01 March 2023

Sydney Football Stadium

Building Local, Kicking Goals

Australian Construction Achievement Award
Technical Paper

JOHN HOLLAND

Introduction

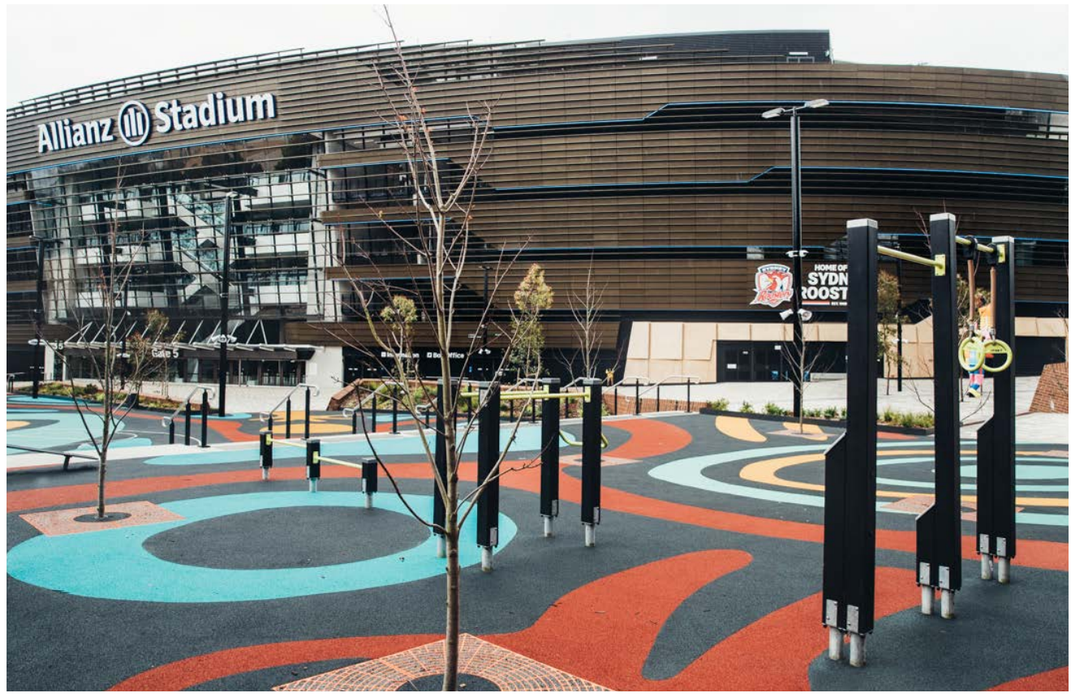
The Sydney Football Stadium Redevelopment (SFSR) has renewed the Moore Park Precinct and ensured that NSW remains the number one choice for sporting and entertainment events. This world class venue completed in 2022 is delivering enhanced game day experiences for fans, providing 42,500 undercover seats with unobstructed sightlines, improved accessibility and mobility options, and an enhanced public domain reconnecting the precinct with the local community.

This stadium serves as a new home ground for the Roosters, NSW Waratahs and Sydney FC clubs who are supported by a world class fitness facility - the Stadium Club.

John Holland designed, constructed and delivered this landmark $828M project on time, on-budget and without community disruption despite losing 150 days due to extensive rain events and 30 days to the COVID-19 pandemic.

We delivered outstanding design and construction outcomes including a highly efficient grid optimisation solution and a prefabrication-focused construction methodology providing program assurance.

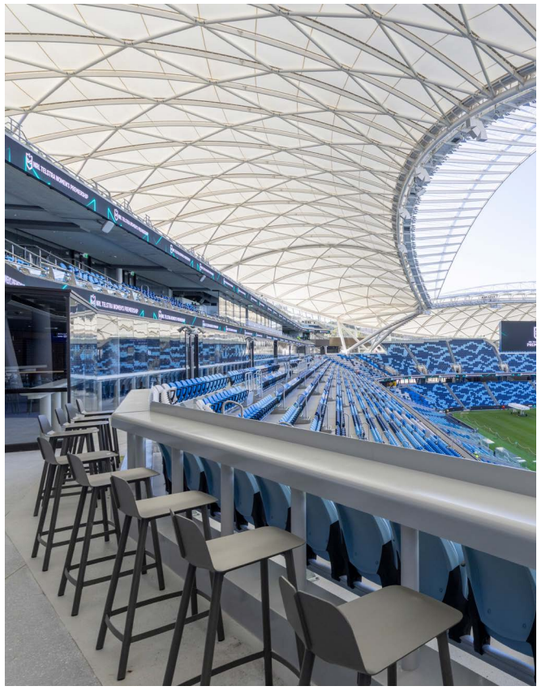
The SFSR has provided a lasting social and environmental legacy for NSW through highly successful pre-employment training programs, exceptional performance against all social procurement targets, and the implementation of environmental initiatives designed to reduce the long-term carbon impacts of the stadium.

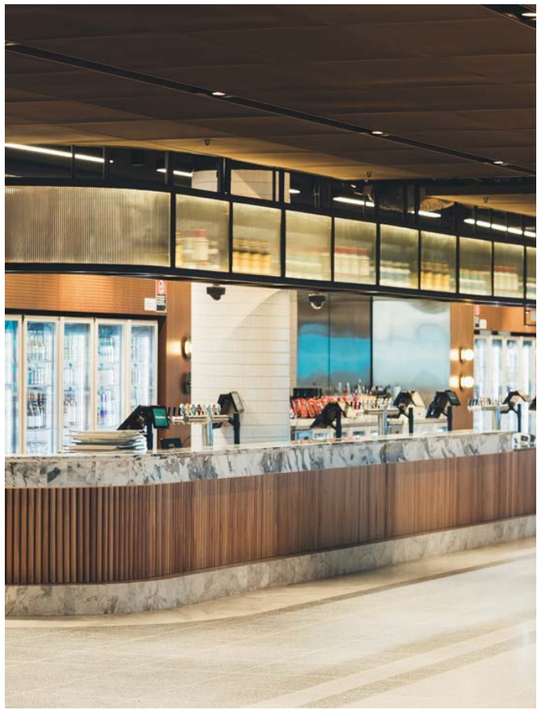


External landscaping and unique bronze stadium facade

Project Scope of Works

- **42,500 seats**
- **90,000sqm floor area across 7 levels**
- **540-space carpark**
- **Interconnecting public domain works**
- **Integrated fit-out of all spaces**
- **64 food and beverage outlets**
- **128 toilet blocks**
- **51 separate suites**
- **13 passenger lifts**
- **12 escalators**





