METRICON STADIUM

STEEL AWARDS 2012

WINNER CASE STUDY

AUSTRALIAN STEEL INSTITUTE

LARGE PROJECT AWARD 2012 STATE WINNER (QLD)

ENGINEERING PROJECTS WINNER (QLD)

ARCHITECTURAL MERIT

The project was a redevelopment project compromising of a significant reconfiguration and a complete renovation of the existing Carrara Stadium. The 25 000 seat Metricon Stadium will be the new home for the Gold Coast Suns and the potential main stadium for the Gold Coast's 2018 Commonwealth Games. Working to a tight program, Arup's core team of experienced stadium engineers helped deliver the $144m stadium within an 18 month construction period.

The stadium has a lightweight tension membrane roof, utilising optimised slender steel members. Arup utilised in-house form finding software and applied experience gained from the design of other iconic fabric canopies. This experience, combined with the ability to interact and collaborate with wind engineers and the architect, rapidly improved the reliability of initial design concepts for the fabric shapes and early steel structure estimates.

> The resulting design was a curved membrane roof form supported via curved members, which are in turn supported by planar trusses.

Using 3D software, the project team carefully analysed the membrane roof structure, ultimately designing a robust structure to avoid catastrophic failure as a result of any individual element failing.

Laminated glass photovoltaic cells were incorporated into the roof to capitalise on the stadium's vast roof surface as an energy source.

> The stadium has a lightweight tension membrane roof, utilising optimised slender steel members with a benchmark weight of around 40kg per square metre.

INNOVATION IN THE USE OF STEEL

The architects and engineers worked closely through the concept phase of the project in order to establish and design a solution which is both aesthetically pleasing and cost-effective. This was particularly challenging given the reasonably tight project budget and fast tracked construction program.

The result, which met the time and budget criteria, was a curved membrane roof form supported via curved CHS members, in turn supported via simple planar CHS trusses on a large 12-14m grid.

Through early design and collabration with the membrane designer, Arup was able to avoid any last minute additions of steel to the structure, resulting in optimised benchmark steel

weights of around 40kg per square metre.

From a materials and longevity perspective, the exposed yellow structural steel, for improved maintenance, has been painted with a 3 coat Polysiloxane paint which will provide enhanced long-term performance of the steelwork, particularly areas which will be more difficult to maintain during the lifespan of the facility. As a general rule the steel used on the project was hot dip galvanized where below ground or where inaccessible to maintenance.

EFFICIENT USE OF STEEL PRODUCTS

From the outset and with collaboration from client and builder, the stadium bowl and Western Grandstand were designed almost entirely with constructability and speed of erection in mind. The structures are entirely steel framed from top of pile cap to tip of roof.

> The stadium bowl and Western Grandstand were designed with ease of construction and speed of erection in mind.

Construction from steel enabled swift erection of the frame, closely followed by installation of precast floor and terrace plat units. Throughout the facility, standard UB, WB, UC, WC and CHS sizes were used in order to enable swifter fabrication and site delivery of the structure.

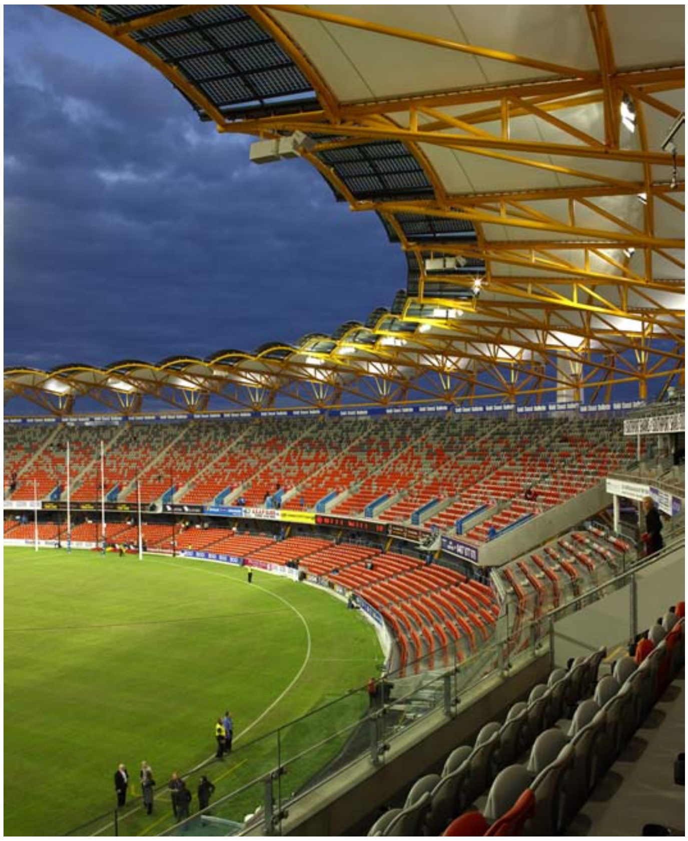
From a material cost perspective, the use of steel and precast would be more expensive than a traditional concrete structure, however compared with the longer program requirements in order to build the facility, steel was cheaper over the cycle of the project.

