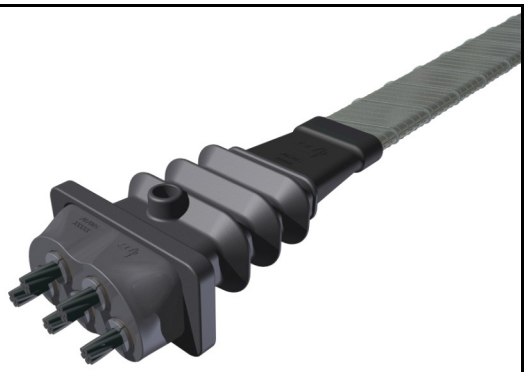
The 2011 PTA Post-Tensioned Structure Awards

Worcester Library and History Centre Worcester, UK

PROJECT DETAILS



Project Name	Worcester Library and History Centre
Building Users	Worcester County Council & Worcester University
Building Operator (FM)	SGP
Building Owner	ProjectCo
Architect	Feilden Clegg Bradley Studios
Engineer	Hyder Consulting (UK) Ltd.
Main Contractor	Galliford Try Construction Ltd.
Sub-Contractor	Northfield Construction Ltd.
PT Design	CCL
PT Contractor	CCL
PT System	CCL XF10 and XF20
Duration of PT Works	3 months

The Worcester Library and History Centre

The £42m Worcester Library and History Centre, also known as the Hive, is a fully integrated public and University library which also incorporates the Worcestershire Records Office, the environment and archaeology service and the council customer service centre. Including more than 10,000m^2 of public space over five floors the Hive is expected to attract more than one million visitors a year. The building will utilise natural sources of daylight and cooling, and the striking pyramid roof cones will act as a natural ventilator.

Design Considerations

The building was originally schemed as a steel frame with precast units. However this could not satisfy the required floor zone restriction. It was then re-designed with traditional reinforced concrete floors, the slabs of which were of varying depths, typically 300mm, but with some areas of 400mm and 500mm.

Reduced slab depth was required to maximise headroom and the internal open space of the library.

The post-tensioned concrete slabs had to incorporate Velta pipes which would carry water throughout the building to provide a passive cooling system. The design of the tendon profiles and punching shear reinforcement was coordinated around the required layout for the Velta system.

The Library also contains seven archive strongrooms which will house the county's entire archive collection on one site. Each room is a concrete box, designed to accommodate heavy movable archive racking. Twelve miles of shelving will be required to hold the collection. The rooms have temperature and humidity control to protect the contents and must also have a four hour fire rating.

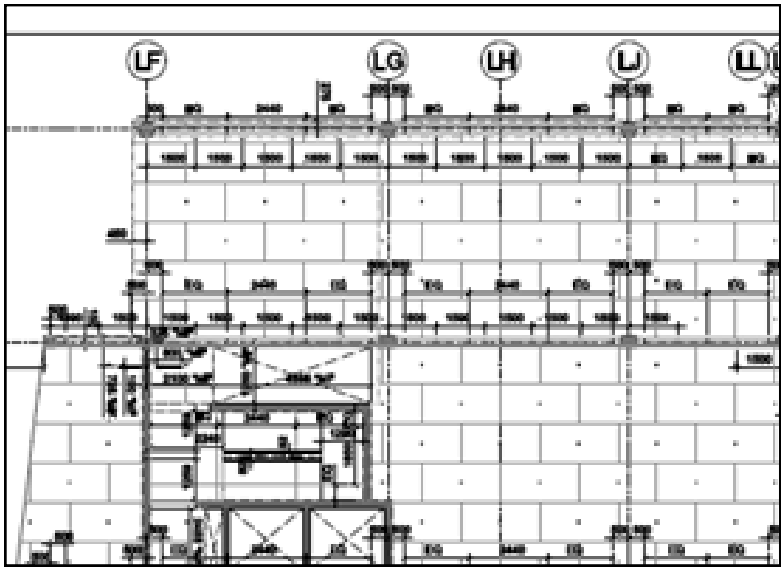
Construction

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

The installation process for the PT slabs was carefully co-ordinated around the Velta cooling pipes to ensure compatibility of reinforcement layering and a continuous installation for all trades.

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



The shuttering 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 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 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.

Sustainability

As part of Worcestershire County Council's carbon management plan, and the environmental objectives of Worcester University, the Worcester Library and History Centre aspires to provide carbon neutral service delivery.

CO_2 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 was going to produce a longer curing time. By post-tensioning the slabs, the Architects were able to achieve the same BREEAM material rating for the concrete (BREEAM MAT 1) as originally intended, whilst still obtaining the curing time required by the main contractor. This still incorporated a large percentage of ggbs replacement.

The use of post-tensioning on the project saved more than 250m^3 of concrete across three levels, reducing embodied CO_2 by approximately 95 tonnes to lessen environmental impact during the construction process, and lowering the expenditure on both concrete and reinforcement.

The recycled content of the construction (by value) for the project will be at least 22%.

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.

The river water cooling system by Velta, which consists of pipes embedded in the soffit of the post-tensioned slabs, is designed to carry water extracted by coils from the nearby river Severn. This will be circulated within the building to help reduce emissions as part of the environmental objectives of the project.

Opening in July 2012, it is anticipated that the Hive will achieve a BREEAM assessment rating of 'Excellent'.