SECTOR CASE STUDY

Sports & Entertainment Stadia

OPPORTUNITIES THROUGH EXCELLENCE

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BG&E

Sydney Football Stadium

TEMPORARY WORKS

SYDNEY, NSW, AUSTRALIA
CLIENT: JOHN HOLLAND

The Sydney Football Stadium (SFS), now known as Allianz Stadium, is a $828 million, state-of-the-art stadium near Sydney's CBD that was funded by the NSW Government and reopened to the public in 2022.

BG&E was engaged to undertake temporary works for the fabrication, transportation, and erection of the steel roof for SFS. These works included:

- Erection staging of the major roof elements, including a staged FEA model for each roof element, with temporary supports on the pitch to control the local soil bearing and overturning.
- Review of lift studies and design of temporary supports for out-of-plane lifting induced loading.
- Design of the temporary support jigs and mechanisms to allow movement in the stressing stages and lifting of the radial arches.

The new stadium was built to meet the future safety and access requirements and boost growth in the Sydney visitor economy.

Sydney Cricket Ground

STRUCTURAL AUDIT & CONDITION ASSESSMENT

SYDNEY, NSW, AUSTRALIA
CLIENT: SCG TRUST

The Sydney Cricket Ground (SCG) Trust engaged BG&E to undertake a structural audit and condition assessment of several grandstands at the SCG.

The works intended to provide the SCG Trust with reports that confirmed the condition, identified remediation works (if required), and an approximate time frame and order of priority for any remediation work required.

A structural audit of each grandstand was performed for the roof and structure - which included the following:

- Audit of the roof structure including primary trusses and supporting structure, secondary steelwork such as purlins, soffit cladding, roof cladding, guttering, and ancillary metalwork including bracketry, handrails, and other fixtures.
- Audit of the rest of the structure including all concrete structures (slabs, beam, columns, tiering), brickwork and blockwork, steel structures (including cladding and associated support structure), and ancillary metalwork including bracketry, handrails, and other fixtures.
- Identification of non-structural contributing factors such as water ingress issues and suggested remediation.
- Inspection of each asset by visual means on foot (grandstand, roof structure, and basement structure where accessible).
- Identified remediation works required with priority and time frame identified for the proposed works. Each identified item was provided with a risk rating with a corresponding rectification time.
- Recommendation of additional inspection/ testing requirements (including scope and frequency) where required.
- An audit report was developed for each grandstand with the audit captured using PlanRadar software. Each defect identified was captured and marked on the drawings (where available) including a description of the defect, a risk rating, and a repair priority.

Passmore Oval

STRUCTURAL & CIVIL DESIGN

WICKHAM, NSW, AUSTRALIA
CLIENT: CITY OF NEWCASTLE COUNCIL

The $2.35 million grandstand upgrade at Wickham delivered dedicated female changerooms, improved disability access, and new community function areas – setting an inclusive benchmark for Newcastle's sporting facilities.

The redevelopment includes a new two storey clubhouse and changing room amenities building built next to the existing historic Passmore Oval grandstand.

BG&E were engaged by Newcastle City Council to provide structural and civil engineering design services for the multi-million-dollar project. The structure included design of concrete strip footings on fill, new external blockwork walls, a reinforced/post-tensioned concrete floor slab, and lightweight steel roof structure.

The project also involved assessment of the heritage existing grandstand as the new structure projected through into the existing grandstand to form a viewing platform. The project was completed using a novated builder with BG&E providing construction site support throughout.

The project was completed in early 2024 and will be opened to the public in the coming months.

Max McMahon Oval

CIVIL DESIGN

RUTHERFORD, NSW, AUSTRALIA
CLIENT: MAITLAND CITY COUNCIL

BG&E were engaged by Maitland City Council to prepare concept and detail design plans for the civil works associated with the upgrade of Max McMahon Oval.

The project included demolition of the existing facility and replacement with a single-storey amenities building over two stages, including changerooms, toilets and canteen plus multi-purpose hall.