Design Innovation

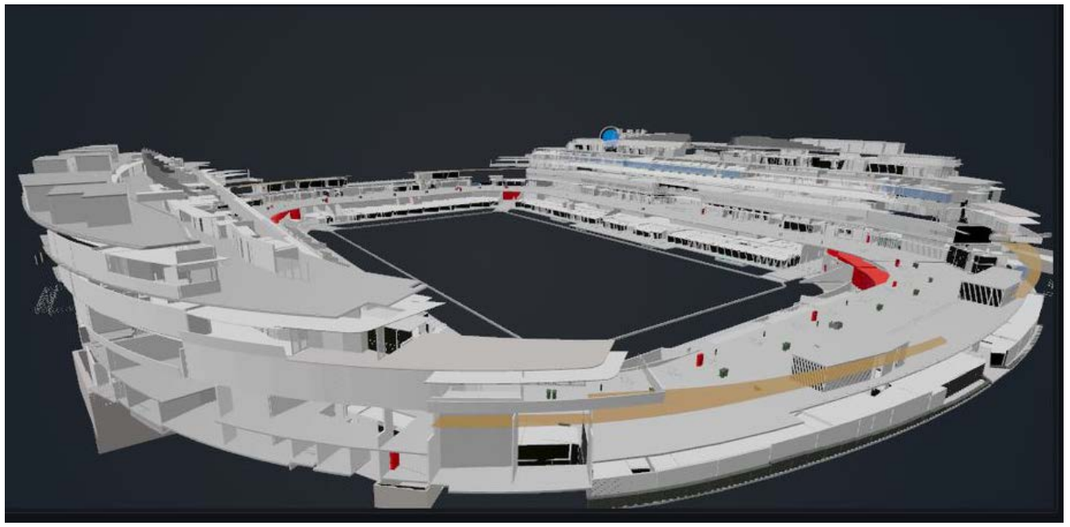


Figure 1 - Digital twin model of the Sydney Football Stadium

Through the Sydney Football Stadium's design, we realised a 360-degree open concourse with sweeping views and steep seating angles providing unparalleled visibility of the field with better accessibility and increased amenities.

John Holland partnered with Aurecon, Cox Architecture and Schlaich Bergermann to design the innovative, lightweight, cloud-like steel roof structure that reflects noise back into the stadium to minimise impacts on the local community. This highly complex structure required 4,000 individual pieces of steel, each with pre-set length and geometry.

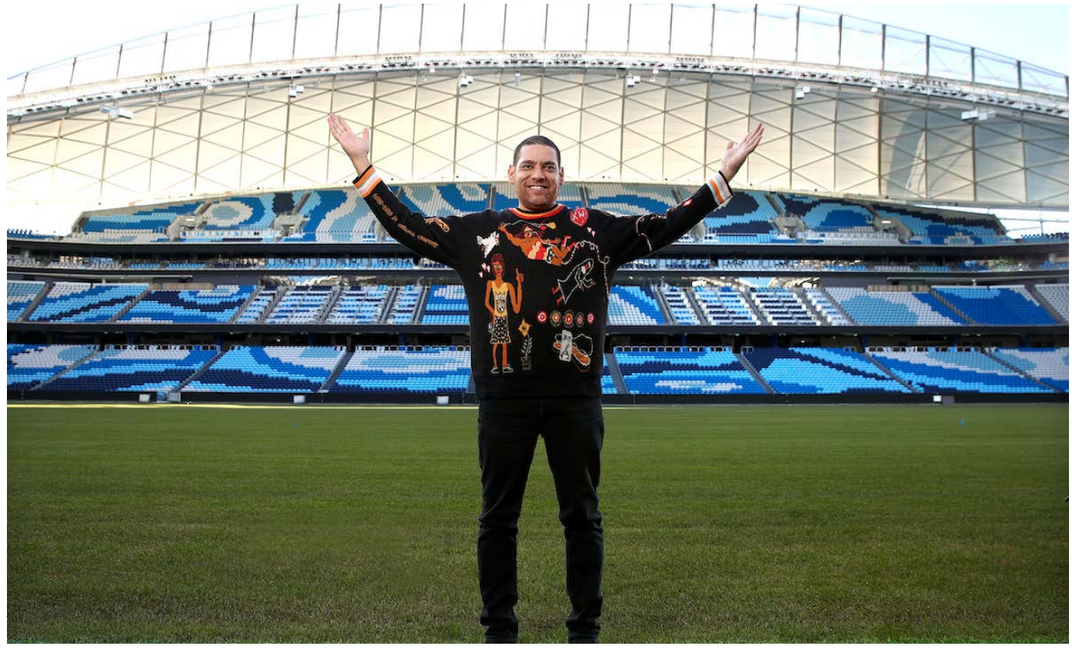
John Holland digitally modelled the entire roof geometry at key stages during the project to provide highly accurate fabrication data and drive project efficiency (Figure 1).

The stadium features a unique bronze fin façade system, with design and materiality fusing art and engineering to visually integrate with the Moore Park Precinct and the enhanced public domain.

Grid optimisation

A key value engineering option was changing the structural piling and column grid to maximise efficiencies and improve buildability. This engineered design solution was investigated early in the design process, resulting in numerous benefits including:

- Enhanced visibility and sight lines -achieved by increasing the grid spacings from 8 to 12 metres thereby removing approximately every third column.
- Reduced material and labour requirements
- Increased construction speed and reduced in-ground piles while providing program assurance.
- Reduced crane time and plant requirements delivering time and cost benefits.
- Reduced the number of required lifts from 3,850 to 860 for the seating plats and works at height, improving overall site safety.
- Increasing the span of precast elements by 50%
- Reduced grouting requirements, jointing, and the sealing of panels to increase installation efficiencies and provide enhanced value for money.
- Improved buildability and whole of life benefits through the reduction in maintainable joints.



Tony Albert on the Sydney Football Stadium field

Digital innovations driving productivity

Throughout the design and delivery of the SFSR, John Holland was focused on embedding digital technologies that provided safe and sustainable construction solutions and captured and drove efficiencies across the life of the project including:

- Developing a digital twin to drive efficiency post-occupancy and support the integration of the sophisticated SFS ICT system with the existing SCG infrastructure.
- Completing over one million dynamic digital simulations to ensure compliance with one of the most detailed client briefs of any Australian sports stadium

Additionally, John Holland incorporated leading-edge technologies into the stadium, including:

- A fully merged IT fibre backbone system with onsite storage
- A campus wide one-system approach integrated into the existing SCG systems
- An ICT supported wayfinding system programmable to event and user requirements
- Motion controlled and interfaced lighting systems to cater for the various operating modes

Promoting Connection to Country through the SFSR

John Holland was committed to providing a real and tangible

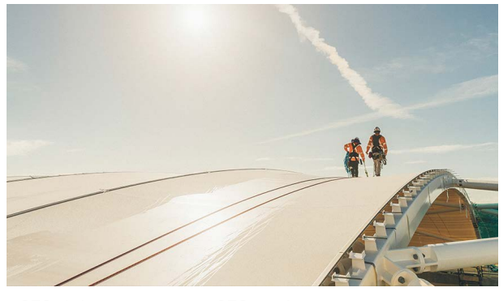
Connection to Country through the SFSR. Teisha Coos Kuku Yalanji man Tony Albert was commissioned to develop the seating artwork for the new stadium – a piece based on the theme of 'two worlds colliding' to represent the idea that the stadium is a meeting of two cultures and two teams.

