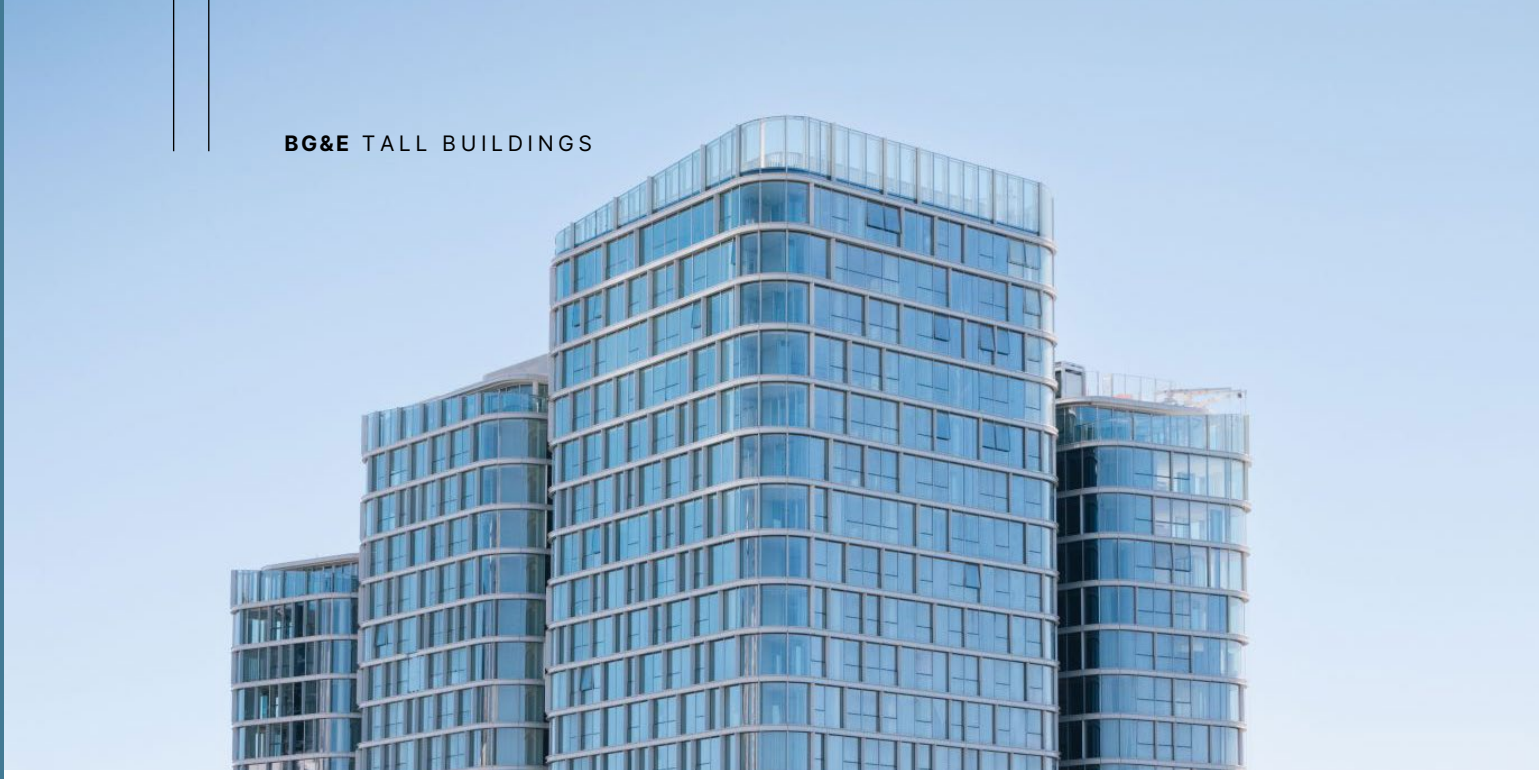
SECTOR CASE STUDY

Tall Buildings

One The Esplanade (Chevron Tower) — EQ Lot 7 — Perth, WA, Australia.