The three million dollar upgrade of the Max McMahon Oval will bring this important community facility up to 21st century standards.

Maitland Regional Athletics Centre

STRUCTURAL & CIVIL DESIGN

MAITLAND, NSW, AUSTRALIA
CLIENT: BUILT PTY LTD

In 2023, BG&E undertook structural and civil design from tender to construction stage for the new amenities building at the Maitland Regional Athletics Centre.

The structural design included:

- A suspended slab on the ground, supported on timber driven piles due to the deep fill in the Maitland area.
- Load bearing masonry walls supporting a suspended RC concrete roof, which was also designed as a trafficable viewing platform for the sports field.
- A new eight metre high and 10 metre wide LED lighting base-cantilevered score board structure.

The civil engineering design included:

- Drainage design from the new amenities building to the existing storm water pits.
- Cut/fill optimisation.
- A new footpath design surrounding the
- sports field.

Moore Park Stadium

TEMPORARY WORKS

SYDNEY, NSW, AUSTRALIA
CLIENT: S&L STEEL

BG&E were engaged to undertake temporary works for the fabrication, transportation and erection of the steel roof for the Sydney Football Stadium.

BG&E undertook erection staging of the major roof elements. These works included a staged FEA model for each roof element member by member with temporary supports on the pitch to control the local soil bearing and overturning.

BG&E reviewed the lifting studies and incorporated lifting requirements and out of plane lift loads and support conditions. BG&E designed the temporary support jigs and mechanisms to allow movement in the stressing stages and lifting of the radial arches.

Hunter Stadium

STRUCTURAL AUDIT & CONDITION ASSESSMENT

NEWCASTLE, NSW, AUSTRALIA
CLIENT: VENUES NSW & MCDONALD JONES STADIUM

The transformation of Hunter Stadium (now known as McDonald Jones Stadium) has cemented it as the iconic venue for sports and entertainment in Newcastle.

The rectangular, multi-purpose stadium has a seating capacity of 30,000 and serves as the home ground for the Newcastle Knights rugby league team and the Newcastle Jets Football Club.

BG&E have been involved in a number of work packages for the improvement of the stadium, including:

- Provision of ablution amenities on the north and south terraces.
- Structural inspection and load-verification of new LED screens on the bleacher cantilevers.
- Inspection, monitoring, structural modelling and rectification of existing issues around building movement joints.

Te Kaha

TEMPORARY WORKS

CHRISTCHURCH, NEW ZEALAND
CLIENT: JINGGONG STEEL INTERNATIONAL

The Te Kaha – Christchurch Stadium is a state-of-the-art addition to Christchurch, set to accommodate 30,000 for sporting and 36,000 for music events.

BG&E is providing construction engineering and temporary works services to the $683 million project - including design review of temporary propping, lifting lug assessment, trusses construction jigs, temporary stability of roof trusses, and access platforms.

With the project set to span from 2023 to 2025, the design review for Christchurch Stadium presents challenges involving coordination with overseas designers and a Mandarin-speaking team, as well as addressing the designer's unfamiliarity with local codes. Effective management of critical factors such as logistics, crane availability, and tight project timeframes and time constraints is essential.

Our technical team will apply their robust earthquake engineering knowledge, 3D FEM modelling skillset, expertise in legislative requirements and local design codes, and multilingual capacity to ensure the project's success.

The stadium promises to invigorate, the city centre, spur development, and reestablish Christchurch as a sports and cultural hub - drawing visitors from around New Zealand and the world.

Fortitude Valley State Secondary College

STRUCTURAL & CIVIL DESIGN

BRISBANE, QLD, AUSTRALIA
CLIENT: COX ARCHITECTS

BG&E were appointed as the structural and civil engineers for the Fortitude Valley State Secondary College, which comprises a sports centre and a vertical college that is valued at $98.7 million.

