



2011 PTA
Post-Tensioned
Structure Award

Winner

Worcester Library

Timber roof cone.

Worcester Library and History Centre, Worcester

The £42 million Worcester Library and History Centre, also known as The Hive, is a fully integrated public and university library, which includes more than 10,000m² of public space over five floors. The building will use natural sources of daylight and cooling, and the pyramid roof cones will act as a natural ventilator.

The Hive was originally schemed as a steel frame with precast units but this did not satisfy the required floor zone restriction. It was redesigned with traditional reinforced concrete floors, the slabs of which were of varying depths – typically 300mm but with some areas of 400mm and 500mm. Post-tensioning was then used to reduce slab depth in order to maximise headroom and the internal open space of the library.

CCL post-tensioned concrete slabs had to incorporate Velta pipes that would carry water from the nearby River Severn and circulate this throughout the building to provide a passive cooling system.

The library contains seven archive strongrooms to house the county's entire archive collection on one site. Each room is a concrete box, designed to accommodate heavy movable archive racking. The rooms have temperature and humidity control to protect the contents and must also have a four-hour fire rating.

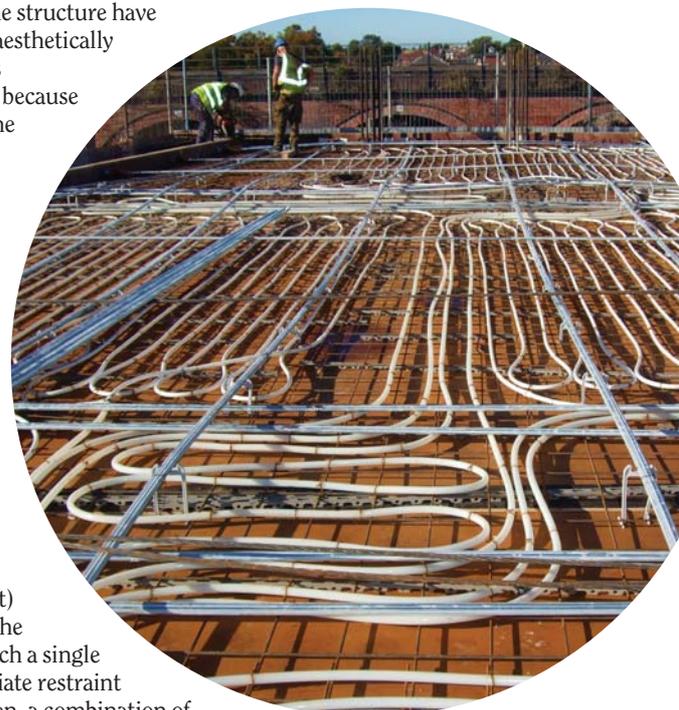
Post-tensioning was used to reduce and rationalise the depths of the original reinforced concrete floors from 300–500mm to an overall depth of 250mm in all areas apart from the Level 2 strongroom, while

accommodating the integral cooling pipes. The required four hour fire rating coupled with the 12kN/m² loading for the archives meant that a 450mm slab thickness had to be maintained in these areas, although this was still 50mm less than the original slab depth.

Ceilings throughout the structure have exposed soffits giving an aesthetically attractive finish, with less susceptibility to cracking because of the post-tensioning. The minimal fabric provided removes the risk of rust staining and cover loss sometimes associated with traditionally reinforced slab construction.

The formwork was laid out in a stretcher bond design to suit architectural requirements to provide the impression of a 'tiled' ceiling. The use of the stretcher bond restricted the use of pour strips (in order to alleviate restraint) to a single direction and the width was tailored to match a single formwork board. To alleviate restraint in the orthogonal direction, a combination of

Post-tensioned slab incorporating passive cooling system.





Above: Exposed soffit with rebated lighting track.



Above right: Concrete frame during construction.



Right: Internal atrium timber feature staircase supported by cantilevering post-tensioned slab

pour strip and Ancon lockable dowels was used to ensure the required architectural finish could be achieved.

The concrete ceilings included rebates for lighting on each gridline and every 1.22 x 3m formwork board was provided with a cast-in small-diameter plastic tube at its centre through the slab to allow for future M&E to be brought through from the floor above without the requirement for drilling of the slabs. The lighting and M&E was fixed directly into the concrete.

Services were located under raised access floors, the depth of which was increased by an extra 50mm because of the post-tensioned slabs, to aid access.

From an architectural perspective, reduction in the thickness of the slab, particularly at the perimeter of the

Completed frame showing placement of copper roof tiles.



building, meant that the depth of the air vents could be reduced by 50mm, and that an additional 50mm was available to make access to the actuators easier when servicing or replacement was required.

Carbon-neutral service delivery

As part of Worcestershire County Council's carbon management plan, and the environmental objectives of Worcester University, The Hive aspires to provide carbon neutral service delivery. Carbon dioxide emissions from the library are predicted to emit 15.8kg CO₂/m²/yr, which is a 50% reduction in Part L2 Building Regulations requirements. A typical library emits 61kg CO₂/m²/yr.

The replacement cement content of the concrete in the original reinforced concrete design would have produced a longer curing time. By post-tensioning the slabs, the architect was able to achieve the same BREEAM material rating for the concrete (BREEAM MAT 1) as originally intended, while still obtaining the curing time required by the main contractor and incorporating a large percentage of GGBS replacement.

The use of post-tensioning on the project saved more than 250m³ of concrete across three levels, reducing embodied CO₂ by approximately 95 tonnes to lessen environmental impact during the construction process, and lowering the expenditure on both concrete and reinforcement.

In line with the carbon-neutral aspirations of the library, the thermal mass properties of the concrete were maximised by maintaining fair-faced soffits, which will be finished with a wash to maintain the characteristic appearance of the concrete. ●

Post-tensioning designer	CCL
Post-tensioning subcontractor	CCL
Engineer	Hyder Consulting (UK)
Main contractor	Galliford Try Construction
Subcontractor	Northfield Construction
Building owner	ProjectCo

PTA Award Commendation:

Network Rail National Centre, Milton Keynes

Awarded a BREEAM 'Excellent' design stage rating, Network Rail's new hub will accommodate 3000 employees. One of the features contributing to the 'Excellent' rating is the flat slab with an uninterrupted flat soffit, to optimise natural ventilation.

The continuous flat soffit was combined with a clear single 13.5m span across the building and a 9m multi-span orthogonal to it. Deflection control, a key benefit of post-tensioning, was accommodated by the 350mm solid post-tensioned flat slab designed by Matthew Consultants.

The challenge of keeping deflection within tolerance (35mm) presented by a shallower slab depth and a revised column size of 350 x 1000mm - 350mm in the 13.5m span - was met by marginally increasing the concrete strength class from C32/40 to C40/50, which stiffened the slab without necessitating an increase in post-tensioning.

Post-tensioning designer	Matthew Consultants
Contractor	Getjar