

raising football's new stage



Visible from over 20 km away, the Wembley Stadium arch is fast becoming one of the most recognised features on London's skyline. Tall enough for the London Eye to roll underneath, the 133 m arch is more than four times as high as the stadium's original twin towers. And it'll have another claim to fame too – it'll be the longest single span roof structure in the world.

The new Wembley Stadium roof structure was designed by our structural experts in Connell Mott MacDonald in close collaboration with architects Foster and Partners and HOK Sport for Wembley National Stadium Limited. Its unique features – retractable roof panels and the arch which supports them – were developed in response to the particular requirements of the stadium, one of which was the need for a high quality grass pitch in order to achieve UEFA 5 star stadium status. "By using retractable roof panels, which retract to the south, we're allowing as much daylight and ventilation to reach pitch level as possible," explains structural engineer David Satchell, a key member of the design team who continues to play a major role in the development. "The end solution is an architecturally strong design which is structurally efficient. And the arch is by no means a cosmetic feature – it supports the north roof and a sizeable area of the south roof."

leading edge support

Designed to give the appearance of solidity without incurring the penalty of high wind loads, the 315 m span arch has a lattice form consisting of 41 steel rings (diaphragms) connected by spiralling tubular chords. The arch tapers at its ends and is supported on concrete bases founded on piles 35 m deep. Inclined to the vertical, the arch is held in position by a series of forestay and backstay cables tied to the main stadium structure. The leading edge of the north roof is in turn suspended from the arch by the forestay cables. Cables from the arch are arranged in a diagonal pattern to help spread loads to control in-plane bending while also providing out-of-plane restraint to resist buckling.

"Overall the arch geometry has been optimised to provide efficient support to the 7000 tonne roof structure, maintain sufficient tension in the cable systems and clear the building while keeping its abutments within the site confines," says David. "It also replaces the need for columns, ensuring that all fans will have fantastic views of the pitch."

four-stage lift

A structure of the arch's magnitude needed to be raised incrementally rather than in one continuous lift. Five sets of strand jacks operating on five gigantic turning struts that were in turn attached by steel cables to the arch were used to winch it into its vertical position. "The arch lift began in late May 2004. It was initially taken to 30°, then a further three lifts over a four week period took it through 65°, 100° and then to 112°, its final position," explains David.

"Once the arch reached 65° the temporary restraining cables on the opposite side to the pulling cables were used to take part of the load and control the position of the arch as it moved into its final position where it is inclined to the vertical and held in place by five restraint cables. These will be removed when the roof perimeter truss is completed and the permanent backstay and forestay cables can be connected."

tube of light

Adding to its dramatic presence, the arch will illuminate the north-west London sky on match days. Lighting such an enormous lattice structure is not for the faint hearted but our building services team was eager to take on the challenge. "The vision adopted for the arch was a tube of light that would hover over the stadium at night creating an iconic statement," explains Tristan Ilich, one of our specialist lighting design experts.

To achieve the desired effect, 258 metal halide floodlights have been mounted within the arch to illuminate the internal faces of the lattice and the structural rings that hold it all together. "Because the arch is lit from within, the outer faces remain dark and increase the dramatic effect by adding depth and contrast and giving the appearance that the light is trapped within the lattice structure," says Tristan. "And because of its height and proximity to the Heathrow air corridor we've had to install three aircraft warning beacons to ensure the safety of both the arch and aircraft at night."

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