"The intersection between art, sport, and culture intertwines and creates a rare opportunity to bring us all together in a meaningful way."

Tony Albert

Reduced carbon footprint and environmental impact

The Sydney Football Stadium is on track for a US Green Building Council LEED gold rating. The structure features solar panels and a water harvesting system on its roof, while the building profile was specifically designed to reduce overall impacts on nearby parkland and reduces noise pollution.

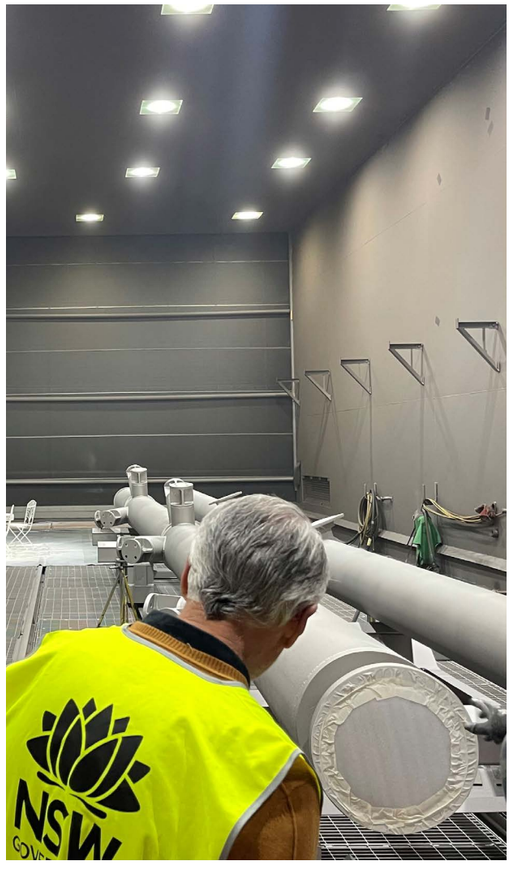


SFS delivery team on SFS rooftop

Durable steelwork providing whole-of-life benefits

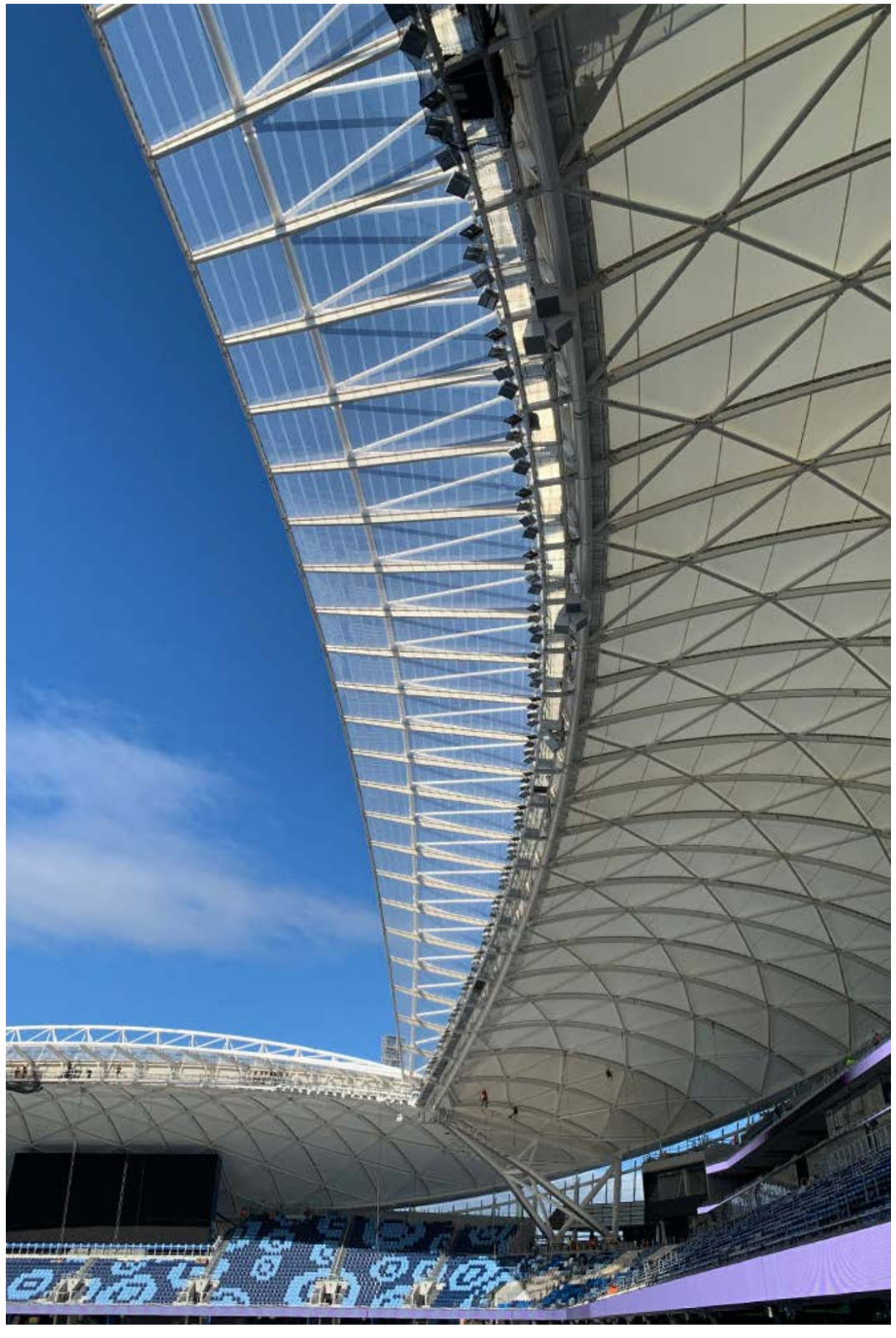
John Holland's solution for the stadium steelwork achieved a massive 25-year increase in life to first maintenance. The atmospheric corrosivity category for the stadium is C3 to AS/NZS 2312.1, and John Holland implemented a three-coat protective paint system to protect the steel while ensuring all sharp edges or welds were rounded to ensure an appropriate application of paint.

Additionally, we minimised the exposed surface area of the steel through the effective design of enclosed areas to reduce the potential build-up of sulphates, chlorides and other organic material which typically accelerate the rate of corrosion.



Innovative drainage system

Our in-house hydrology and drainage specialists developed an innovative drainage system designed to drain excess water off the working platform and removing stormwater pollutants prior to discharge. This industry-first drainage solution delivered improved environment outcomes, enhanced the environmental approvals process, and allowed us to resume work quickly following multiple rain events.



Meeting the Challenge

John Holland delivery team on site at SFS

This complex engineering project, required John Holland's specialist combination of general building and heavy engineering expertise. Our team of specialists delivered innovative and scalable solutions for formwork systems and the Prefabrication and Preassembly of major project components offsite.

