AAMI PARK

ARCHITECTURAL STEEL DESIGN AWARD 2010

NATIONAL AND STATE WINNER (VIC + TAS)

STRUCTURAL ENGINEERING STEEL DESIGN AWARD 2010

NATIONAL AND STATE WINNER (VIC + TAS)

ARUP, Cox Architects + Planners

Architectural merit

AAMI Park (The Melbourne Rectangular Stadium) is a purpose built rectangular pitch stadium designed to accommodate 31,000 fans, and will host soccer, rugby league and rugby union matches. The stadium is a world-class facility, featuring a sports campus, elite training centre and sports administration complex.

The brief called for the stadium to achieve world standards, and be extraordinary in terms of structure, atmosphere and spectator experience.

This new stadium makes the best use of the environment in which it is constructed. The playing arena is sunken into the structure, creating an environment similar to an amphitheatre. The lightweight, self-supporting, bio-frame roof made up of interconnecting triangles provides structural integrity while opening up the sightlines so that spectators have uninterrupted views.

Detailing for economy

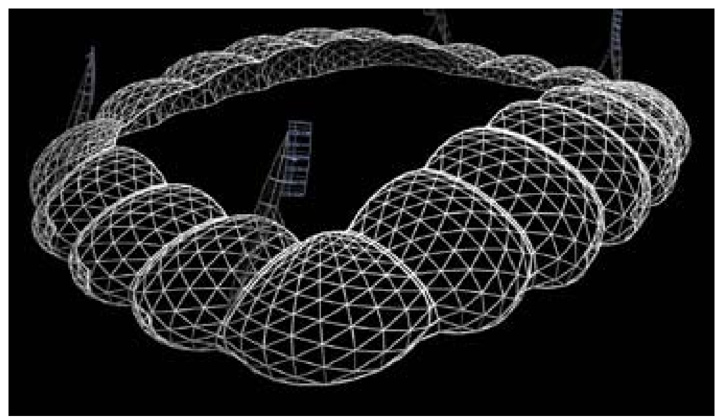
The stadium roof is a three dimensional structure, with twenty interdependent shells sharing the load. The structural system consists of single surface shells (no trusses with depth), transferring load via a combination of cantilever, catenary, shell and arching actions. As a result, the structure is considerably lighter and uses less steel than similar stadium roofs.

The roof structure allows internal space to be more efficiently used, with unobstructed sight lines. The roof geometry is also driven by the requirement to maximise natural light and ventilation, both for spectator comfort and the health of the playing surface.

The structural concept and geometry allows the roof to be delivered with approximately 50% of the steel required, compared to similar stadium roofs. Further, the shell concept allows the roof to work with a single layer of structure, where the façade is fixed directly to the structural frame, eliminating secondary steelwork. Parametric modelling allowed variations in geometry to be tested quickly to provide the most structurally efficient form.

The roof structure is formed from 273mm diameter tubes, rigidly connected to form shells. Each shell is bounded by a 508mm diameter edge and front edge members, and a 457mm diameter back edge member. The structure is clad in a combination of aluminium, glass and louvres.

The roof structure also supports four light towers on the corners of the stadium, with additional lighting fixtures and services suspended below the main canopy.



Practicality in fabrication + erection

AAMI Park's design allowed shells to be fabricated off site in transportable sized sections, and erected on site on a temporary support system. Steelwork could be fabricated off site, allowing works on the concrete bowl structure to progress, and shortening the construction critical path time.

The design consisting of 20 individual (inter-connected) shells allowed the contractor to appoint three separate

fabricators, therefore reducing fabrication and overall construction time. The design also provided some repetition to simplify the construction process. Each of the four quadrants is symmetrical, allowing repetition of cladding panel shapes and sizes.

Attention to corrosion protection

Steelwork corrosion protection was achieved using an "International Paint" system to provide an adequate level of corrosion resistance while achieving the desired architectural aesthetic.

The system comprised of:
- 75 micron Polyamide cured Epoxy
- 125 micron Polysiloxane final coat

Corrosion protection was applied off site, with final touch ups to repair any minor surface defects during erection.

Innovation

The design team worked within a virtual 3D environment, from concept stage through to construction. Parametric modelling was used to define the roof structure because of its ability to test alternative geometric configurations to optimise the structural form, and to accommodate the final preset geometry for fabrication and construction purposes.

During concept stage, initial studies of the roof and shell geometries were undertaken in conjunction with Cox Architects and RMIT University's Spatial Information Architecture Laboratory, using a combination of Catia models and 3D CAD.

A parametric model was developed using Bentley's Generative Components software after concept design, when basic geometric principles were agreed between Arup and Cox Architects. The advantage of parametric modelling was the speed at which revised geometry could be generated, and imported into the structural analysis model, in order to study structural geometric efficiencies.

The parametric modelling software created the centreline wireframe models, which were used by the structural engineering design team, and also used by Cox Architects for coordination and approval.

Design efficiency

Arup's structural design team utilised in-house optimisation software together with Strand7 analysis software to study the structural efficiency of the roof geometry.

A total of 24 models were studied with variations in shell curvatures and heights, to determine the most efficient geometry. By optimising the structural size required for each of the 4156 roof members, the most efficient structure was determined, providing steel tonnage savings.

Arup used its own in-house buckling analysis to design the structure. The structural analysis method allows complex 3D structures to be understood by studying the local and global buckling behaviours.

Project documentation and steelwork drawings were generated from the parametric geometry, after input into Bentley Structural software. The parametric model was also utilised to make allowance for the self weight deflection of the structural steelwork at the front edge of the roof.

Sustainability

The efficiencies produced by the structural design process generated a structural steel weight of approximately 50kg/m2 (not including cladding). This steel tonnage is approximately 50% of the steel tonnage used on stadium roofs of similar size.

In addition to the structural efficiencies, the stadium design also allows rainwater to be collected from the roof structure, for use in seating wash down and toilet flushing. Rainwater tanks are in and under the southern stand and low water-use fittings are a feature of the corporate boxes, toilets, kitchens and bars.

Other features decreasing the environmental footprint of the stadium include:

- The low embodied energy hollow core concrete slab upon which the stadium is built.
- The roof dips slightly to the north so it exposes the turf to the maximum sunlight throughout the year.
- The roof shape improves air movement over the playing surface improving turf health.

Summary

AAMI Park utilises an innovative steel structural system to form a stadium design which utilises minimum quantities of steel to create an efficient and economical structure as well as a unique audience experience. The use of extensive parametric modelling allowed for a truss-free structure utilising a combination of cantilever, catenary, shell and arching actions, which combine to create a distinctive aesthetic.

Project team

Architect:	Cox Architects + Planners
Structural engineer:	ARUP
Head building contractor:	Grocon Constructors
Steel tubing supplier:	Orrcon
Steel fabricator:	Haywards Steel Fabrication & Construction GVP Fabricators Aus Iron Industries Eliott Engineering
Steel detailer:	PlanIT Design Group, Bayside Drafting
Coatings:	International Protective Coatings