BG&E
Part of SYSTRA



35 STOREYS

AURA by Aqualand

STRUCTURAL | CIVIL

NORTH SYDNEY, NSW, AUSTRALIA
CLIENT: AQUALAND

BG&E provided structural and civil engineering services for AURA by Aqualand — a $1 billion, premium residential development on the site of the former headquarters of SAP at 168 Walker Street in North Sydney.

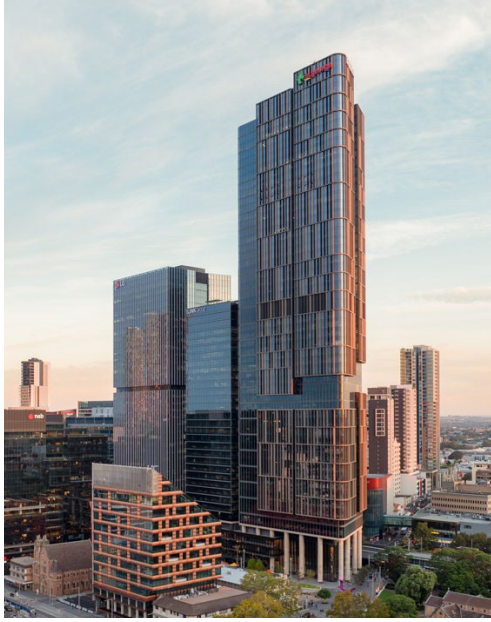
This project involved coordination with award-winning architects Woods Bagot, Richards Stanisich, and Webber Architects. The development includes:

- Four interconnected towers.
- 386 residential apartments.
- An enormous rooftop terrace.
- A community lounge and media rooms.
- A fitness centre.
- Commercial space.
- Prime retail areas.

Civil services included civil design, stormwater design, external footpath and driveway design, coordination with the council and the wider project team, and 3D surface modelling.

Structural services included design of a structural system with reinforced concrete core walls, columns, and post-tensioned slabs.

AURA's undulating façade, multi-towered design, and distinctive hourglass shape mark it as an iconic addition to Sydney's skyline.



20-63 STOREYS

Parramatta Square

STRUCTURAL | CIVIL | FLOODING & HYDROLOGY

PARRAMATTA, NSW, AUSTRALIA
CLIENT: WALKER CORPORATION

BG&E provided schematic design development in collaboration with the architect, as well as civil, flooding, and drainage engineering services from concept through to construction for Parramatta Square, a landmark project of major significance to the community.

Parramatta Square is a three hectare mixed-use precinct developed by Walker Corporation, consisting of a total of six stages and accommodating a mix of commercial, education, and retail developments.

3PS, 4PS, and 6PS/8PS are Class A commercial office towers with with a 5 Star rating, directly adjacent to the Parramatta Train Station and the main western train line.

Civil works included road design, pavement grading, stormwater drainage, subsoil drainage design, utility coordination, water sensitive urban design, and erosion and sediment control.

BG&E was commissioned to undertake a flood assessment of the site to consider local overland and mainstream flooding from the Parramatta River. This involved developing a 2D hydraulic model, preparing flood maps and reports as well as scenarios that informed design, and diverting lunch trunk stormwater drainage infrastructure to accommodate site development.

35 STOREYS

9-25 Commonwealth Street, Edition Residences

STRUCTURAL

SYDNEY, NSW, AUSTRALIA
CLIENT: WR SYDNEY

Located in Sydney's vibrant Surry Hills, 9-25 Commonwealth Street is a 35 storey tower comprising four underground car-park floors, ground floor retail, a boutique 13 floor hotel, and luxury residential apartments.

BG&E provided structural engineering services for the $55 million high-rise development. Key features include:

- A slender mixed-use tower design.
- Transferring core walls.
- Car lifts in lieu of conventional ramps in the basements.
- A truck turntable in the loading dock.
- Post-tensioned concrete floors.
- A 15 metre high façade truss on the roof.

