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# CONCRETE

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## A PASSION FOR RED

The distinct precast cladding of a Manchester hotel

## LOW-CARBON CONSTRUCTION

Decarbonising concrete with no impact to cost or programme

## REPAIR AND STRENGTHENING

Carbon savings of a repair and rehabilitation alternative

# WHITE EAGLE LODGE – NEW TEMPLE COMPLEX

Situated on a large rural site in Hampshire, **Eckersley O'Callaghan** (EOC) has been privileged to assist in a very special project with James Gorst Architects (JGA), and its vision for a new temple at the White Eagle Lodge (WEL) – a multi-faith organisation founded in 1936. The building forms part of a wider 6000ft$^2$ (557m$^2$) gross internal area complex, which when complete is set to become a spiritual centre for the worldwide WEL community. **Duncan Walters** reports.

**White Eagle Lodge, Hampshire**

**Architect**
James Gorst Architects

**Structural engineer**
Eckersley O'Callaghan

**Specialist contractor**
Evans Concrete Products

**Main contractor**
Beard

**MEP consultant**
Skelly and Couch

**MAIN IMAGE:**
Temple space interior view, pendentive arch.

The new building replaces the dilapidated 1970s temple with a combination of resilient, long-lasting and renewable palette of materials. The new complex has been designed as a composition of orthogonal pavilions arranged around a courtyard and connected by cloisters. Within the building, the temple follows an outworking of sacred geometries and harmonious mathematical ratios imbued with religious teachings. A 12m-diameter circular roof defines the inner temple space, focusing the congregation on a central altar, positioned to align with the original building lay lines, which were carefully surveyed and retained in the final construction. The glass and timber lantern, also designed by EOC, employs an array of larch glued and laminated timber frames, which meet at an oculus above the central altar.

## PENDENTIVE FORMATIONS

The timber lantern is seated onto the four pendentive stone formations with perfectly cylindrical arched openings to the cardinal points. The heavy set 1.2m-wide connecting joint at the apex of the three-pointed arch is only 150mm deep, and the pendentives expand and then contract towards the base spring point, lightly touching the ground with only a 300mm triangular zone of structure in each corner. Horizontal thrust and gravity loads are carried into four pad foundations onto the underlying sand. The subfloor employs a low-energy labyrinth to help cool the spaces, drawing fresh air from beneath the suspended concrete floor beneath the temple.

In truth, the original concept was for the temple space to comprise natural load-bearing stone construction. While it could have been achieved that way, it certainly would not have been the cost-effective solution, hence a precast concrete solution was preferred. Other benefits of using a precast concrete were the reduced risks in design and execution, construction programme and of course budget, which were understood to be several-fold.

The cast stone cylinder is divided into four quadrants, each consisting of three structurally visible pieces. The architecturally expressed internal primary structure would be scrutinised heavily by building users and from close proximity, so there was heightened importance placed on the detailing of shadow gaps and allowable tolerances of construction, for which great lengths were taken to control. There was no full-scale mock-up prototype produced and no budget to build it twice! Any lack of fit between elements would have been unwelcome and very difficult to rectify, and once installed it would have been difficult to hide. In order to mitigate and predict the movements of the assembly, an in-depth analytical process was followed, with final connection forces provided to the specialist precaster, Evans, who was building the individual component parts at its factory in Derbyshire before delivery to site.

Our finite-element analysis model was checked and re-checked to ensure that structural deflections could be kept to a minimum; knowing that no superficial finishes were being overlaid, unforeseen deflections ran the risk of being visible to spectators. On receipt of JGA's architectural 3D visualisation, we were able to generate a 3D BIM model of these 12 elements, allowing for communication of the reinforcement size and spacing design intent to the specialist precast contractor. Timber forms were built with exceptional skill, care and attention to detail, creating three symmetrical moulds,

**TOP:**
Pendentive reinforcement cage at Evans Concrete.

**ABOVE:**
Site installation of precast units.

each one only being used four times, required a fine smooth surface within each panel, each one a sculptural piece in its own right. The factory formwork was produced as the negative space from a flattened 3D carcass model, with closely spaced ribs creating

**LEFT:**
During casting of pendentive ‘wings’.

**ABOVE:**
Wing unit curing at Evans’ yard.

**RIGHT INSET:**
Temple exterior view.

the radius of the body and an autogenerated cutting list.

Once the structural carcass and ribs were assembled, the mould shutter faces were formed around the ribs in layers to create curved faces. The shutter faces were continually sanded, filled and measured to ensure continuity of the form. Once completed, the formers were finished in fibre glass resin to ensure any unseen imperfections were filled. The concrete mix design provided in-house by Evans Precast was a light-coloured Italian Dolomite coarse and fine aggregate incorporating Portland cement and some GGBS replacement. Once struck, the finished concrete faces were acid-etched to create a softened natural effect exposing a small aggregate portion, referencing the stone used during the construction of sacred buildings in the ancient city of Rome.

## REINFORCEMENT

A reduced reinforcing bar spacing ensured minimum potential for surface cracking and imperfections in the concrete, and relatively small 12mm-diameter bars were used to limit the carbon footprint of the units. Using our EOC-$ECO_2$ Embodied Carbon Calculator, we established the final embodied carbon score of the structure, 265kg embodied $CO_2/m^2$, which for a single-storey building is low and environmentally had always been a key driver for the client group.

The 12 segments were cast vertically in their actual proposed resting position to ensure entrapped air could escape from the wet concrete, and therefore any blemishes, which are almost unavoidable, are present only in the top surface of the concrete and above the eyeline (and therefore out of sight!). Each one was poured in a single batch to prevent any potential for colour variation and visible anomalies.

The assembly on-site was carefully orchestrated to bring the units together and lock each into alignment. The weight and scale of the units forced these pieces to be some of the first deliverables during the construction programme; once installed, the remainder of the building enveloped these obelisk structural elements within the lightweight timber frame construction. The end result is a fine testament to the co-ordination and communication across the design and site delivery teams, and a really elegant production.