The vertical college incorporates engineering marvels, including a 23 metre concrete floors that span over the twin basketball courts.

The proximity to the rail line means that the design took into consideration will take into consideration rail impact loads and partial collapse criteria.

Bruce Street, Principal Buildings – QLD said, “We enjoyed working on the college and it’s exciting to now be involved in the Sports Centre. I’m proud of the opportunities that the centre will provide to surrounding communities.”

Peninsula Kingswood Country Golf Club

STRUCTURAL & CIVIL DESIGN

FRANKSTON, VIC, AUSTRALIA
CLIENT: BUILT PTY LTD

The Peninsula Kingswood Country Golf Club underwent the most extensive course redevelopment in Australian golfing history, officially reopening its doors in 2019. This transformative project has catapulted the north and south courses onto the global stage, marking a significant milestone for the club.

BG&E played a pivotal role in this redevelopment, providing structural, civil, and sports field engineering services.

The construction of the new 6,000m² golf clubhouse unfolded across three levels, encompassing function rooms, dining areas, bars, members' facilities, a pro shop, a buggy store, an indoor swimming pool, a spa room, a wellness centre, a gymnasium, and onsite accommodation.

The clubhouse stands as a testament to architectural excellence, with externally exposed structural steelwork defining its form. Cathedral ceilings contribute to an expansive atmosphere, while operable doors enhance flexibility throughout the space.

State Football Centre

STRUCTURAL DESIGN

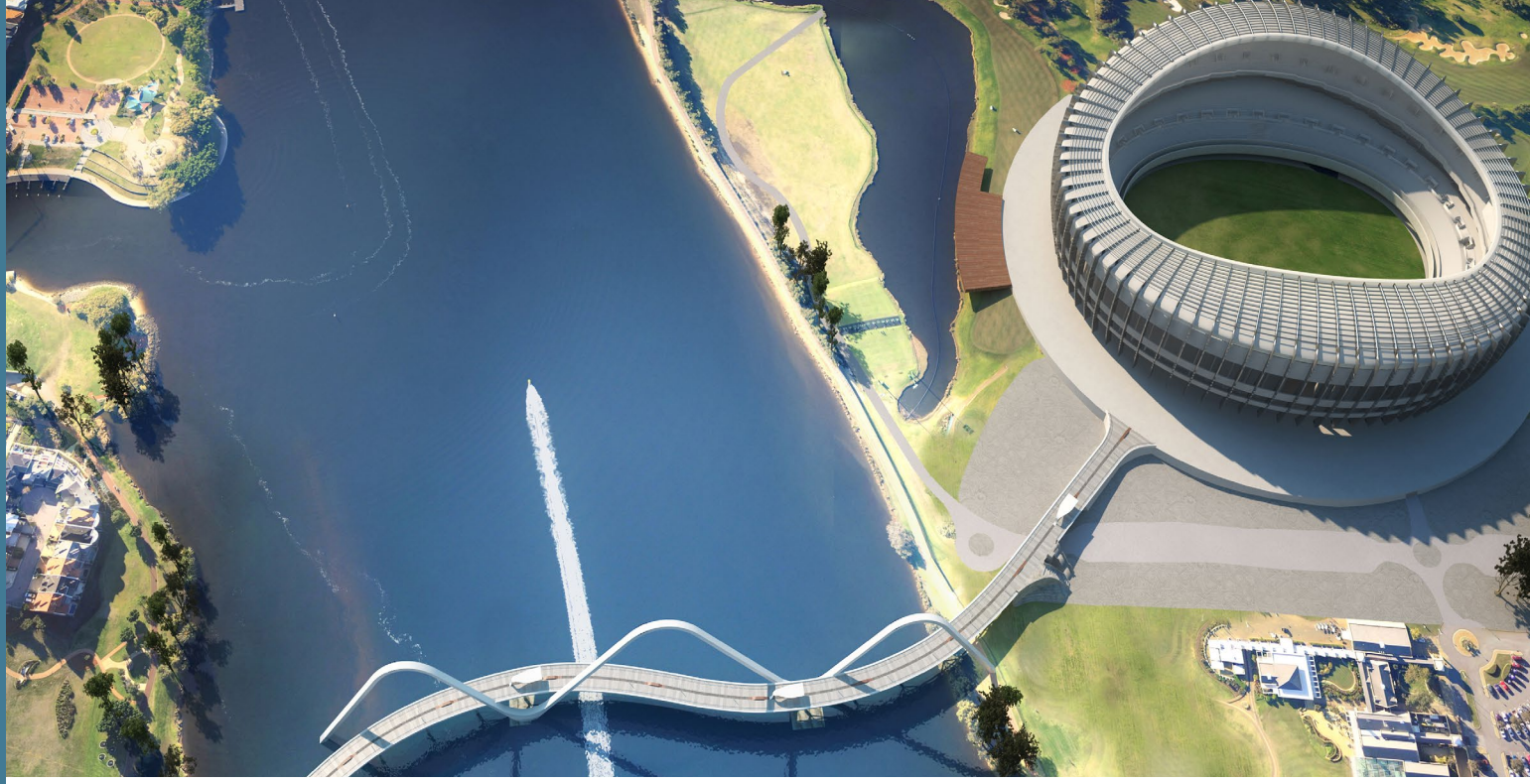
QUEENS PARK, WA, AUSTRALIA
CLIENT: DEPARTMENT OF LOCAL GOVERNMENT, SPORT & CULTURAL INDUSTRIES