37 STOREYS

Castle Residences

STRUCTURAL CIVIL

SYDNEY, NSW, AUSTRALIA
CLIENT: UNITED DEVELOPMENTS SYDNEY

BG&E provided structural and civil engineering services for Castle Residences and The Porter House Hotel, a mixed-use development in the heart of Sydney with a unique design — a 37 storey tower cantilevering over the heritage-listed Porter House building, originally built in 1876.

The slender composite tower comprises both hotel and residential levels, supported by an eight storey basement. At level 11, the tower cantilevers 10 metres over the historic Porter House, with three concealed four storey steel trusses supporting the 27 storeys above.

Located on the corner of Castlereagh and Bathurst Street, the site required a soldier pile retention wall along its full perimeter, designed to accommodate the adjacent heritage structure and Roads and Maritime Services interface.

The foundation system was developed above the Cross City Tunnel (CCT) that runs approximately 20 metres below the bulk excavation level. During construction, a Sydney Metro tunnel was also excavated parallel to the site, five metres from the eastern rock face.

The project was designed in accordance with RMS Technical Direction for Deep Excavations (GTD2012/001), with excavation depths reaching up to 25 metres.

25 & 52 STOREYS

EQ West — EQ Lots 2 & 3

STRUCTURAL CIVIL

PERTH, WA, AUSTRALIA
CLIENT: CA CORPORATION

The $300 million development of Lots 2 and 3 Elizabeth Quay (EQ West) represents a key component in realising the vision for one of Perth's premier inner-city precincts.

BG&E provided structural and civil engineering services for this contemporary mixed-use development.

EQ West comprises:

- 182 metre, 54 storey residential tower.
- 100 metre, 27 storey mixed-use tower.
- Four basement car parking levels.

Together, they comprise 493 residential apartments, a 190 room hotel, contemporary commercial space, end-of-trip facilities, an art gallery and viewing deck, back-of-house facilities, and car parking.

The tower floors have been designed with post-tensioned concrete slabs, and the buildings' lateral stability is provided by the lift and stairwell cores with supplementary shear walls. A mass damper is provided at the upper level of the residential tower to control building horizontal accelerations under service winds.

The four basement levels are fully submerged below the water table. Diaphragm walls and hydrostatic slabs designed to resist up to 120 kPa of water pressure form the basement walls and lower slabs.

37 STOREYS

EY Centre

STRUCTURAL

SYDNEY, NSW, AUSTRALIA
CLIENT: MIRVAC

Designed by leading architects Francis-Jones Morehen Thorp, the EY Centre at 200 George Street is a landmark of Sydney's skyline. BG&E provided structural design services, full temporary works design, and construction methodology advice.

The high-rise comprises 37 floors and five basement levels, delivering 115 metres in height and 38,000 square metres of premium office space.

Key features:

- Post-tensioned composite banded concrete floors and transfer beams.
- Pure tension transfer columns suspending multiple levels from upper decks.
- A four level lobby supported by 22 metre architecturally inspired slender composite "Y" transfer columns.
- Varying floor plate geometry.
- Challenging excavation methodology.
- Efficient design using high-strength, high-performance concrete, made possible by advice from BG&E's Materials team.
- Lateral stability achieved through an eccentric cantilevering concrete core.