Materials

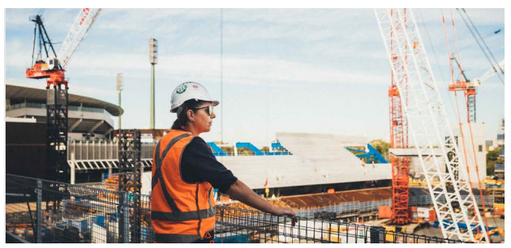
- **150,000m3 of earthworks**
- **3,500 precast plats**
- **38,000m3 of concrete**
- **5,000 tonnes of Australian fabricated steell**

Temporary works solutions

John Holland's in-house TEK (Technology, Engineering, Knowledge) team designed the temporary works using an innovative solution including headstock and jacking platforms which ensured the safe and efficient erection of the steelwork.

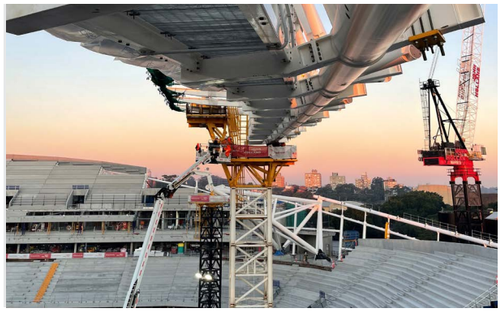
Our design, manufacturing, lifting and installation teams worked closely to develop solutions which enabled manufacturing and installation of large, complex roof members through the use of multipurpose temporary steelwork ensuring the ensuring the following:

- No reworks were required for any steel or precast elements
- All major steel and precast elements were manufactured and installed once
- No safety incidents occurred associated with steel or precast installation
- The delivery of an enhanced program through temporary works
- Cost and quality benefits



John Holland delivery team on site at SFS

We ensured certainty of final installation and the connection of steel trusses using complex support jigs for derrick assembly and by welding and conformance checking to ensure we met dimensional tolerances.

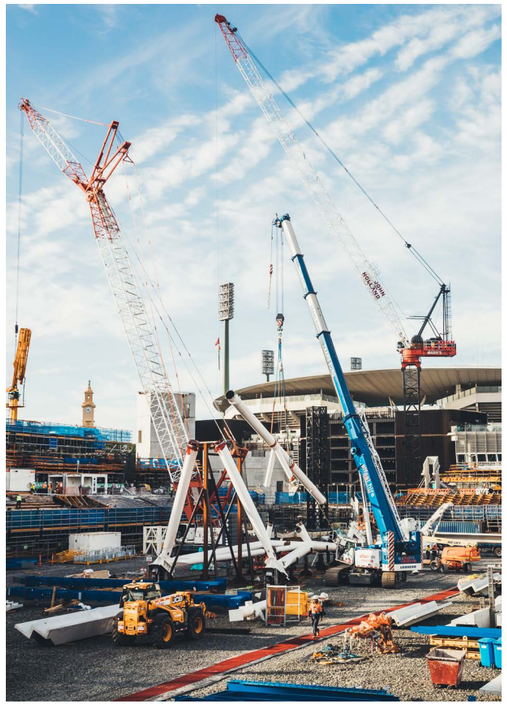


Temporary Platform/Headstock complex removal from under the installed trusses

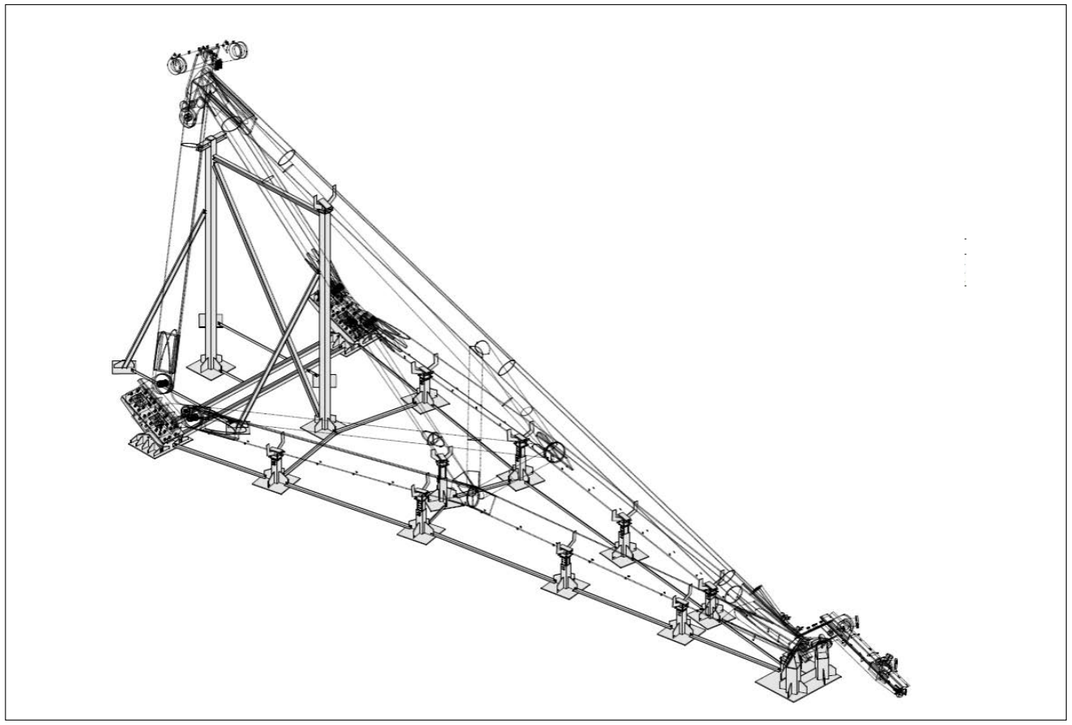
Temporary Headstock platform , with three truss sections positioned

All four roof derricks were successfully lifted into position and surveyed as dimensionally correct, ready for truss installation without rework.

Dry fit of Derick in the manufacturing yard, positioned in Jig, checked for dimensional conformance, prior to initial welding



