Jawaharlal Nehru Stadium (JNS)

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Summary

Cantilevered cable & membrane roof system was used to cover the seating bowl at Jawaharlal Nehru Stadium.

Keywords: Commonwealth games 2010, Stadium, Membrane, Cable, Roof, Seating bowl.

1. Introduction

Structural upgradation at Jawaharlal Nehru Stadium, New Delhi, were carried out to provide a roof over the seating bowl, and to upgrade the existing bowl to meet with the requirements of the new seismic code. Additional amenities such as sports lighting, PA system, wheel chair access etc. were also provided for the Commonwealth games 2010. A master plan was developed for the sports complex to separate various accreditations and for security reasons, and were landscaped using a combination of hard and soft surfaces.

2. Main roof structure

The seating area was roofed using fully locked steel cables and a PTFE covered glass fiber membrane structure which cantilevers 70 m (the depth of the seating tiers) resulting in a column free interior. The new roof succeeds in covering the seating bowl without imposing additional load on it.

The roof is designed on a wheel and spokes principle with a tension ring forming the inner edge of the cable system. Instead of a single outer ring as in a wheel, two rings have been used at different elevations to enable an architectural draping of the membrane. These two outer compression rings are connected to the inner tension ring with the help of radial cables which form the spokes of the wheel. Alternate radials are attached at two different heights at the exterior edge forming ridges and valleys. A tensioned membrane is draped over these radial cables to form the roof structure. Additional cables are run along the free edges to maintain structural equilibrium of the membrane.

The lower (and inner) compression ring is supported on a ring of vertical steel columns forming a V shape in the circumferential plane, while the upper (and outer) compression ring is supported on a ring of X shaped columns, inclined to the vertical. The space between these concentric rings of columns has been used to provide fourteen ramps to access the upper stands of the seating bowl. These new circumferential ramps replaced eight radial L-shaped ramps which resulted in freeing up a substantial amount of space around the stadium structure.

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Large uplift and horizontal forces experienced at the base of the columns required the use of a radial concrete shear wall connecting the two column bases and prestressed hold down bolts at each base plate. This in turn rests on a pilecap combining 6 – 1.5 m diameter piles. Since the peak lateral forces from the roof structure are quite high, the pilecaps are connected by two concrete ring beams which allow some redistribution of lateral forces between adjacent pilecaps. That allowed foundations to be designed for vertical rather than the lateral pile capacity.

3. Seating Bowl

As a part of the upgradation effort, the lower stands of the stadium were reconstructed as framed stands. This allowed for much necessary operational space to be created under the seating galleries. The existing framed structures of the upper galleries were retrofitted to meet with the requirements of the new seismic code. In addition, the seating plats were repaired since they had deteriorated due to their long exposure to the elements. The stands were also modified to include additional public conveniences, lifts, escalators, staircases, and interior ramps for wheelchair access. Some of the existing framing had to be cut and the remainder modified for these changes. A tunnel was added under the main arena to accommodate the entry and exit of performers during the opening and closing ceremonies.

The Common Wealth games 2010 were declared to be a huge success by the organizers, spectators and the participants. The team of German roof engineers and architects, the Indian engineering and architectural counterpart, British checking engineers and the Indian client represented by interested and very supportive engineers on one side, and the Indian main contractor on the other, went through numerous unexpected challenges. The successful implementation of the project was to a large extent due to advantages in the use of a light weight cable membrane structure which lends itself to spanning such large distances with a minimal footprint.