The Sam Kerr Football Centre is a $50.8 million state football centre that was built to serve as a training facility for the FIFA Women's World Cup in 2023.

BG&E provided structural engineering services to the project, which included the following building components:

- Main building – two-storey building housing administration facilities, change rooms, function area, and tiered seating overlooking the main playing fields.
- Maintenance Building – a single-storey working building, store, and compound for site maintenance equipment and materials.

The stadium features match day and training facilities to support the development of junior and high-performance players, as well as grassroots and community football programs.



Perth Stadium Transport Projects

STRUCTURAL & CIVIL DESIGN

BURSWOOD, WA, AUSTRALIA
CLIENT: BGC CONSTRUCTIONS PTY LTD

Under commission from the Public Transport Authority and Main Roads WA, BG&E were involved in the conceptual design of the infrastructure works to support the proposed Major Stadium on the Burswood Peninsula in Perth.

Key issues we addressed included:

- Planned modifications to the Graham Farmer Freeway/Victoria Park Drive interchange, including modifications to, and additional, rail and pedestrian access bridges.
- Modifications to Great Eastern Highway/ Victoria Park Drive intersection.
- Concept design for bus station facilities on the Burswood Peninsula and East Perth to support the proposed Stadium development.
- Concept design for a pedestrian bridge across the Swan River to connect East Perth to the Stadium precinct.
- Concept road and parking infrastructure design surrounding the proposed Stadium.
- Drainage strategy and design for the full rail and freeway corridor in the Burswood precinct.

Optus Stadium

STRUCTURAL & CIVIL DESIGN

PERTH, WA, AUSTRALIA
CLIENT: BROOKFIELD MULTIPLEX

Formerly known as New Perth Stadium, Optus Stadium was completed in 2018 and accommodates permanent seating for up to 60,000 patrons, with the potential for expansion to accommodate up to 70,000 seats. The stadium forms a permanent centerpiece for the wider sports and entertainment precinct on the Burswood Peninsula, overlooking the Swan River.

Procured and delivered through a Design & Construct Managing Contract, BG&E was engaged as a subconsultant to Arup to provide both civil and structural engineering services for the stadium and wider precinct development.

For the structural component of the project, BG&E provided detailed structural engineering design, modelling, and documentation for the stadium substructure components.