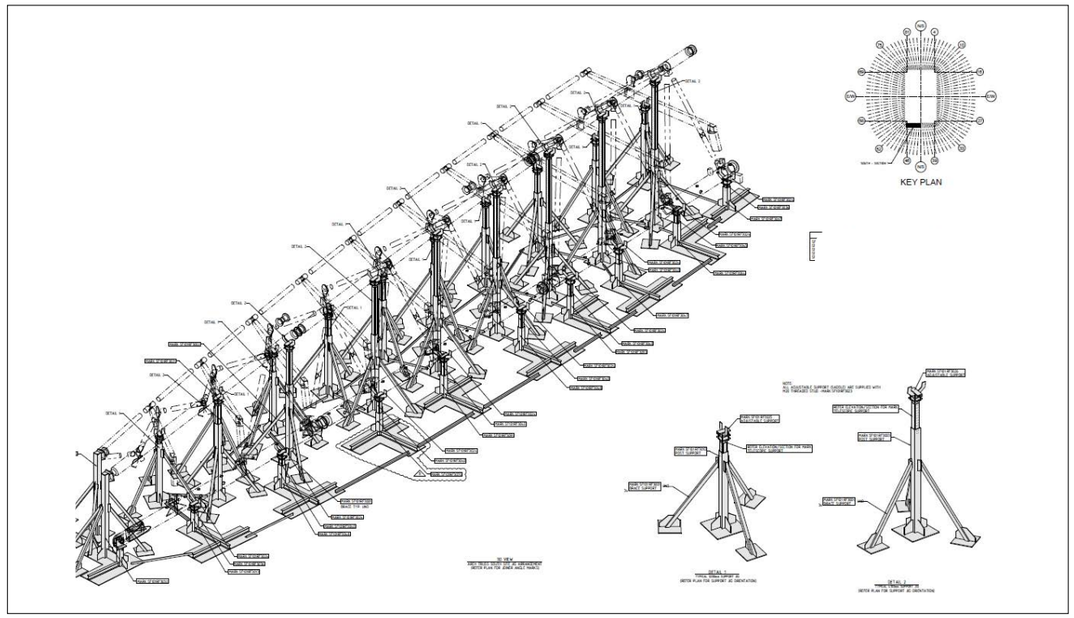
Derick being assembled on the pitch, at site. The only onsite welded components of the roof frame due to its size and weight (non transportable as a single unit)



Design drawing Derick assembly jig

The temporary steelwork was prepared in a factory environment, including conformance surveying, painting, and preparation. This same temporary steelwork was then re-used on site to support trusses prior to installation to increase the speed of installation and provide enhanced safety outcomes.

Aerial view of SFS during construction, as the team reuse temporary steelwork during roof installation



Design drawing temporary steelwork

Truss sections being assembled on the pitch, dimensionally checked prior to lifting

Roof Construction

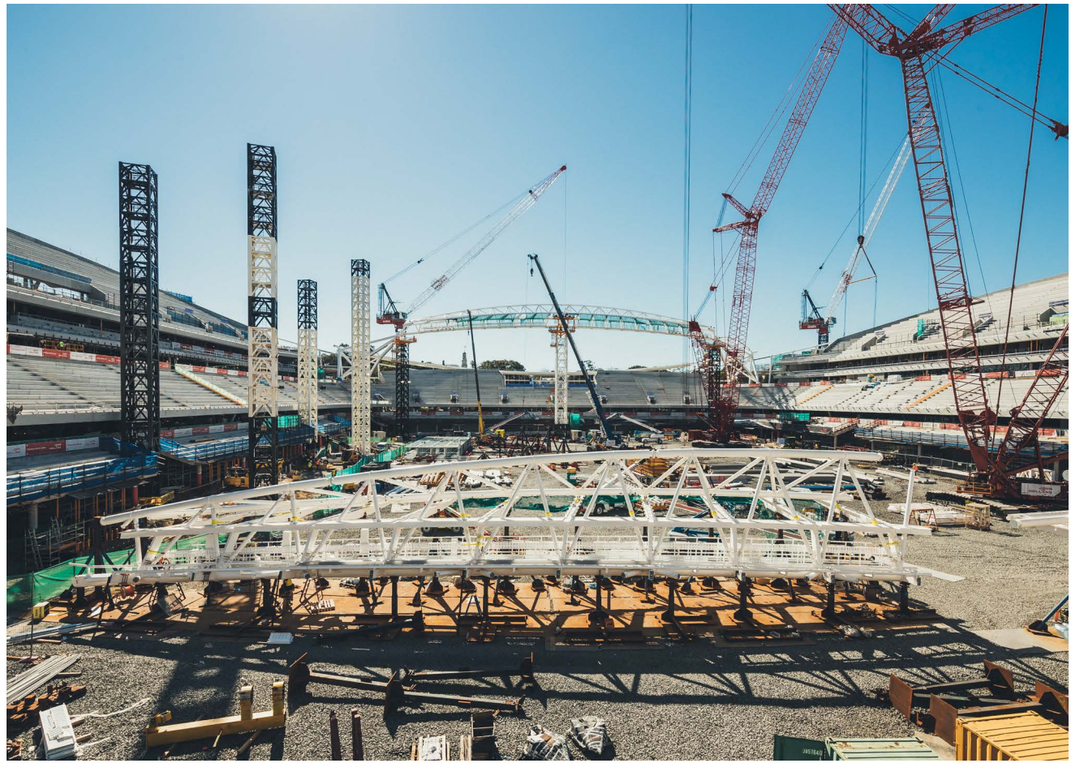
Minimising risk through pre-assembly

The iconic SFS roof represented significant safety risks due to its complexity and the tight deadline for delivery. John Holland eliminated these risks and drove an efficient, safety-first program by developing an on-the-ground installation approach: 85% of roof steelwork connections occurred at ground level. Through this approach, the team successfully installed 5,000 tonnes of Australian fabricated steel,

In addition to reducing working at height risks and reducing the under over risk at the back end of the program, this methodology allowed for quality inspections to be completed on the ground and prior to erection.

We carefully designed the roof elements to be stable in partially constructed lifted modules which enabled us to pre-assemble large segments of trusses and diagrid, and then lift them into position.

Rafters and diagrid were pre-assembled on the pitch and fitted with roof fabric netting to facilitate the roof fabric installation. Every second bay was assembled on the pitch and then lifted into position, limiting work at height and dropped object risks. This approach minimised plant and equipment movements on site, reducing installation time and congestion.



