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7. National Athletics Stadium, A.C.T., (Australia)

Owner: National Capital Development Commission
Architect: Philip Cox Storey & Partners Pty Ltd.
Structural Engineers: Bond James Laron Pty Ltd.
Civil Engineers: Scott & Furphy
Contractor: Leighton Contractors Pty Ltd.
Works Duration: 19 Months
Service Date: October 1977

General

The stadium site at Bruce is located approximately 5 km North-West of Canberra City and covers an area of 40 hectares.

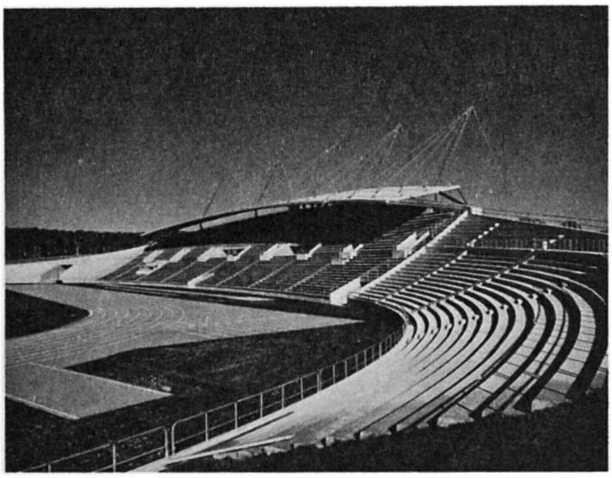
The stadium is a sports complex which was planned and constructed to meet the requirements of the 1977 Pacific Conference Games. In addition it can be used for alternative sports such as soccer and rugby by laying artificial or plastic grass over the athletic track for protective and playing purposes.

Accommodation has been made for:

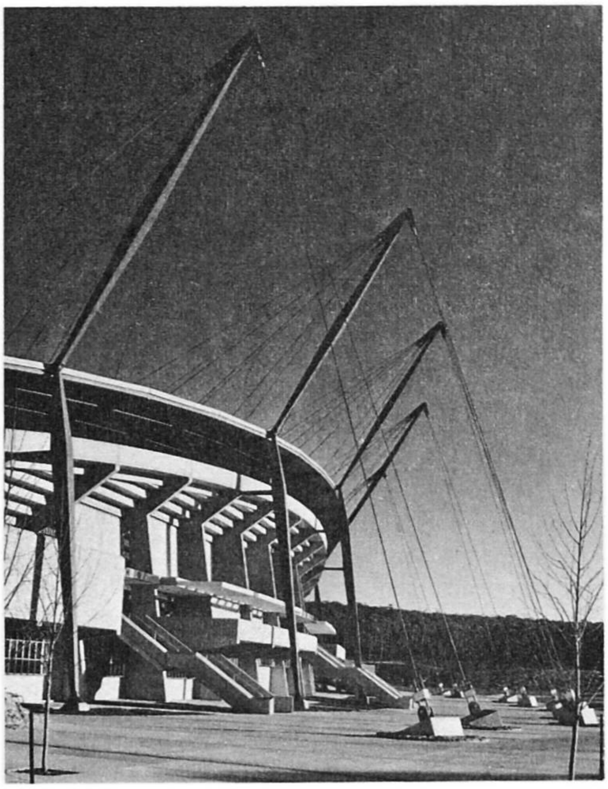
- 3,000 seats under cover
- 3,000 seats in tiers uncovered
- 6,000 plus seats on banks which could feasibly be increased to 10,000 under controlled crush conditions giving an absolute capacity crowd figure for the stadium of 16,000 persons.

The seating part of the stand consists of transverse reinforced concrete frames supporting precast concrete seating units.

The roof consists of a cable-suspended structure with all of the supporting columns located at the rear of the stand to give unobstructed viewing from the seating.



View from inside the stadium showing the grandstand with its cable suspended roof.



Some of the tapered steel box column masts which support the roof cables of the stadium; each mast is back-stayed by two 50 mm diameter cables fixed to post-tensioned ground anchors.

Wind Tunnel Tests

The prevailing wind is from the north west and the arena and stand have been located so as to give maximum protection against this wind.

Wind tunnel tests were carried out on a scale model of the whole site and satisfactorily proved the effectiveness of the orientation of the stand and adjacent hill forms in reducing the adverse effects of the prevailing winds.

Stand Roof-Description and Concept

The roof structure consists of a cable-suspended steel framed deck covered with a 100 mm thickness of concrete. The total weight of the roof is 650 t.

The roof cables are supported by a total of five tapered steel masts which are located at the rear of the stadium and back-stayed to ground anchors.

Advantages of this type of structure are:

a) The roof generally has a light appearance.

b) There are no columns or heavy support structures to obstruct complete vision of the arena from any seat.

