Project

Woodland Trust headquarters

Architect
Feilden Clegg Bradley Studios
Environmental engineer
Max Fordham
Structural engineer
Atelier One
Location
Grantham, Lincolnshire
Completion date
July 2010

By Amanda Birch

Here's an interesting paradox for an architect: how do you construct a building in timber that requires the thermal mass of concrete? This was the conundrum that the design team faced when considering the structure for the new £5 million Woodland Trust headquarters rapidly taking shape on a formerly vacant site west of the market town of Grantham.

The paradox was unlocked when the team developed the unusual idea of using cross-laminated structural timber panels for the walls, floor and roof, and fixing pre-cast concrete "radiators" or panels to the soffits of the timber floors.

"The concrete would serve to work compositely with the timber panels to act structurally and, critically, would also provide the required thermal mass," says Matt Vaudin, partner in charge at Feilden Clegg Bradley Studios.

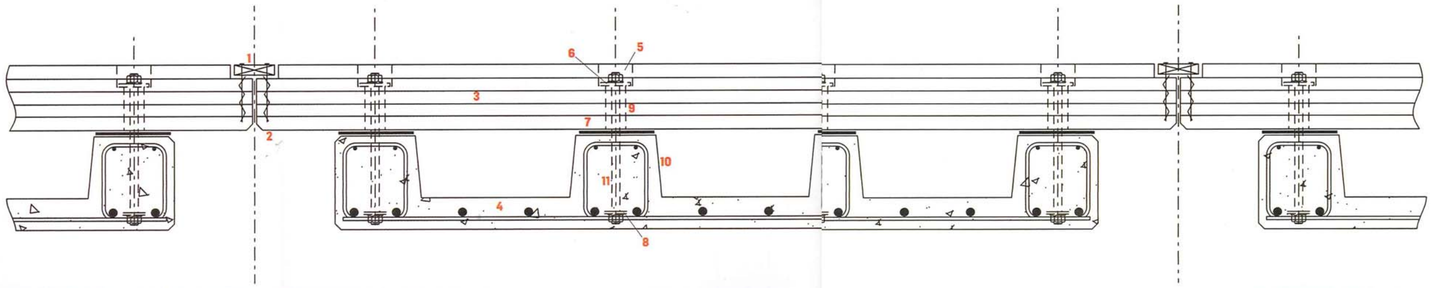
It seems such a blindingly obvious solution, but like most good ideas it came about because of a particular set of circumstances: the information available and the individuals involved.

"Combining timber with concrete has been done before but usually on the upper surface, with the timber acting as shuttering," says Neil Thomas, director at structural engineer Atelier One. "We've come up with a holistic solution that is architectural, works environmentally and performs structurally."

The concrete radiators are being used throughout the 2,800sq m naturally ventilated office building, which gradually descends and sweeps around from a three-storey, 15m-wide block to a two-storey reception area and down to a one-storey wing housing meeting rooms. The unfolding spiral continues wrapping around a courtyard garden where eventually the larch-clad building comes to an end by forming an entry point to the building beyond. The garden will be landscaped to create a "woodland experience" - perhaps to soften the blow that the headquarters are not situated in a picturesque woodland as one might anticipate.

'The concrete would work with the timber panels to provide the required thermal mass'

The headquarters building is now on site.



SECTION THROUGH CEILING SHOWING CONCRETE RADIATORS

1 Softwood or plywood cover strip glued or nailed to top of floor panels.
2 162mm-deep prefabricated floor panel.
3 5mm x 5mm chamfer to all exposed edges of KLH timber floor panels.
4 Concrete panels bolted through floor panels.
5 85mm-diameter hole for non-shrink grout.
6 75mm-diameter x 8mm-thick washer plate.
7 Interface adhesive to take up irregularities.
8 60mm x 6mm-thick x 60mm washer plate.
9 50mm-diameter hole for non-shrink grout.
10 Slope to ease removal of mould in precast process.
11 M20 threaded rod bolts.

DESIGN OF THE CONCRETE RADIATORS

The concrete radiator solution was a slow burner. Feilden Clegg Bradley's Matt Vaudin and Max Fordham partner Guy Nevill had worked together on a number of offices, and knew that a timber-framed building alone would not provide the required thermal mass to avoid the building overheating. They were faced with the problem of how and where to add the required mass and the choice of material.

Other materials were considered, says Vaudin, but none met the criteria of exposed concrete, which at a thickness of 80mm can provide enough thermal mass for night-time cooling.

