(Photo: Lend Lease.)

Cultural Centre at Barangaroo Point, Sydney, Australia

Annabelle Wilson of Ancon Building Products explains how a range of Ancon shear-load connectors and locking pins has contributed to the build of the cavernous new Cultural Centre at Barangaroo Point, Sydney, Australia.

On the banks of the world-famous Sydney Harbour, the development of a landmark 22-hectare site known as Barangaroo is taking shape. Hidden below the surface of the completed project will be a giant subterranean 'cultural space', which will be made available for multi-functional use. Measuring some 140m long × 50m wide × 18m high, the space will be illuminated by skylights set into the landscaping above and feature a dramatic sandstone cliff-face along one full side.

Lend Lease has installed 1300 slab-to-slab connectors in the suspended post-tensioned concrete floor of the Barangaroo Cultural Centre. Use of these products at the temporary movement joints, in place of traditional pour strips, has significantly accelerated the build programme, saving both time and money. The design uses a combination of DSDQ double-shear dowels and ALP locking pins that accommodate the initial shrinkage of the concrete before allowing the joints to be locked, preventing further movement, while simultaneously transferring high shear loads in both the locked and unlocked state, without the need for additional mechanical supports.

Ancon Locking Pin in-situ.

Ancon Locking Pin Sleeve, fixed to formwork.

Barangaroo Cultural Centre, post-tensioned suspended floor slab.

Barangaroo Headland Park (front centre).

(Photo: Lend Lease.)

Challenges

As would be expected with such a distinct project of this scale, a number of engineering challenges have arisen. These include the design of the enormous suspended concrete floor of this area, which must not only be strong enough to withstand the demands of the completed public space but also the weight of the construction activities involved in the creation of the colossal green roof which soars above the space and will form part of the park itself.

The roof comprises 300 precast concrete bridge

Ancon Locking Pin, pouring of high-strength, non-shrink grout.

segments. Each segment is 30m long and lifted into position by a 450-tonne crane standing on the suspended post-tensioned floor slab.

Pour strips

A key design consideration in any post-tensioned concrete slab, where long uninterrupted spans can be achieved, is the accommodation of normal concrete shrinkage. This has traditionally been accommodated by leaving 1m-wide 'pour strips' or 'delay strips' in the slab. These strips are filled once movement has stabilised, typically one to two months after the first pour, providing the desired continuity to the slab.

Although common, these strips are not ideal as they require the slabs to be propped from below. This restricts site access and delays construction work and follow-on trades both above and below the slab while the mechanical props are in place.

Lockable joints

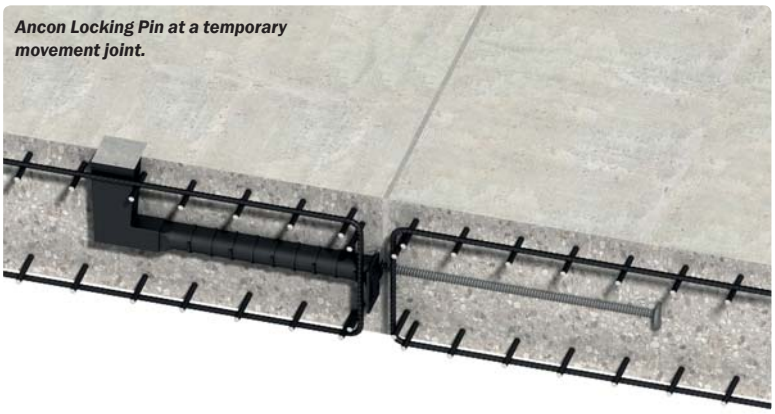
Dowel Bars transfer load across joints in structural concrete and are used with a sleeve to debond the dowel where movement is required. Ancon developed this principle further by engineering a dowel that could be locked after an initial phase of movement.

The lockable range was developed specifically for use at temporary movement joints in post-tensioned concrete as an alternative to pour strips. These products accommodate initial concrete shrinkage and are then securely locked, mechanically and chemically, preventing further movement taking place.

The original lockable dowel transfers shear load in both its locked and unlocked state, while the Locking Pin, a recent extension to the product range, is ideal for applications where tension loads are high and there is a requirement for a joint to be locked but the shear load can be accommodated by other means.

The Barangaroo cultural space project used Locking Pins in conjunction with DSDQ double shear dowels; the first enabled the joint to be quickly and cleanly locked after movement, while the latter carried the high shear loads without any requirement for additional slab supports. Together, these products provided the quickest, safest and most cost-effective solution for this complex application.

Aaron Blanchard, Lend Lease project engineer, says, "Prior to Ancon's involvement, our design was for a delay strip. This design would have slowed us down as we had a set date to install the roof. By using lockable fixings, we were able to eliminate the pour strip, and saved time on our programme. We were able to accelerate the programme by 50–60 days, which also has obvious significant financial implications."



Ancon Locking Pin at a temporary movement joint.

Site of Barangaroo Headland Park, Central and South (front).

(Photo: Barangaroo Delivery Authority.)

Components

Locking Pins comprise a pin and a sleeve component. The pin is manufactured from coil bar; one end features a hot-forged head, which increases its resistance to tensile forces and the other end features a notch to accept the locking plate. When installed in the heavy-duty injection-moulded L-shaped sleeve, the pin is cradled to ensure even distribution of the high-strength, cementitious, non-shrink grout poured from the top of the slab. The sleeve is ribbed on the outside for increased bond with the concrete and features indentations on the inside to maximise grout bond. The Ancon DSD is the original two-part, double-dowel, high-load shear load connector; specific to the 'Q' version used on the Barangaroo project, the dowels fit in cylindrical sleeves contained within rectangular box sections to provide movement in two directions. Both products allow some lateral and rotational movement in addition to longitudinal movement in the initial phase.

Reflection

Reflecting on this part of the project, Mike Cummins, Lend Lease site engineer, says, "We've had no problems with the slabs. They stood up to the weight of the cranes during the roof installation and we've had plenty of trucks on them since with no adverse deflections. For our purposes it worked exactly how we wanted it to and locking the joint up was really quick and clean."

When it opens to the public in mid-2015, Barangaroo Point will provide an attractive vantage point from which to take in the atmosphere of Sydney Harbour, while the awe-inspiring cultural space below, with a floor area of up to 20,000m^2, will provide the flexibility to house almost any future event. ●