54 STOREYS

Quay Quarter Tower

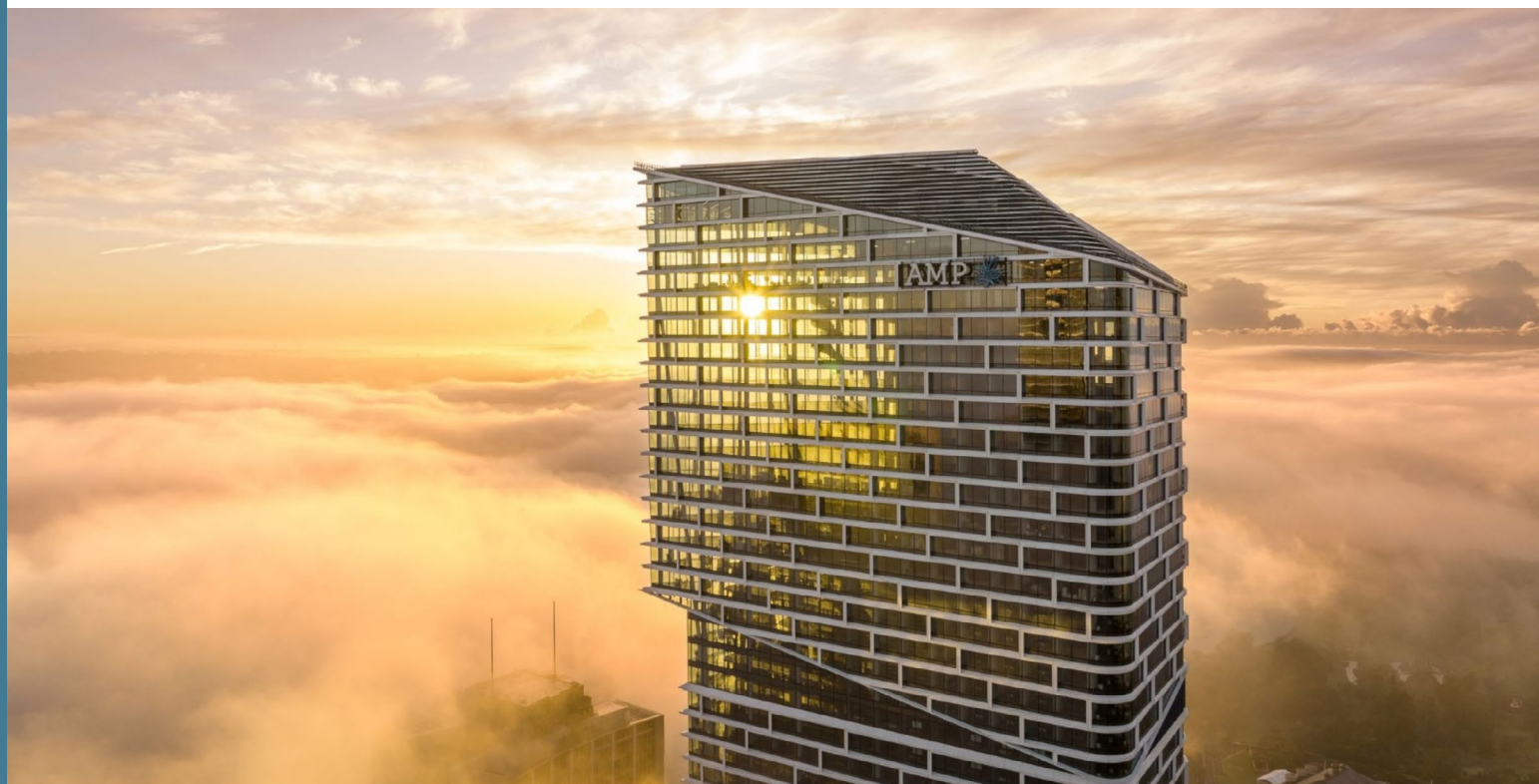
STRUCTURAL | CONSTRUCTION ENGINEERING | MATERIALS & DURABILITY | SUSTAINABILITY

SYDNEY, NSW, AUSTRALIA
CLIENT: DEXUS

The Quay Quarter Tower (QQT) project comprised conversion of a 50-year-old, 45 storey asset into a highly sustainable commercial vertical village, wildly recognised as the largest adaptive reuse project in the world.

BG&E played the key role in transforming the architect's ambitious vision into a constructible solution through our structural, construction, materials, and sustainability services from concept to completion.

In a construction world-first, one side of the tower was demolished and reconstructed while the other side of the tower was retained and refurbished simultaneously — enabling significant environmental and operational efficiencies.

