured cabling runs throughout, providing back-up incase one of the wings has to temporarily close, the staff simply moving here to work.

The third floor houses a staff restaurant and gym, services plantrooms and a 'Creativity room'.

Firefighting stairwells in the central area and end of each wing are heated via a wet radiator system served from the fan coil circuit at constant temperature. Colt ventilators in the stairwell roofs are activated by fire alarm or panic buttons in the reception.

The Termodeck system

This was IBSEC's second full involvement in a Termodeck project, the other being at Peel Park, Blackpool1. Termodeck's Derrick

Braham was closely involved with both.

As mentioned, the client wasn't easily convinced and visited several other Termodeck buildings throughout the UK, collecting user-opinions and energy data before giving the go-ahead to install the system.

One of the client's primary concerns was slab quality. The PO wanted a completely smooth finish as the slabs would ultimately be on display as part of the office. This is not an easy task with concrete, and the PO designers had not been impressed by existing schemes. This demand for quality affected everything from transportation to delivery and placing of the slabs, with often an extra construction worker available during unloading to make sure slabs were not damaged. Rather than be left bare, the Termodeck planks were finished off with a coat of white paint. The result was "better than PO had seen elsewhere", said the client's representative, Steve Battison.

The system provides 100% fresh air at 4 ac/h , the design temperature of 2263°C being closely adhered to. The design of the Termodeck system loosely follows that used in the Peel Park building with upgrading and additional features included to make it more flexible and reliable. Motorised dampers on the collection to each slab enable different areas of an office to be heated or cooled within the same 24 h cycle. This is something that was not available at Peel Park and the lack of which caused subsequent balancing problems when cellular offices were introduced.

The bulkheads are crammed with services: two supply ducts run through the central batwing bulkhead and all electrical cabling, fire alarms, security systems and some lighting are held in these.

Spigot tapoffs from the two supply ducts route supply air into the Termodeck slab. This then passes through the slab three times before flowing down purpose-made flues which are integrated into the office walls. Final supply to the occupied area is through regular swirl diffusers in the raised floor, sited throughout the office. The flue blocks used in the walls were not airtight enough, so three plastics pipes were inserted.

The return air rises back into the centre bulkhead then through a perforated return air plenum. A large bellmouth at one end of the office areas helps to collect the exhaust air.

Caps on the core slabs enable access for cleaning, which theoretically should be carried out every five years of the 60 year lifespan. However, as long as EU7 filters are used the cores should remain relatively clean.

The slabs are charged overnight for the following day. This is all bems controlled: the temperature at 18.00 h is used to determine the level of heating or cooling needed to get the slab to the required daily temperature - thermal wheels on the Termodeck ahu's currently handle most of the space heating loads.

The slab heating cycle runs from 18.00 to 24.00 h, during which warm air at 30°C is passed through the slab in the required areas. Cooling occurs between 24.00 and 08.00 h. Current findings show the lower floors need heating, when upper floors need cooling.

The motorised dampers open according to cycle. An inverter on the supply air and extract fans prevents dangerous pressure build-ups if a lot of dampers are closed.

The heating system works on flow and return temperatures of 65°C and 45°C, so low flow rates are required. Two 300 kW atmospheric gas-fired condensing boilers help gain a mean temperature of 55°C, maximising energy saving on condensing.

Two air cooled chillers serve all the ahus in the building. A lack of external plantroom space for the chillers led to the addition of centrifugal extract fans to provide extra static.

Energy saving methods are abundant. All pumps have inverters with two-port valve control: as valves close, pressure builds up and the pumps slow down. There is a heat meter on the Termodeck ahu supply and water meters on the evaporative humidifiers which serve the Termodeck ahus.

It is hoped to use the wetted surface humidifiers on the Termodeck system for free cooling in summer. The ultimate aim is to switch the chillers off completely during these periods and simply have them as backup.

The entire system is closely controlled by a Trend bems, with almost an excess of wall-mounted sensors in the Termodeck-serviced offices. All setpoints are temperature controlled and on-site monitoring is being carried out via the system bems, although a computer virus was playing havoc with this on the day of visit. IBSEC is remotely monitoring the system for the first year of operation and the BSRIA is currently selecting between this and the Peel Park site for a monitoring program.

Having been occupied from only July it is too early for overall energy monitoring results, the system currently being fine-tuned. However, it seems that the near obsession with control is actually causing problems. As there are so many within the vicinity of the slabs, any adjustments to control local hotspots are unlikely to be picked up accurately.

Lighting

Energy efficiency, as with the other services, plays a strong role in the building's lighting system. The main office areas are lit by high efficiency T5 fluorescent lamps suspended directly from the Termodeck slabs above each working bay. The fitting supports bore 20 mm into the slabs, the maximum depth possible without penetrating the cores.

Rows of lamps six wide run the length of the two wings. These are controlled by movement detectors in each bay, so lamps only operate in the areas currently in use. The lamps nearest the windows are fitted with daylight sensors and dim according to daylight levels; the inner rows are of fixed illuminance, their distance into the deep plan making daylight sensors unnecessary.