> The stadium has been designed to allow for an additional 15,000 potential patrons for the Commonwealth Games, should the Games be awarded to the Gold Coast consortia.

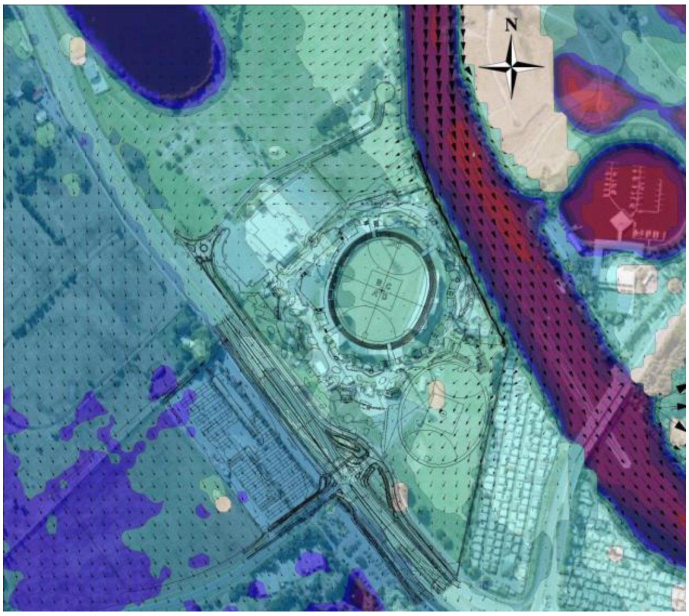
The stadium is founded fully on piles, both driven precast and continuous flight augur (CFA) piling, giving vertical and lateral support to the structure. This was adopted due to the variability of the material below the surface and the potential differential movement around the site. The robust system comprises up to 350 precast piles, typically 900mm apart, anywhere between 5m to 20m into bedrock. Rather than pour large footings, piling is quick and simplifies the process with just concrete pile caps on the surface to pour. It is a good long-term solution, particularly given the variability across the site.

> From a material cost perspective, the use of steel would be theoretically more expensive than a traditional concrete structure, however compared with the longer program needs in order to build in concrete, steel was cheaper over the cycle of the project.

The stadium has been designed to accommodate an additional 15,000 patrons for the Commonwealth Games, should the Games be awarded to the Gold Coast consortia. To this end, the lower bowl, which is built from precast terraces, has been designed on the northern end of the ground to be removable to enable the extension of the pitch resulting in a warm-up area for athletes.



Integrated solar panelling in roof structure.



Arup's flood modelling was used to control external hydraulic impacts.

The stadium bowl and structure on the north western end of the west stand has been designed to accommodate extension of the western grandstand for additional media and corporate facilities required for the games. The large TV screen at the northern end of the ground has been designed to be removable to enable temporary seats to be installed in this location.

In summary, the stadium's planning is unique in its ability to be utilised for both AFL and allow for crucial modifications required to achieve the Commonwealth Games overlay.

ENVIRONMENTAL PERFORMANCE

Energy renewal, water collection and recycling are highly visible structural design features of this public building, in accordance with Queensland government policy to showcase its environmental commitment.

Sustainable development was a major consideration in the design and construction of the stadium. From the investigation and re-use of existing civil infrastructure on a badly drained and flood prone site, to the cost-effective structural and facade design of the stadium, the project team worked to reduce the environmental impact of this major sporting venue.