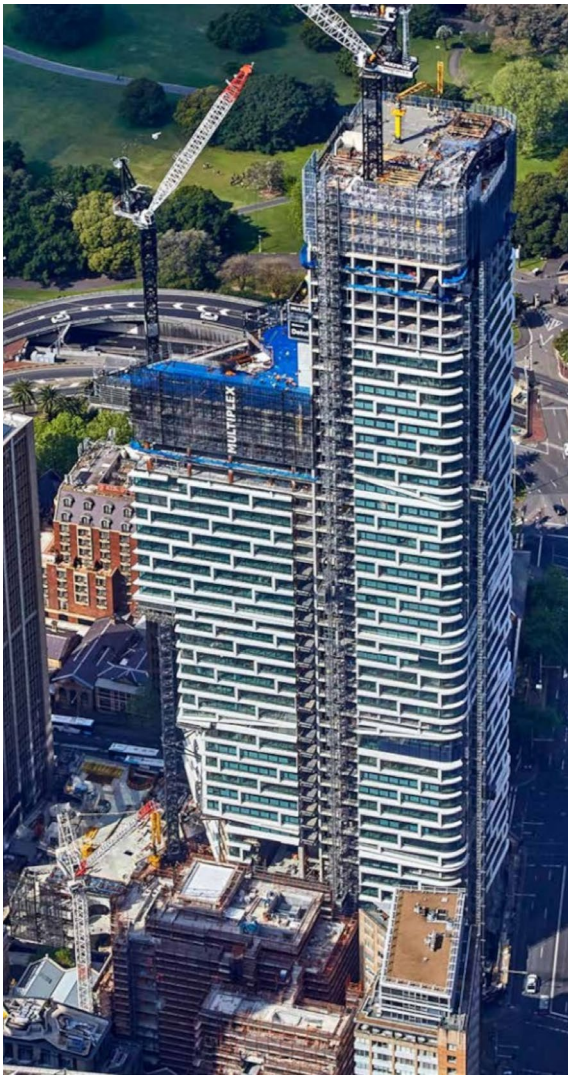


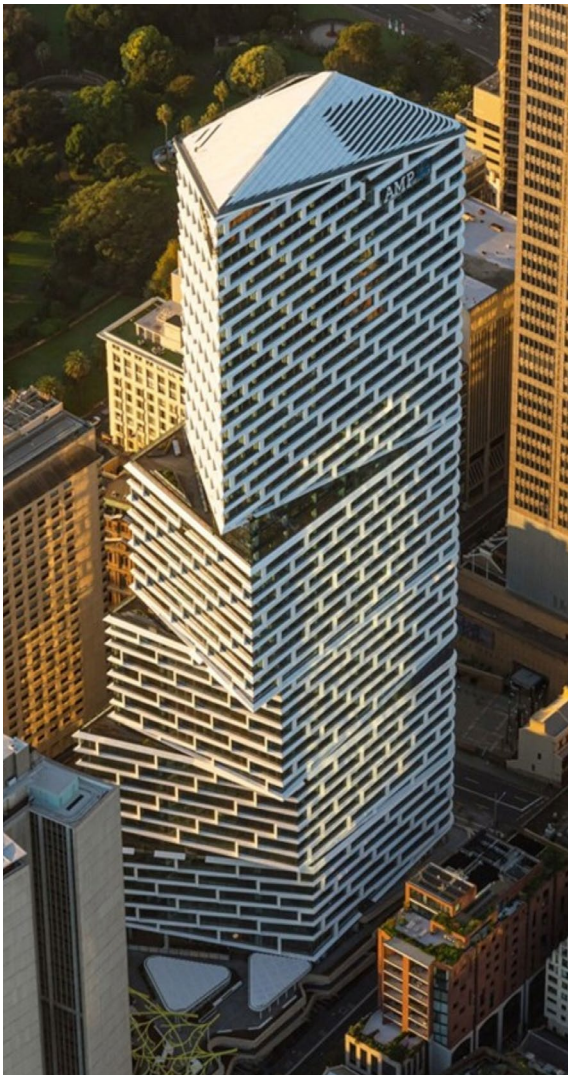
During the upcycle of the existing building, around two-thirds of the towers original core were retained — conserving approximately 12,000 tonnes of embodied carbon.

The upcycled QQT now boasts doubled usable area and user accommodations, compared to the original tower — from 45,000 to 102,000 square metres of usable area, and from 2,500 to 9,000 user accommodations, respectively.