The lamps are low glare 48 W Category 2, with a load of 13 W/m2 used to meet the BREEAM rating. The luminaires are Philips optics whose concave shape, gives a 65° illuminance on axial and transverse planes.

Meeting room and core office lighting is controlled by movement detectors, with dimmer switches available. Circulation areas are bems time-controlled, with movement detection sensors included for security patrols.

Lighting in plantrooms is controlled by three methods: movement detection, bems controlled timeswitching and a keyswitch. The lights will turn off after a preset time unless the keyswitch is turned on, in these areas an external indicator displays if a light is left on.

Electrical supply

The electrical plantroom is situated on the west wing third floor.

The 11 kV mains supply runs into a packaged substation, through a stepdown 1250 kVA cast resin transformer into a single enclosure. A cast resin unit was chosen over heavier oil-filled versions due to structural implications.

The main lv electrical panel is a basic split essential/non-essential unit with a 1250 A dropout contactor bus coupler. In full operation the bus coupler is closed and all supply is through an adjusted 2000 A acb. If supply is lost, the bus coupler drops out of the circuit and a bems signal automatically starts the 850 kVA standby generator. This supply powers the essential side of the split panel only, catering for certain coolers, one chiller, computer rooms, 30% of the lighting (central lighting), all pcs and the Termodeck ahus.

Full load is reached within 15 s, with full management communications on after 5 s. By the time it is fully running, full load shedding will have been completed by the bems. In theory, the building can run on standby power indefinitely: all environmental methods will continue to run but at a lower efficiency.

The main 1250 litre storage tank outside the building accommodates one week's supply. This connects to a 600 litre daily service tank. The entire system is fire valved, so in a fire all diesel is dumped to the external tank.

Power is distributed to the main communications rooms and each floor via rising busbar mains down risers, again two systems - essential and non-essential - are catered for, separated to either side of riser cupboards which can be accessed on each floor. These serve underfloor busbars in the office areas from where individual systems are tapped. Emergency lighting is run from a 25 kVA static inverter and central battery system.

With the main functions in the building being carried out on pc, the supply to this system is vitally important. The building has two main communications rooms based on the first floor, one in each wing, each with a 60 kW load. On the ground and second floors there are supplementary wiring closets.

Each communications room is self-sufficient. Every cabinet has an individual uninterruptible power supply (ups), and an additional 10 kVA ups provides overall back-up for the entire room. The temperature in these areas must be maintained between 18-19°C as the cabinets will 'melt' at 24°C. Two Airedale air conditioning units provide the means to maintain this, blowing air into underfloor plenums around each cabinet.

Rather than using an aspiration fire detection system, the client opted for Notifier high-intensity point detectors. In addition to cost savings, this leaves the flexibility to alter the space use and install conventional detection systems without having to recable the area.

Security

A bank of high resolution cctv screens in the reception constantly displays the surrounding external areas and secure internal areas to monitoring security staff.

Entry past this area is by security card only. A row of waist-height optical security gates lines the reception exit, and passing through without first displaying a suitable card to the reader sets off an alarm. The entire system works on smart technology, with the credit-card style cards serving three purposes: visual and electronic id and a credit system.

Every working area, plantroom and office throughout the building is entered by passing a reader locked door. The cards are programmed to recognise the specific areas an individual is allowed to enter (primarily their workplace, the restaurant and gym) and will only open doors to these areas. If someone tailgates into an unauthorised space, they will be unable to leave without alarms sounding.

The company has a non-monetary policy and no cash need change hands on-site. Security passes can be charged with money in two regeneration points on the third floor then used to buy food and drink in the restrooms and restaurant. The cards can also store biometric information for assisting with gym exercise plans. This is something the PO considered but haven't yet implemented.

Will it all work?
Aside from a few minor problems, the building seems to be well received by the client. The project was notable for the close working relationships between the consultants and the client, indeed, the engineers themselves wished that "all jobs ran this way".

The advantage of the Termodeck approach is that if the building is ever re-zoned, setpoint conditions can still be met through the individual damper control.

However, the main post-handover problem has been the difference between design and actual pc density. In some areas this has been "substantially oversubscribed" say the engineers, with more than double the design limits being installed. This has created local hotspots and a need for controls to be re-tuned. The client has opted for generously sized desks which will make it difficult for higher levels of occupancy to be spread evenly around the building and could increase this problem. Design occupancy has already been exceeded by 100 staff. Some areas are also being used 24 h, giving further control issues.

This raises the question of what is an appropriate response to a green brief. If spot loads can be anticipated, briefing could place greater emphasis on cutting out those loads at source. Proposing the use of liquid crystal display screens for example, may be preferable to providing extra plant cooling capacity2.

One group certainly satisfied with the result is the local football fans. The external lighting is arranged so the building is lit in blue and white stripes - Chesterfield football club's colours - making it an immediate favourite.

Creativity in Chesterfield

One unusual but highly regarded feature of the building is the Creativity Room, which features, among other things, banana beanbags and a giant cone. This was PO's Steve Battison's stroke of genius and is based around the Maltese philosopher Edward De Bono's "six thinking hats theory".