Due to the presence of underlying soft alluvial soil materials with high consolidation settlement characteristics, a piled foundation system was adopted to found the steel-framed stadium structure and the event level concourse ground slab. Driven concrete piles were selected to avoid handling, treatment, and management of the contaminated soils.

Coordinating with the super-structure team, BG&E developed pile layouts, designed all pile-caps, and the suspended event level slab. Due to the high soil settlements below, slab services were integrated into the slab using thickenings or in suspended service trenches.

In addition, BG&E designed and documented the external ticketing gates structures and external landscaping structures, and assisted the contractor with temporary works designs for components of the superstructure.

Taking the lead for the civil design, BG&E's team focused on addressing the existing land conditions of the 73 hectare precinct. The civil works and stormwater design philosophy was to provide a sustainable and environmentally considerate design solution integrated with the interfaces of the surrounding State Transport Infrastructure and the landscaping vision and design for the sports precinct.

Given the soft underlying soil materials, our Civil team had to work to the existing ground levels, as significant fill would trigger long-term consolidation settlement. This approach was adopted to avoid ongoing maintenance of the pavements, roads, in-ground services, and key landscaped areas such as the community oval.

This was undertaken over the asset's design life while minimising the impact of the design and construction on the surrounding important ecological features, such as the Swan River and river-fed lake.

The Swan River Foreshore is a significant existing public realm resource, and the project provides an important opportunity to ensure that this resource is maintained and enhanced from environmental, infrastructure, health and safety, and ecological perspectives.

Optus Stadium - Perth, WA, Australia.

Karratha Leisure Centre

CIVIL DESIGN

KARRATHA, WA, AUSTRALIA
CLIENT: PINDAN

BG&E provided civil design services for the development of a $63.7 million recreational facility for the Shire of Roebourne in Karratha - including pools, courts, ovals, and car parks.

Developed on an elevated site overlooking Karratha, the recreational facility created some unique design challenges in relation to one in 100 year overland flows from the surrounding hillside.

The site required innovative rechannelling of existing watercourses around the development that satisfied both architectural and engineering requirements.

Perth Arena

FAÇADE DESIGN

BURSWOOD, WA, AUSTRALIA
CLIENT: BGC CONSTRUCTIONS PTY LTD

BG&E provided façade consultancy and engineering services to Perth Arena - Western Australia's landmark home of live entertainment, music and sports, that seats 15,500 and features breathtaking design and world-leading technology.

This project has a complex façade with unique construction challenges, stringent thermal performances and a tight time frame.

Our façades team provided the main contractor, BGC, with consultancy and engineering services for the composite panels, ETFE, aluminium louvres and the glazed façade including the secondary steel.

HBF Arena, Basketball & Football Facilities

STRUCTURAL & CIVIL DESIGN

JOONDALUP, WA, AUSTRALIA
CLIENT: BUILDING MANAGEMENT & WORKS

BG&E were engaged to carry out the structural and civil design of the new basketball and football facilities at the HBF Arena on Kennedya Drive in the suburb of Joondalup.

From a structural perspective the project comprised a new basketball court to match existing with a double and single storey link structure between the new structure and existing, and a double storey football pavilion with link bridge to existing structure. New fitout was also required to existing under croft area.

The structure comprised bow trusses with tie rods and struts which were expressed internally and externally. To eliminate the requirement for foundations to hold down the tie rods to one side of the building BG&E proposed and designed connecting tie rods and struts between the existing and the proposed structure, effectively allowing the buildings to support one another.

BG&E developed and supervised the construction sequence to allow successful transfer of load from the existing building to the new structure. BG&E calculated that a deflection of 10mm would occur at the mid span of the existing structure once the transfer of load had taking place. Surveying carried out during this process measured the deflections at almost exactly 10mm.

From a civil perspective, the project comprised of a new paved car parking area, hardstand areas around the buildings and stormwater drainage disposal. The civil stormwater drainage works also provided an outlet for the building roof water as provided by the hydraulic consultant.