A near fully prefabricated structural design was developed, enabling the site works and amount of material waste to be minimised.

Flood investigations were undertaken in order to determine impact on upstream and downstream developments along the Nerang River. It was important that the footprint be managed in order to achieve minimal impact during flood events.

The structural and façade design for the stadium's

integrated solar panelling enables the stadium to minimise its power usage and run on 20% renewable energy.

A near fully prefabricated structural design was developed, enabling the site works and material waste to be minimised. The stadium was designed to be primarily shop fabricated and bolted together, therefore minimising material use and waste, enhancing the speed of the build, particularly in difficult and trying weather conditions experienced in Queensland during 2010 and 2011.

> To improve efficiency in the construction process, TD Drafting shared their 3D steel model with the precast manufacturer, enabling greater coordination and better understanding of tolerance between steel and precast trades.

During the design development of the stadium, additional funding was made available to the project in order to adopt clean solar energy into the development. As part of this, it was determined that by utilising a five metre wide glazed photovoltaic cell into the front of the roof, it would be possible to achieve 20% renewable energy target for the facility.

Arup's façade teams in Brisbane and Berlin were integral to the design and testing of the roof glazing incorporating the photovoltaic cells to ensure that they were capable of withstanding design wind loading as well as impact criteria. Each of the glazing panels are supported on a faceted to curve RHS purlin frame – the unique way it was developed enabled the glazing to be panelised, fixed and installed in a temporary on site glazing facility.

The RHS frame was designed enabling the lifting into final position via a mobile crane. The end result is that this solar panelling will generate approximately 275,000 kWh of electricity a year making it the largest installed solar power plant in the Southern Hemisphere.

Wind engineering testing for the stadium was also intensive. Wind tunnel tests carried out in Colorado by CCP involved numerous configurations with the roof and Southern Stand, environmental weather conditions testing, people on concourses and around stands and wind on the playing surface.

BUILDABILITY

Shop fabricated and site assembled elements included:

- Precast concrete piles
- Structural steel

- Precast concrete walls
- Precast concrete hollowcore floors
  PTFE roof membrane.

Knowing these elements clearly from the outset and with the knowledge that the stadium would be a piled structure, Arup was able to take full advantage and utilise the natural spanning capacity of the prestressed precast terraces, as well as steel beams to maximise the structural grid to between 12-14m.

Given the accessibility of heavy lifting machinery, the intent of using larger grids and spans from the outset was to improve the speed and efficiency with which the stadium could be built. For the east and south stands, the upper precast terraces are supported by double steel beams (or rakers), aligning with vomitory (exit aisle and stairs) wall locations. The result of this unique structural grid system is a facility that enhances public space that is particularly evident in the concourse spaces along the east and south of the stadium.

Arup and Populous worked collaboratively with Watpac and the shop detailer, TD Drafting, throughout the project. A 3D BIM model was shared between all parties at the outset of the project. Both Arup and Populous collaborated using Revit at all times during documentation phase while at the commencement of shop detailing (which was at the end of design development), TD Drafting used the 3D Revit model provided by Arup and Populous to commence shop detailing in ProSteel

Being a fast tracked project where shop detailing was occurring at the same time as design and construction documentation, Arup, Watpac and Populous regularly liaised directly with TD Drafting, creating hand sketches and standard details to keep the shop drawing process moving, and fabrication occurring, while documentation of the more bespoke connection detailing occurred separately and was documented by Arup.

By adopting this proactive approach Arup was able to minimise the number of RFIs on the project and improve the workflow between all parties. Uniquely, and also to improve buildability, Arup created fully interactive 3D PDF documents which enabled the TD Drafting to interrogate the structural details enabling quicker resolution of the details. To further improve efficiency in the construction process, TD Drafting shared their 3D steel model with the precast manufacturer, enabling greater coordination and better understanding of tolerance between steel and precast trades.

PROJECT TEAM

Architect:	Populous
Structural Engineer:	Arup
Head Building Contractor:	Watpac
ASI Manufacturer:	Bluescope Steep, OneSteel
Fabricator:	Beenleigh Steel Fabrications
Steel Detailer:	TD Drafting Services
Coatings Supplier:	International Protective Coatings, Industrial Galvanizers
Steel Processing:	BSF Metal Centre