Awarded the 'World Building of the Year' at the 2022 World Architecture Festival (WAF) in Lisbon and the prestigious 2022/23 International High-Rise Award — these accolades highlight the extraordinary transformation and sustainability of the project, setting a new global standard in adaptive reuse.

Quay Quarter Tower - Sydney, NSW, Australia.





63-85 STOREYS

West Side Place

FAÇADE

MELBOURNE, VIC, AUSTRALIA
CLIENT: FAR EAST CONSORTIUM

BG&E Façade Consultants led the visionary design for West Side Place, a $2.5 billion landmark mixed-use development at 250 Spencer Street, Melbourne, featuring Australia's largest bluestone façade installation to date.

This development comprises four luxury towers (ranging from 63 to 85 storeys) housing 2,853 luxe apartments, connected by a 10 storey podium with a ground floor lobby, 3,000 square metres of retail space, and basement parking.

Tower 1 is the pinnacle — rising 270 metres as Melbourne's second tallest building, with the upper 15 levels hosting the flagship Ritz-Carlton Hotel and the remainder high-end residential apartments.

BG&E delivered complex and innovative façade typology services, including tensile cable structures façades, different façades materiality, and modular façade systems.

The façade is characterised by its tessellated articulation and consists of a complex unitised curtain wall with sloped and folded panel types. The podium façades feature bluestone panels meticulously installed as a curtain wall system — the result of rigorous testing and innovative methodology to ensure the installation meets stringent structural and safety design requirements.

65 STOREYS

Addax Tower

STRUCTURAL

ABU DHABI, UNITED ARAB EMIRATES
CLIENT: MULTIPLEX

The Addax Tower is a $320 million iconic high-rise commercial tower that forms part of a grand waterfront mixed-use development on Al Reem Island, approximately one kilometre from Abu Dhabi's CBD.

BG&E provided structural engineering services for Addax Tower, a 266 metre tall skyscraper that is one of Abu Dhabi's tallest buildings. The tower was constructed using reinforced and post-tensioned concrete and is enclosed in a striking aluminum and glass façade.

The development comprises 65 storeys of office space, a 26 storey hotel, a six level car park, and three basement levels. Together with its adjoining podium, Addax Tower has a total floor area of approximately 240,000 square metres.

48 STOREYS

Grosvenor House

STRUCTURAL

DUBAI, UNITED ARAB EMIRATES
CLIENT: SHEIKH AHMED BIN SAEED AL MAKTOUM

BG&E provided structural design engineering services for Grosvenor House — Tower 1, the first hotel to open in the iconic Dubai Marina.

Standing at 210 metres or 48 storeys, the high-rise structure comprises a five star hotel and serviced apartments, as well as luxurious conference, banquet, and food and beverage facilities.

Occupying an 8,000 square metre plot at the northern mouth of the Dubai Marina, the three storey basement construction made use of proprietary precast planks alongside precast band beams and a composite structural concrete topping. This process enabled the efficient construction of the three below ground floor levels and early commencement of the superstructure.

The vertical elements — columns, cores, and shear walls — were constructed using high-strength concrete, drawing on experience gained by BG&E's Buildings team from the construction of the Emirates Tower project. This approach reduced reinforcement requirements and bar diameters, facilitating off-site prefabrication of column wall and reinforcement cages.

80 STOREYS

JW Marriott Marquis Hotel

STRUCTURAL

DUBAI, UNITED ARAB EMIRATES
CLIENT: EMIRATES GROUP

Upon completion in 2012, this awe-inspiring development was the world's second tallest hotel, with twin-tower skyscrapers standing 355 metres high in Dubai's skyline.

BG&E provided structural engineering services for the high-rises that include the following key features:

- Twin concrete-frame towers on piled raft foundations.
- Glazed guest lifts in the 80 storey towers.
- Expansive podium areas with tall, unrestrained tower columns.
- Stability via the use of a concrete core and outrigger walls.
- Transfer structures at first hotel floors above the podium.
- Post-tensioned flat plate slabs.