Subiaco Oval

STRUCTURAL DESIGN

SUBIACO, WA, AUSTRALIA
CLIENT: CLOUGH ENGINEERING LTD

BG&E was appointed as the structural engineers for the new three tier western stand (originally named the Orr-Simmons-Hill Stand) at Subiaco Oval, a football stadium that accommodates 43,500 people.

The three tier stand has six levels and the top two levels (five and six) are covered by a roof. Access is via reinforced concrete stairs and walkways that are generally to the rear of the stand.

The structure consists of reinforced concrete tiered floor slabs. The rear is supported by reinforced concrete columns and precast walls. The roof sheeting is supported by steel beams, purlins and stiffeners.

AK Reserve Stadium

STRUCTURAL DESIGN

MOUNT CLAREMONT, WA, AUSTRALIA
CLIENT: DEPARTMENT OF HOUSING & WORKS & DEPARTMENT OF SPORT & RECREATION

BG&E provided structural engineering services for the development of the AK Athletics Reserve in Mount Claremont, which incorporated structural elements associated with the main grandstand, concourse and forecourt areas, back-straight facility, and two lighting towers.

To achieve the high quality level of finishes desired by the architect and to minimise the 'footprint' of the construction activities - a significant portion of the structural elements were prefabricated off site, prior to delivery and erection on site.

The widespread adaptation of precast concrete and prefabricated steelwork was particularly suitable for AK Reserve Stadium, given the repetitive nature of structural elements in grandstand structures.

Western Australian Cricket Association (WACA) Ground

STRUCTURAL DESIGN

PERTH, WA, AUSTRALIA
CLIENT: WESTERN AUSTRALIAN CRICKET ASSOCIATION

BG&E has enjoyed a long-standing involvement with structural works at the WACA, dating back to 1986. Specific projects include the Lillee-Marsh Stand, the Inverarity and Prindiville Stand, light towers, perimeter seating, scoreboard relocation, and gates and entrances.

Typically, all construction works at the WACA are scheduled to occur during the cricket off-season, between April and October. This is a relatively small window of opportunity for large-scale works, particularly as it falls during the winter period when inclement weather is more frequent.

A major focus for design is on the constructibility of the structure to ensure completion within the tight time frame. The Lillee-Marsh Stand and light towers projects are examples of large-scale works that were successfully undertaken during the off-season.

Previous to the design of the WACA light towers - new lights were installed at the Melbourne Cricket Ground (MCG), and the MCG lights were subject to significant cost overruns and an extended construction period of two years. The WACA administration was keen to ensure similar problems were not encountered at their stadium, and we worked with Multiplex to consider multiple structural forms and construction approaches prior to adopting a precast and prestressed tower structure.

The Lillee-Marsh Stand was a large undertaking for the off-season period and the design of the precast elements allowed the primary structure to be erected in only 18 days. Grandstands and lighting towers are wind-sensitive structures in that they are susceptible to dynamic excitation. We employed state-of-the-art design to ensure the grandstand roof and light towers were as slender as possible, yet stable when subject to wind.

WACA Stadium -
Perth, WA, Australia.

ECU Academic Building

STRUCTURAL & CIVIL DESIGN

PERTH, WA, AUSTRALIA
CLIENT: EDITH COWAN UNIVERSITY

BG&E was engaged to provide structural and civil engineering services for Edith Cowan University (ECU) - including an academic building, a large administration building, an iconic colonnade structure, and an undercroft car park.

The brief from ECU was to create a grand statement with the academic building as it forms the centrepiece of the campus for both staff and students. We worked closely with the architect to achieve the complex structural form and high-quality finishes required to meet the brief.

The Academic Building at ECU Joondalup campus was completed in 2003. The cross-section of the building closely resembles the form of the new proposed facility for Rushton Park and included coloured precast concrete steps and seating facing a large podium area for ceremonial occasions e.g. graduations. Tall masonry walls flank the sides of the building, and the glazed façade overlooking the podium area is also inclined.