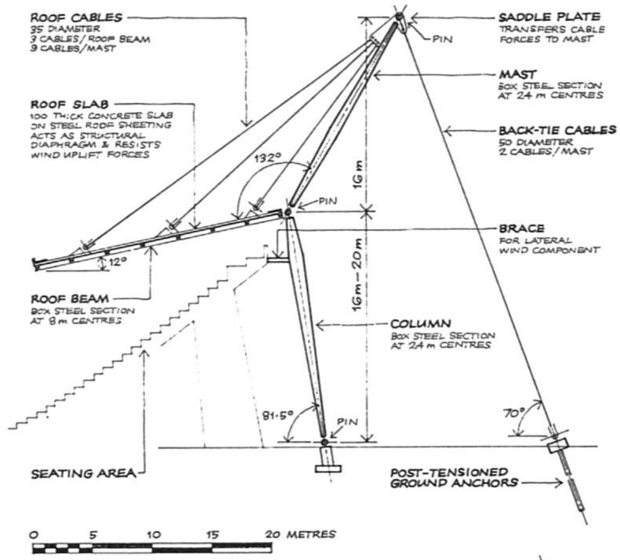
c) The structure lends itself to simple erection methods.

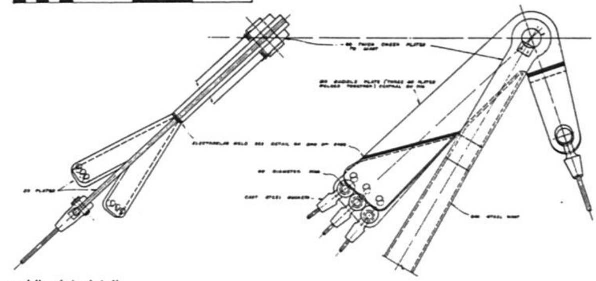
d) The concrete surface to the steel deck has acoustic value from external and impact noises in addition to providing some thermal control. The main purpose of the concrete is to provide sufficient dead weight to overcome uplift forces at periods of high wind velocity.

e) The economy of the structure compared with more orthodox structures.

The roof and supporting members have been designed to be in static equilibrium under gravity loads without any external lateral bracing.

Lateral wind forces are resisted by steel struts between the steel columns and the concrete seating frames. Longitudinal wind forces are resisted by steel braces between the south west end of the roof and the adjacent reinforced concrete retaining wall. The braces at the north east end have sliding joints and do not contribute to longitudinal wind resistance. They are necessary however, to control the wind flow pattern and also to collect the rain water run off from the roof.





saddle plate detail

Stand Roof-Details

The concrete on the roof is supported by ribbed steel decking spanning on to rectangular hollow steel section purlins at three metre centres.

The main transverse roof beams are rectangular hollow steel sections spaced at approximately eight metre centres. Each beam is supported by three 35 mm diameter roof cables, each cable consisting of nineteen, seven mm diameter wires. The maximum dead load force in any cable is 470 kN.

The roof cables are supported by tapered steel box column masts. The masts are pinned at each end to allow rotation to occur during both erection and wind loading.

Each mast is back-stayed by two 50 mm diameter cables, each cable consisting of thirty-seven, seven mm diameter wires. The maximum dead load force in any back tie cable is 600 kN.

The back tie cables to the masts are fixed at the lower ends to post tensioned ground anchors. Each anchor consists of a grouted tendon anchored into the mudstone or sandstone rocks of the substrata.

The upper ends of the nine roof cables and two back tie cables at each mast head terminate in cast metal sockets which are pinned through cleat plates welded to a common saddle plate. The welds were made using consumable guide welding which is one of the later forms of Electroslag welding. These welds are 150 mm × 28 mm in cross-section and required special care during their fabrication. The welding was done as a continuous process using three guides. Following welding the completed fabrication was stress relieved.

Stand Roof – Construction & Erection

The roof framing was erected in its final position on temporary supports resting on the concrete frames of the seating structure below. Following this stage, the metal decking was fixed to the roof framing and the concrete roof slab was placed on top of the decking which acted as permanent formwork.

After the roof slab concrete had cured, the roof cables, which had been precut to their correct lengths, were connected at each end to the mast heads and roof beams. During this operation the masts were held forward of their final positions so as not to tension the cables. At the same time the upper ends of the back tie cables were fixed to the mast heads. The masts were then laid back in their final positions against the weight of the roof and the lower ends of the back tie cables connected to the ground anchors.

The back tie cables were then tensioned in pairs to their calculated design forces causing the roof cables to assume their correct design loads. The roof has been designed so that only one pair of back tie cables needed to be stressed at a time. This reduced the number of jacks required on the job and also the coordination necessary if multiple jacking had been used.

After all of the back tie cables had been tensioned, the temporary supports were removed and final checking and adjustments carried out to the roof cables.

(J. Quinn)