The idea was to create an area which induces creative and lateral thinking for brainstorming sessions. As IBSEC's Simon Cathrine says, "Converting the brief into a design was the most challenging part, but the results were worth the effort." The theory relates six different colours to thought and mood, for example, red is angry, yellow is creative, and green is calm. These colours are used to stimulate the creative and non-creative sides of the brain.

The room separates into six notional zones, each with a different centre colour. Six fibre optic generators with individual motorised colour and dimming wheels above the ceiling enable any permutation of the six colours to be glowing at one time. There is also the facility to switch to a separate set of fibre optic generators, one with a colour wheel and one standard white, to produce a starry sky. Wall washes can be used to intensify the colour and low-level led strip lighting give low illuminance levels at ground level. This is all controlled by touchpad pcs outside the room.

A music system is included for extra effect and the four room corners are curved. To ensure total freedom of thought, a false wall around the room is made completely of Nobo whiteboard so any ideas can simply be scribbled down. And the cone? This is Steve Battison's pièce de résistance, what he calls the "Cone of excellence". This is also Nobo board covered for writing on and resembles an oversized traffic cone on wheels. It includes a section for creative toys, pens and a bucket and basically saves the more relaxed of the creative team from walking over to the walls.

1 Future Walk, Chesterfield

Contract details
Tender date: March 1998
Tender system: Competitive
Form of contract: JCT80
Contract period: 14 Months
Was National Engineering Specification used?: No
External design conditions
Winter: -4°C/100° Sat
Summer(a/c): 27°C db, 20°C wb
Internal design conditions
Winter: 21°C±2°C
Summer (a/c): 23°C±2°c
Circulation & toilets: 21°C max, 19°C min
U-Values (W/m2K)
Walls: 0·23

Floor: 0·104

Roof: 0·106

Glazing: 1·9

Structural details

Slab thickness: 0·3 m

Clear floor void: 0·3 m

Floor to ceiling: 4 m

Occupancy

Offices: 1 Person/7 m2

Noise levels

Offices: 35 NR

Toilet & circulation: 40 NR

External breakout limits: 50 dBA

Target energy use (gfa)

Gas: 57·2 KWh/m2/y

Electricity: 70·7 KWh/m2/y

CO2 target: 60 KWh/m2/y

Fabric leakage: 5 m3 per m2 of envelope @ 50 Pa

BREEAM rating: Very good

Loads

Calculated heating load: 600 MW

Installed heating load: 600 MW

Calculated cooling load: 520 MW

Installed cooling load: 520 MW

Fan power: 1·3 W/litre/s

Gross building load: 5·4 W/m2

Lighting: 13 W/m2

Occupancy: 17 W/m2

Ventilation

Room temp: 20°C min, 25°C max

Fresh air: 100%

Filtration category: EU7

Primary air volumes

Ahus at: 8·6 m3/s

Ahus at: 9·3 m3/s
Offices: 6·5 m3/s
Dining room: 3·5 m3/s
Distribution circuits
LTHW: 65°C flow, 45°C return
DHWS: 60°C flow, 55°C return
Constant temp: 65°C
Exhaust recovery: 24°C
chilled water: 6°C
Refrigerant
Chillers: 2,404c
Electrical supply
KVA transformers: 1250 kVA cast resin
KVA ups system: 2 x 10 kVA
KVA standby power: 850 kVA
Lighting
Lux levels
Office: 500
Conference: 500 dimmable
Kitchen: 300
Computer: 300
Toilets: 200
Stairs: 200
Circulation areas: 200
Lifts
2 x 8 person hydraulic @ 0·63 m/s
1 x 8 person goods traction
3 x 16 person passenger traction @ 1·6 m/s
Costs (£ millions)
Total cost: 12
Building services total: 3·4
Total net cost (£/m2): 480
Mechanical services costs (£)
Cold water services: 82 000

Hot water services: 78 000

Heating services: 450 000

Cooling services: 410 000

Ventilation: 700 000

Thermal insulation: 20 000

Dry risers: 10 000

External gas and water: 20 000

Preliminaries: 50 000

Electrical services costs (£)

Metres and switchgear: 90 000

Lighting installation: 363 700

Power installation: 228 300

Lighting external: 90 000

Controls package: 140 000

Fire alarms: 56 730

Security: 220 800

Telephone & data: 53 400

Earthing & bonding: 2200

Lifts: 341 000

Sundries: 13 700

References

1Bunn R, 'Mass control', Building Services Journal, 11/97. 2Anon 'Going flat out for space savings', Building Services Journal, 3/97.

Credits

Client

Post Office Property Holdings (POPH)

Project Manager

Sue Wilcock, POPH

Architect

Cochrane McGregor, Edinburgh

M&E consulting engineer

IBSEC, Harrogate

Structural Engineer

Curtins, Leeds

Quantity Surveyor

WT Partnership, Leeds

Main contractor

Hbg

M&E Contractor

N G Bailey, Sheffield

Commissioning contractor

N G Bailey, Sheffield

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