Waterproofing the precast tiered seating and steps was critical since the space underneath was to comprise student computer labs. To achieve this, we developed specific details for surface drainage and joint interfaces of the precast elements, as well as a secondary collection system under the precast.
The project brief sought to implement environmentally sustainable design (ESD) principles, and BG&E contributed to this endeavour through selection of construction materials (thermal mass), use of recycled materials (timber), solar efficiency (louvres and shutters), and a focus on durable design (concrete mix and steel surface protection).

Project features include:

- Composite steel/timber colonnade.
- Extensive use of precast concrete for floors and external terrace.
- Prestressed floors for administration building.
- Highly detailed, exposed steelwork.

ECU Academic Building - Perth, WA, Australia.

Al Bayt Stadium

FAÇADE DESIGN

AL KHOR, QATAR
CLIENT: QATAR META COATS

BG&E provided façade design and engineering services for the Al Bayt Stadium - a retractable roof football stadium in Al Khor, Qatar, that was opened in time for matches in the 2022 FIFA World Cup. Located 40 kilometres north of Doha, the stadium can seat 68,000 spectators.

Our approach involved façade engineering and building envelope input from the schematic and detailed design stages of the project.

The concept of the stadium mimics the traditional Bedouin tent (Bayt Al Sha'ar), from which it also takes its name. The canvas-like façade is dominated by strongly contrasting black and white stripes. The interior of the stadium décor resembles that of the traditional tents with warm and cosy red colour.

Al Rayyan Sports Club Stadium

STRUCTURAL DESIGN

DOHA, QATAR
CLIENT: BROOKFIELD MULTIPLEX

The deconstruction of the Al Rayyan Sports Club Stadium was required to make way for the new Al Rayyan Stadium for FIFA World Cup in 2022 in Qatar. BG&E provided structural engineering advice during the demolition stages of the old stadium.

BG&E's scope included the assessment of the original structural design of the precast bowl structure to ensure that temporary load cases could be withstood by the existing structural elements. The overall stability of the structure was also reviewed during the removal of precast raker beams to investigate whether the structure was stable in the partially constructed state.

The 63 metre high light towers were dismantled in-situ in stages. BG&E provided the structural assessment of the structural steel light towers under the temporary load cases during the removal.

Nad Al Sheeba Racecourse

STRUCTURAL DESIGN & TEMPORARY WORKS

DUBAI, UNITED ARAB EMIRATES
CLIENT: CCL GULF PRESTRESSED CONCRETE

BG&E provided structural and construction engineering services for the development, including proposing a design that utilised flat duct slab stressing tendons, thereby only requiring lightweight mono-strand stressing equipment.

The original design by the main consultant proposed the use of multi-strand anchors and heavy stressing equipment. This system presented many logistical problems for the construction team as well as being an expensive option.

Some of the key elements of the design are set-out below:

- Spans for primary beams were up to 23 metres long and cantilevers up to 9.5 metres long, as well as in some cases, beams required to support transfer columns.
- All post-tensioned beams were to be prepared to meet Class 2 design requirements, which essentially means that the concrete must remain uncracked.
- Very large columns that were highly reinforced, thus making it difficult to pass tendons through. There was a limitation of only two locations through which tendons could pass through columns.
- Our technical experts also undertook finite element analysis to assess the effects of restraint from large columns and cores on the final level of pre-compression in the beams and additional stressing was added to compensate for any losses of prestress. This was critical in achieving the Class 2 design requirements.
- By careful placement of tendons and anchors, all of the objectives of the design and construction were deployed.

At BG&E, we are united by a common purpose – we believe that truly great engineering takes curiosity, bravery and trust, and is the key to creating extraordinary built environments.

Our team of more than 700 highly skilled people, in offices across Australia, New Zealand, Singapore, the United Kingdom and Middle East, design and deliver engineering solutions for clients in the Property, Transport, Ports and Marine, Water, Defence, Energy and Resources sectors.

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