This timeless luxury hotel features 1,364 guest rooms, 240 suites, four Presidential Suites, a banquet hall, an auditorium, 18 specialty retail stores, 19 restaurants, and a day spa, all surrounded by perfectly manicured landscaping.

10-46 STOREYS

Jumeirah Beach Residences

STRUCTURAL

DUBAI, UNITED ARAB EMIRATES
CLIENT: DUBAI TECHNOLOGY, ELECTRONIC COMMERCE & MEDIA FREE ZONE AUTHORITY

BG&E provided structural engineering services for Jumeirah Beach Residences — the foundation of a thriving waterfront community on Dubai's coastline that comprises 35 residential towers and four hotels on shared podium sprawled across a 230,000 square metre site.

The tower buildings and hotels range from 10 to 46 levels, above a four to five level podium that covers most of the site.

BG&E provided the Theme Architect with master planning and schematic design, while detailed designs for four of the tallest buildings were delivered for the Dubai Technology, Electronic Commerce and Media Free Zone Authority.

The elongated site, about 1.7 kilometres long and width varying between 70 metres and 200 metres, lies between the Dubai Marina and the coast adjacent to the Hilton Dubai Jumeirah, Sheraton Jumeirah Beach, Ritz Carlton, Oasis Beach, Metropolitan Resort, and Le Royal Meridian hotels — all meccas for the thousands of visitors to one of the most popular Middle Eastern destinations.

85 STOREYS

The Index

STRUCTURAL

DUBAI, UNITED ARAB EMIRATES
CLIENT: UNION PROPERTIES

The Index is a 328 metre tall skyscraper in the heart of Dubai's International Financial Centre, featuring 50 residential storeys and 30 commercial storeys on top of a four storey lobby and a five storey underground basement.

The tower is oriented on an east-west axis, enabling the structures concrete core to protect internal spaces from the low-angle desert sun while the south façade incorporates extensive sunshades to reduce solar gain.

BG&E provided structural engineering services, including:

- An innovative 300 metre high double portal concrete frame and attenuated buttress walls to optimise stability.
- Large transfer structures at mid-height.
- Prestressed concrete floors.
- Reinforced bored piled raft foundations.
- A seven level basement excavation designed for variable sand conditions and a high-water table, resisted by tension piles.
- A predominantly glazed curtain wall façade with highly detailed precast cladding.

21 STOREYS

The Opus

STRUCTURAL

DUBAI, UNITED ARAB EMIRATES
CLIENT: BROOKFIELD MULTIPLEX

BG&E provided structural engineering services to the Opus, a mirrored glass building designed by the late architectural legend, Dame Zaha Hadid. It consists of two 21 storey towers connected at roof level by a six storey deep composite sky bridge and six basement levels.

Due to the unusual shape of the building, BG&E developed an innovative construction methodology for the bridge assembly, podium, and temporary platform on the bridges underside that enabled façade installation.

The groundbreaking segmental construction sequence for the bridge involved building main trusses and external façade grids bottom-up.

Upon releasing temporary diagonal members, load paths transitioned from temporary to permanent, forming a "top-hung" structure. This innovative approach enabled simultaneous work in various locations across the site, allowed the use of lower-capacity cranes, reduced steel segment tonnage, and minimised construction time and overall construction cost.

Other innovative design outcomes achieved by BG&E include:

- Saved three months in construction time by revising the footing design and eliminating 240 piles.
- Reduced reinforcement by 30% and saved over 60 tonnes of material by incorporating an isolation strip in the hydrostatic slab to prevent differential settlement stress.
- Improved constructability and reduced the program time by designing flat floor slabs that eliminated the need for edge and cross beams.
- Removed podium and link bridge complexities from the critical path by shifting to composite steel construction.
- Expedited tower completion by enabling three simultaneous construction fronts.
- Optimised construction sequencing by minimising temporary diaphragm actions.
- Developed innovative connection details to facilitate bottom-up construction with a significant portion hanging in the permanent case, as the segmentally launched sky bridge didn't require propping, enabling uninterrupted work on the podium below.
- Designed a temporary steel bridge platform to support façade installation.

The Opus —
Dubai, United Arab Emirates.