Truss assembly on the pitch

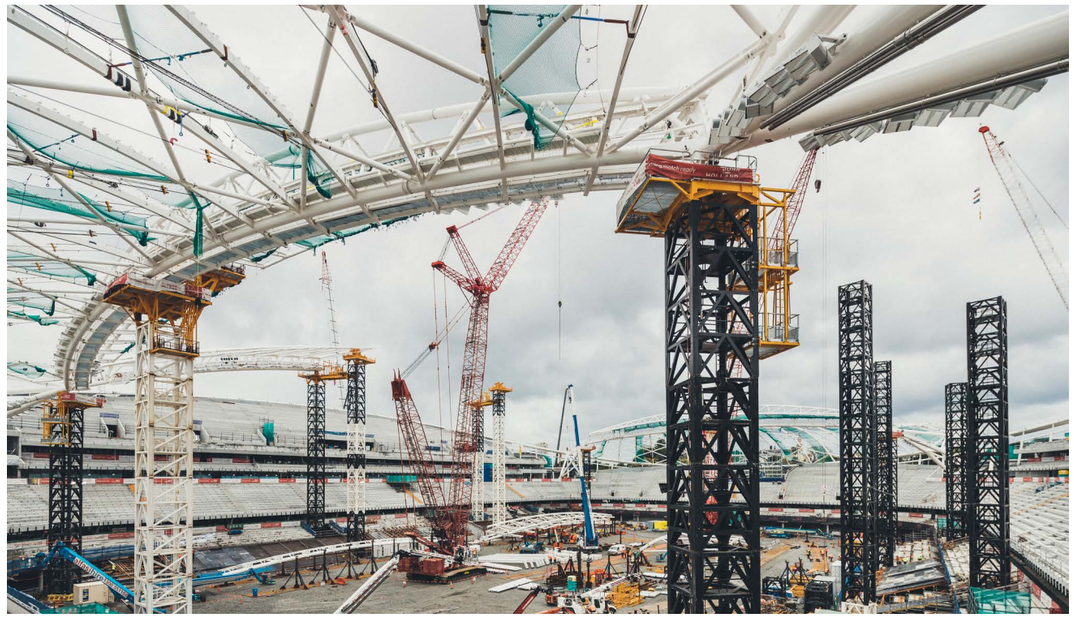


Figure 2 - Diagrid assembled on pitch prior to erection

Figure 2 and 3 illustrate the main roof truss completely pre-assembled with hanging walkways, plant deck and cantilevered roof sections. This methodology significantly reduced elevated works and optimised the post-steel erection relating to lights speakers and cable reticulation. Once complete, the main trusses were lifted into position and installed for energisation and interconnectivity.

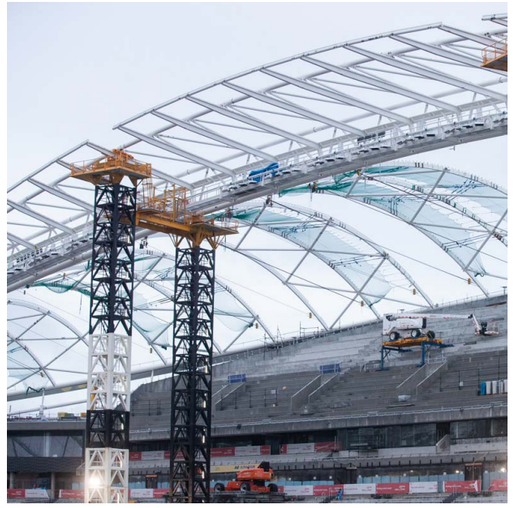
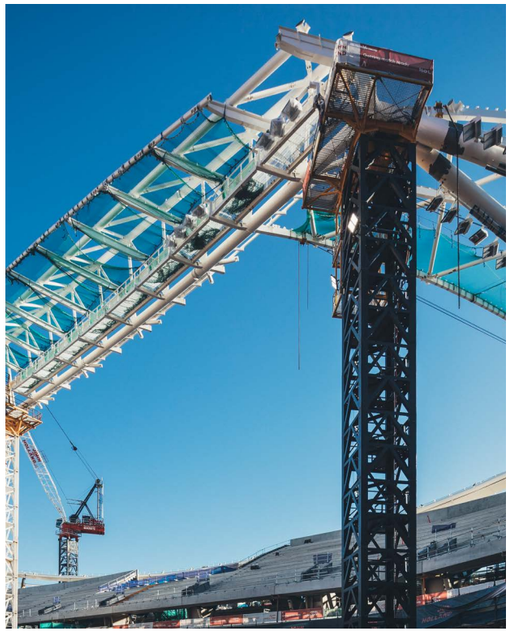


Figure 3 - Diagrid and netting installed

As part of the modularisation process, site welding was eliminated from the entire roof structure, except with respect to the supporting derricks, which required onsite welding due to their weight and size.

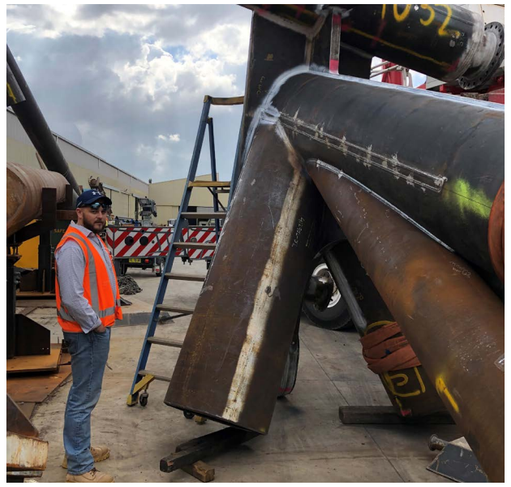


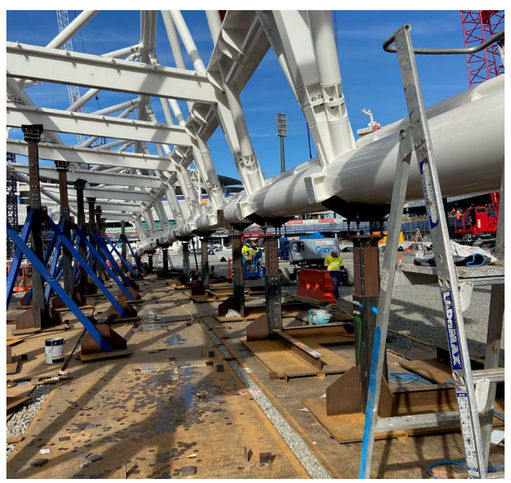
Truss erected, walkways in place underneath, cantilevered netted section installed, speakers, lights and cables evident.