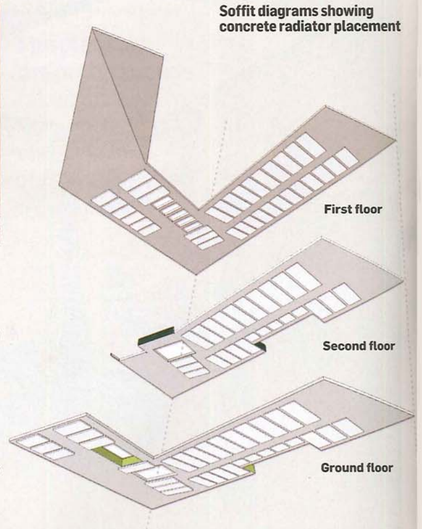
Max Fordham used the Chartered Institution of Building Services Engineers Design Summer Year data for Nottingham, which provides detailed temperature readings for a hot summer. This showed that the location was cooler than average, and so a smaller volume of concrete was required. This information provided Atelier One director Neil Thomas with the facts he needed to propose fixing the soffits of the timber floors with concrete panels.

Concrete radiators installed.

"Max Fordham computer-modelled the timber laminate construction with concrete radiators on each floor covering, 50% of the ceiling by area," says Vaudin. "The thermal admittance of this arrangement was calculated using their in-house Thermal software and then further modelling was done using IES software".

Meanwhile Atelier One used this information from Fordham's to carry out their own computer modeling to work out structurally how much concrete was required. They knew the panels had to be thick enough to work structurally but they also had to try and minimise the weight of the slab.

Soffit diagrams showing concrete radiator placement



Visualisation showing the interior with concrete radiators fixed to the soffits.

Two pre-cast concrete radiators – one 5m long and the other 6m long – were made and grout bolted to a double-span 15m-long cross-laminated timber panel and monitored over a period of four weeks. Measurements were taken daily to assess whether the measured deflections and creep were as estimated in the design.

The design of the pre-cast concrete radiators comprises a simple rectangle in plan and shear fixed to the underside of the 2.4m-wide timber panel. They range in length from 6m to 5m and are typically 2m wide. They follow a ribbed pattern with the ends being 250mm thick and decreasing to a thickness of 80mm where the concrete has been hollowed out.

The 81 radiators have been made by Trent Concrete and, together with the KLH UK cross-laminated timber from Austria, were sent to the main contractor B&K Building Services, which grout-bolted the materials together. Some of the longer concrete radiators are more articulated on one side to accommodate fluorescent tubes, which will provide lighting along the central portion of the three-storey block.

The design team remains upbeat about the radiator solution and is exploring the possibility of using it on a new workplace building in London.

SPECIFICATIONS **Client** The Woodland Trust, **Quantity surveyor** Ridge, **Landscape** Grant Associates, **Project manager** Buro Four, **Main contractor** B&K Building Services, **Cross-laminated timber supplier** KLH UK, **Precast concrete manufacturer** Trent Concrete, **Windows** Velfac, **Woodfibre insulation** Gutex

HOW THE BUILDING COOLS DOWN

Both diagrams show a section through the Woodland Trust headquarters: diagram 1 shows the building during a summer's day while diagram 2 shows the building during a summer's night.

The soffits on each floor have been fitted with the concrete radiators and the Velfac windows on either side can be manually opened at low level, while at high level the windows will open automatically at night for overnight cooling.

During the day, heat is absorbed by the concrete panels located at high level. The large surface area of the concrete ceiling provides a good radiant cooling effect to the people working below. At night the panels radiate heat, which leaves the building via the high-level windows. Cool air can also enter the building via the high-level windows and this cools the concrete.

During winter, the concrete radiators moderate the heating and the windows only open for trickle vent.

Matt Vaudin says when they were resolving the concrete radiator solution they carried out an analysis of carbon dioxide expended within the structure compared with an entirely concrete structure.

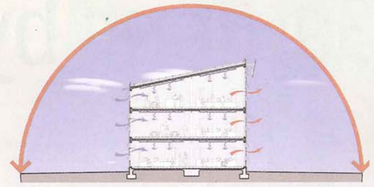


Diagram 1: Summer day

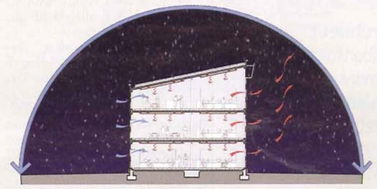


Diagram 2: Summer night

"We concluded that by using more timber and less concrete, the building will save over 400 tonnes of carbon dioxide from entering the atmosphere when compared with an entirely concrete structure, and the fabric of the building will store over 500 tonnes of carbon dioxide," says Vaudin. "The sum of this is equivalent to more than 10 years of carbon dioxide emissions from the occupation of a building equivalent in size and use as the Woodland Trust headquarters".

The building has already received a Breeam "Excellent" rating.