71 STOREYS

Vision Tower

STRUCTURAL

DUBAI, UNITED ARAB EMIRATES
CLIENT: DUBAI PROPERTIES

Vision tower is a slender 260 metre tall tower with sloping façade located in the prestigious Business Bay district of Dubai.

Vision tower comprises a 71 storey tower with 51 commercial storeys, 14 carpark storeys, and six general usage storeys in the tower, as well as 14 adjacent carpark storeys.

The façade includes predominately glazed curtain walls with a sloping illuminated light box feature above the entrance lobby.

Features:

- Extensive wind engineering to achieve acceptable building movements.
- Eccentric core box, sway-frame, and outriggers utilised to stabilise building.
- Banded prestressed concrete floors.
- Reinforced bored piled raft foundations.
- 17 metre clear span carpark.

62 STOREYS

22 Bishopgate

CONSTRUCTION ENGINEERING

LONDON, UNITED KINGDOM
CLIENT: CAREYS DESIGN TEAM

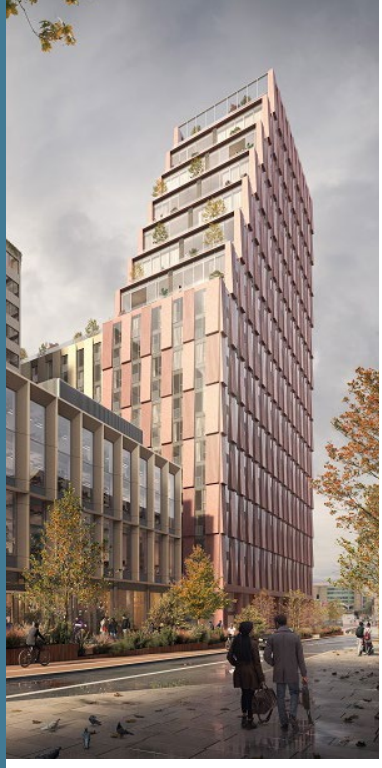
Standing at 278 metres tall, 22 Bishopsgate, also known as Twentytwo, is a commercial skyscraper located in London's financial district and comprising state-of-art commercial workspace, a sky bar, viewing gallery and restaurants.

BG&E provided construction engineering services for the 62 storey tower, including temporary works design. BG&E's Construction Engineering team developed in-situ modification designs to the jump-form that allowed the core structure to be built simultaneously, alongside the basement demolition and construction work.

The jump was split in two, with constant access secured between the two jumps, providing greater flexibility for the construction team. This approach was a critical factor in starting the building works and mitigating the path of the basement works. Due to the unusual size of the rig, a complete modelling of the rig, the screens, equipment, ergonomics and access, had to be developed to confirm they meet with local regulations.

The modelling that was deployed for this iconic project enabled the all parties to provide input for the design at an early stage, via the use of immersive virtual reality which demonstrated how the rig worked.

22 Bishopsgate is an imaginative and collaborative workspace for thousands of Londoners.



27 STOREYS

Renaissance Hotel

STRUCTURAL | FAÇADE | MATERIALS & DURABILITY

MANCHESTER, UNITED KINGDOM
CLIENT: PROPERTY ALLIANCE GROUP

The four star Renaissance Hotel in Manchester has been closed since July 2020, in anticipation of an ambitious redevelopment by Property Alliance Group. Instead of taking the traditional demolish and rebuild route, the original hotel tower will be retained, undergoing restoration and upcycling.

BG&E is providing structural engineering and materials technology services for the refurbishment project.

The revamped 216 room hotel, part of SH Hotels & Resorts, will operate under the "Treehouse" brand. This project is a key component of the £181.6 million redevelopment plan for the Deansgate site, marking the second Treehouse Hotel in the United Kingdom, after the first in London.

Our innovative technical solutions will significantly cut the development's embodied carbon emissions, facilitating owners and operators in achieving BREEAM Certification.

The forecasted environmental benefits are substantial, projecting a remarkable 40% reduction in CO_2 compared to constructing a new hotel of the same size.

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 800 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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