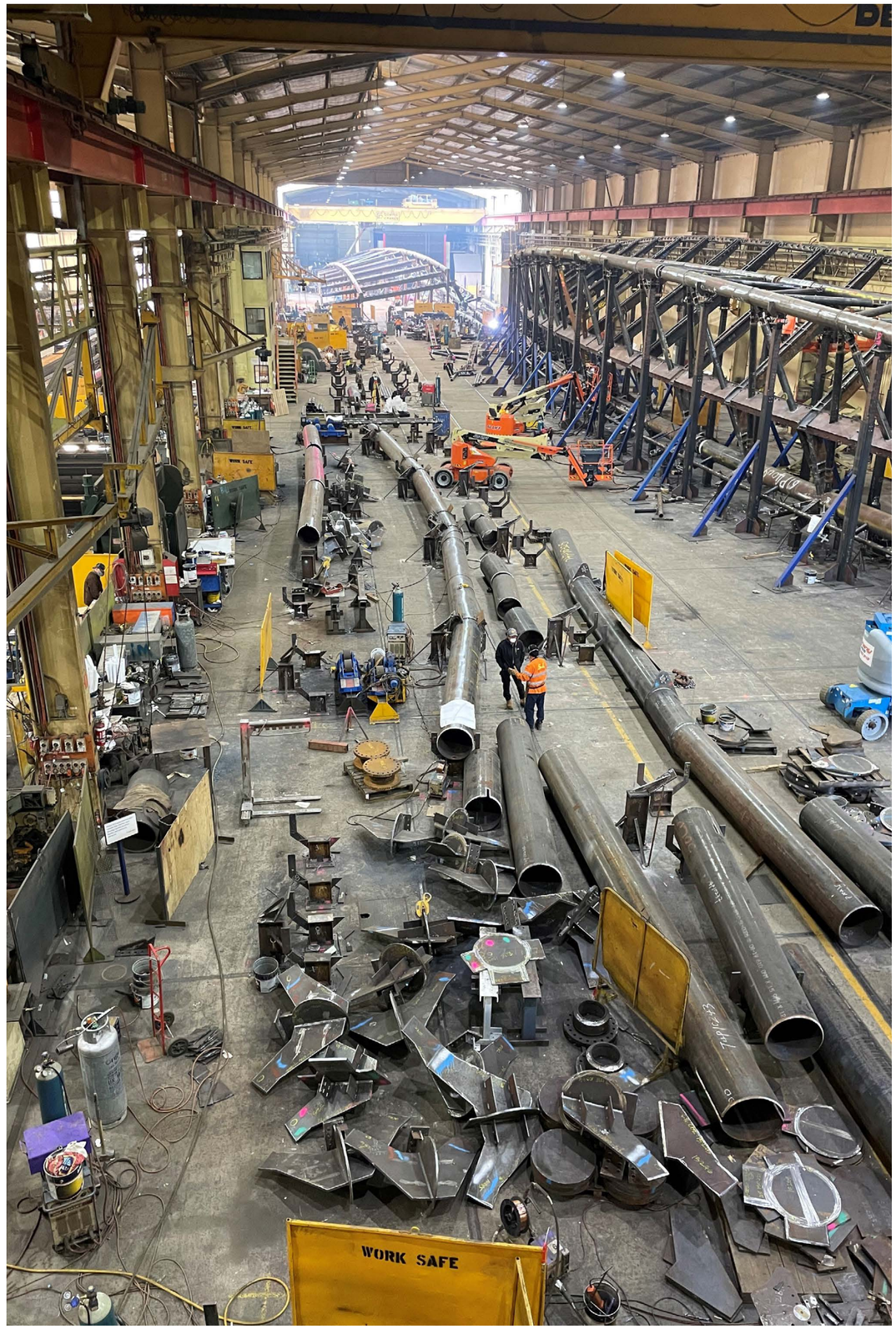
Modularised construction methodology maximising safety + productivity

John Holland adopted off-site prefabrication and modular construction techniques across this project to limit working at heights risks, improve site sustainability, and improve project efficiency. This approach also increased accuracy on site while reducing onsite congestion associated with delivery vehicles: by minimising works on site, we enabled multiple work fronts to progress on the pitch simultaneously without the use of substantial tower or crawler cranes.

The project team established an assembly yard in Western NSW for the offsite assembly of the tension ring and the Glass Fibre Reinforced Polymer (GFRP) nosing panels for the roof. We considered the dimensions of all modular, prefabricated elements in terms of ease of transportation to the site to minimise disruptions and drive efficiency. We ensured each fabrication assembly could be installed in the fabricator's yard prior to transportation to avoid overuse of the laydown areas on site.







Building a Culture of Safety

Through the SFSR project, John Holland delivered industry leading COVID-19 management solutions in line with all government requirements and provided a safety-first project culture that delivered outstanding initiatives supporting our people's physical and mental health. This project included:

- **A peak workforce of 1,400**
- **150 toolbox talks**
- **7,500 safety Inductions**
- **45,000 pre-start talks**

Industry-leading COVID-19 management

The SFSR was completed during the height of COVID-19 restrictions, requiring the project to be delivered through significant new health controls.

John Holland implemented an industry-leading hygiene program, and the SFSR was a pilot project in NSW for onsite PCR testing and onsite Mandatory RATs.

- We consulted closely with our workforce to create an agreement for Mandatory Rapid Antigen Testing, and established an onsite testing facility where we conducted over 1000 tests per day to ensure we could continue delivery of the SFSR project while maintaining the health and safety of our people as an absolute priority.

Supporting mental health in construction through SFSR

Beyond physical safety, John Holland prioritised the mental health and wellbeing of our people throughout this project. We successfully delivered our award-wining construction mental health program through the SFSR – Caring in Construction.

Designed to address the high rates of suicide and mental illness in the construction industry this program mobilises a network of mental health first aiders on site as the first point-of-contact for workers in crisis, offering support and linking them with professional support, and delivers regular awareness and education events about mental health providing access to local services and resources. Additionally, we worked with local community groups including Rabbitoh's Souths Cares, Beyond Blue and Dad's in Distress.

John Holland's Caring in Construction team hosted an event with approximately 700 workers in attendance and guest speaker former South Sydney Rabbitohs player Buddy Gordon.

Social and Community Legacy

Skills and workforce achievements

At project completion of the new Sydney Football Stadium (SFS) John Holland exceeded our apprenticeship target of 30%. This was not a project captured by the ISLP, so additional participation targets were set internally by John Holland. As of Aug 2022, we have achieved 4% Aboriginal participation, 2% participation of women in non-traditional roles and 14.5% participation of people under 25.

John Holland has run successful training programs through the SFS including the SFS Aboriginal Pre-Employment Program (PEP), providing unemployed Aboriginal and Torres Strait Islander people with core, practical entry level industry skills to open career pathways including apprenticeships.

PEP candidates received hands-on training over a four-week program including accredited technical skills, safety awareness and employability training. John Holland partnered with local suppliers and sub-contractors to secure employment for recent PEP graduates.

The SFSR project also established and delivered the Future Construction Leaders program to support three John Holland apprentices through the life of the project. This program provided apprentices with experience across all aspects of site-based operations to create a pipeline of future leaders in the construction industry.

Three graduates from our SFS Aboriginal Pre-Employment Program (PEP) discuss reaching their six month employment milestone.

2020 SFS Aboriginal Pre-Employment Program group graduation. Despite several covid challenges during the year, five young men received contracts to start their career working alongside SFS subcontractors. Former NRL player Robbie O'Davis joined for the special occasion.

Stuart Ayers, Minister for Enterprise, Investment and Trade, Minister for Tourism and Sport, announced the opening schedule of events including a free community day, NRL, rugby and football matches.

Driving local procurement

We prioritised awarding contracts to local suppliers through the SFSR, with approximately $500M of contracts awarded to NSW businesses. This local-first approach was critical to support local businesses adversely affected by the COVID-19 shutdown and provided certainty in program delivery despite disruptions in global supply chains caused by the pandemic. Approximately 1,100 workers were on site every day, providing much needed economic support during a period of significant uncertainty.

We prioritised local suppliers, subcontractors, and manufacturers for precast concrete and steel components, providing assurance of quality product and eliminating risks associated with international supply. This local-first approach maintained the manufacturing skill base for complex structures within the Australian industry and supported specialist local businesses during COVID-19.

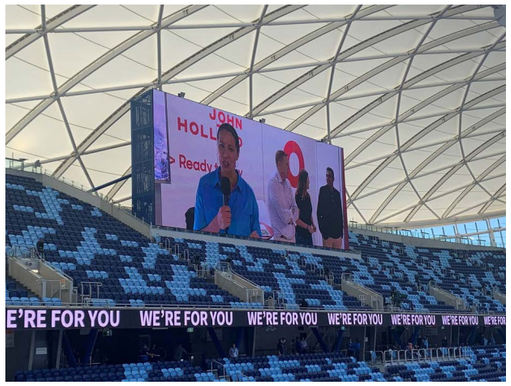
Structural steel for the project (5,000t) was manufactured entirely within Australia with major contracts awarded to manufacturers in NSW (S&L Steel) and South Australia (Samaras). Precast for the project (3,500t) was also manufactured in Australia (Queensland and Western NSW). The 42,500 plastic seats were manufactured in Victoria by Camatic.

We worked closely with Infrastructure NSW to ensure all contract matters were resolved in a timely manner by sharing program, cost recovery scenarios and assessments of actual costs. Infrastructure NSW committed to making upfront payments that were passed through the subcontractor supply chain to allow all the parties to manage cashflow and mitigate insolvency risks during the construction industry shutdown.

Outstanding stakeholder management

A key project driver for the SFSR project was maintaining and enhancing our strong relationships with both Infrastructure NSW and Venues NSW. Our team have successfully drawn on our longstanding relationships with both organisations to ensure enduring engagement with all sporting codes, and with retail and government stakeholders. John Holland provided a dedicated Communications, Stakeholder and External Authorities Manager to manage all external messaging and sensitively engage with the Infrastructure NSW communications team. This manager supported Infrastructure NSW in delivering their community communication strategy including letter drops, and staffing a 1800 hotline.

Business and community neighbours to the SFS project were highly informed and active, including the SCG, Fox Studios, the Entertainment Quarter and a number of neighbourhood groups. Through ongoing collaboration with these stakeholders, we successfully implemented controls to reduce disruption to the neighbourhood, including restrictions to construction zones and parking. We supported operational business continuity for the Entertainment Quarter by restricting deliveries outside of peak times through agreed delivery routes.



John Holland welcomes a crowd of over 25,000 to the stadium for a community open day.

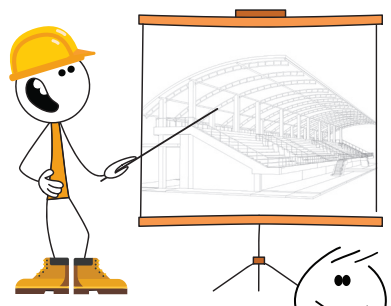
Everyday actions

how we work together

Communicate
openly and honestly

Understand
each other's priorities

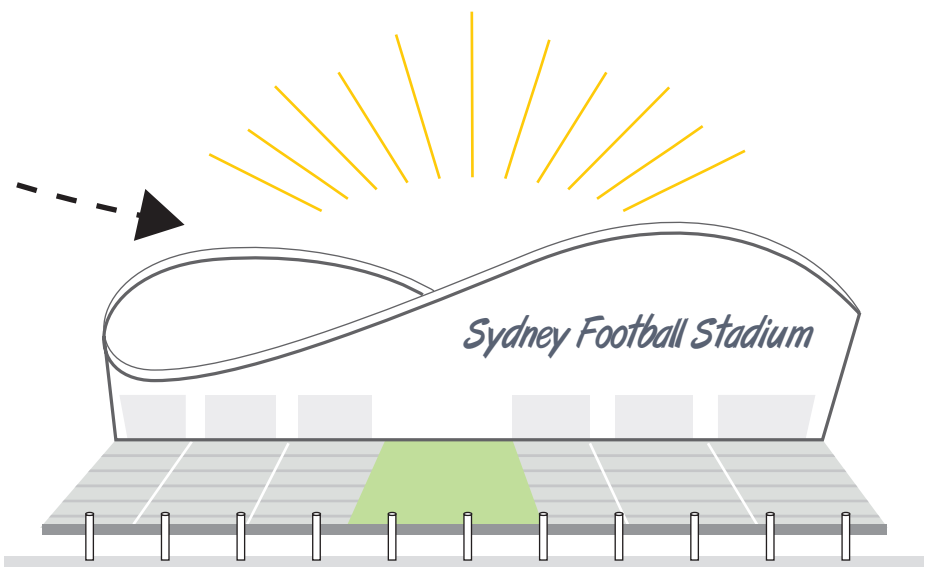
Provide solutions
and drive to deliver them

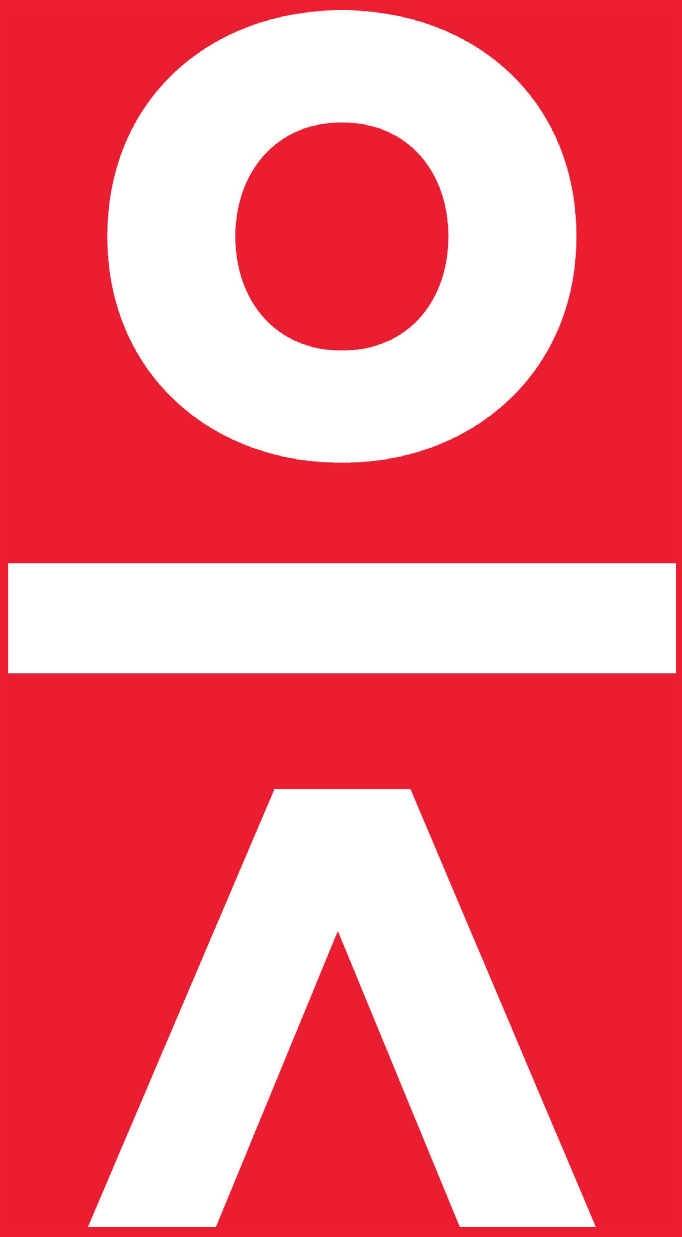


Develop and up-skill
our people from within

Play to our strengths
and give each other the opportunity to shine

Work collaboratively
and respectfully





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