

His Majesty's Theatre –
Perth, WA, Australia.

SECTOR CASE STUDY

Heritage

OPPORTUNITIES
THROUGH
EXCELLENCE

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BG
&E

333 Kent Street

SYDNEY, NSW, AUSTRALIA
CLIENT: FDC



The revitalisation of a 1980's Sydney merchant house at 333 Kent Street has transformed this site into a state-of-the-art workplace designed for 2024 and beyond.

This \$400 million office tower redevelopment project seamlessly merges past and future, maintaining the integrity of the original superstructure - a nine-level building with a ground and mezzanine level, while implementing significant internal and external alterations – including seven additional stories and a new commercial facade while retaining the heritage facade.

BG&E provided comprehensive material testing, construction engineering, and structural engineering services from concept to completion.

Our work involved in-situ testing and investigation and analysis of the existing building's concrete properties to preserve the original structural elements. A key challenge was strengthening the structure to meet the latest design code, and we ensured compliance through preparing performance solutions.

The project emphasised adaptive reuse and sustainability, delivering a carbon-efficient design solution while upcycling the iconic existing structure into an A-Grade commercial building in the heart of Sydney's CBD.

Anden, Coogee

SYDNEY, NSW, AUSTRALIA
CLIENT: CENTRAL ELEMENT



Located on Oberon Street Coogee, Anden comprised the development of 15 residential apartments while retaining the original heritage facade and introducing a new 'L' shaped structure and basement to the building.

BG&E provided structural engineering services for the project, which was completed in 2023.

The heritage facade and streetscape were carefully preserved - ensuring the neighbourhood's unique character remained intact. The development and landscaping integrated various sustainability and well-being design elements.

Anden won the 2023 UDIA NSW & Coronation Property Awards for Excellence in the Medium Density Development category.



Holiday Inn Darling Harbour

SYDNEY, NSW, AUSTRALIA

CLIENT: TUSCAN CORPORATION C/- GOLDEN SWAN INVESTMENTS

Originally constructed in 1890, this heritage building in Darling Harbour precinct has been transformed into the largest Holiday Inn in Australia.

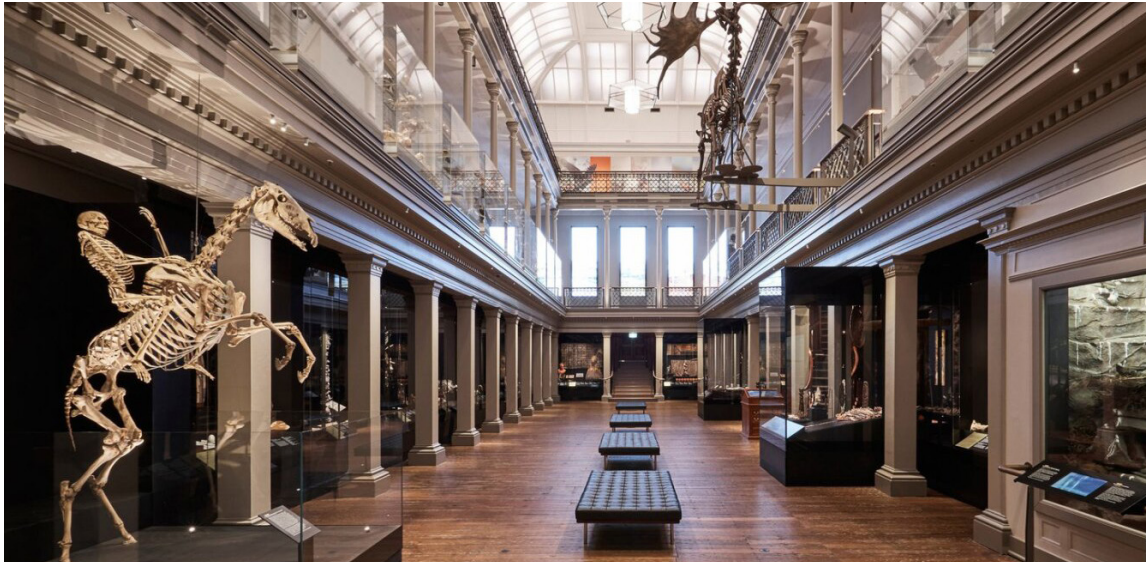
The refurbishment included the construction of three additional storeys above the existing nine storeys, whilst the building remained fully operational during construction.

The proposed additional loads required a total review of the existing building structure, including pile foundations, columns and transfer beams. Various structural options were considered for the new extension and a lightweight mix of timber and steelwork

construction resulted to be the most cost-effective solution. The design had minimal strengthening of select transfer beams and columns, with no impact on the existing hotel layout. The additional three storeys provided a significant increase of the seismic loads to the building, that had been constructed prior to the requirement for seismic loading. This required strengthening for full compliance to the current earthquake code.

Long Gallery - Australian Museum

SYDNEY, NSW, AUSTRALIA
CLIENT: AUSTRALIAN MUSEUM



In 2018, the restoration of Australia's oldest public museum gallery, known as the Long Gallery at the Australian Museum in Sydney, was successfully completed. This historic gallery spans three stories and features a central atrium.

The magnificently restored Westpac Long Gallery houses the 200 Treasures of the Australian Museum - comprising 100 treasures of the Australian Museum alongside the stories of 100 of Australia's most-influential people.

BG&E provided the structural engineering services for the refurbishment, including:

- Investigation and loading assessment of the existing timber framed floors.
- Temporary and permanent works design of entrance door widening.

- Design of bespoke new balustrades, including their anchorage to the existing timber floor structure.

The refurbishment breathed new life into the gallery, ensuring its safety for both specialty museum displays and patrons. This remarkable restoration project was honoured with The National Trust Heritage Award for Built Heritage in May 2018.

Maitland Administration Centre

MAITLAND, NSW, AUSTRALIA
CLIENT: MAITLAND CITY COUNCIL



To accommodate the rapid growth of Maitland, the City Council has established the Maitland Administration Centre, specifically designed to address the needs of their expanding community. The Administration Centre is located across the road from the Maitland Regional Art Gallery and incorporates the 19th century Town Hall Cafe. Redevelopment works ran from 2019 to 2022.

BG&E provided structural and civil design services from concept to tender stage for the alterations and extensions undertaken. The design process included the adaptation of culturally significant heritage assets into new office spaces as well as the design of a new two storey office space connecting into the existing buildings on the site.

Structural design undertaken at the site utilised flat plate post-tensioned concrete slabs with a lightweight steel roof to satisfy the large spans and open plan design proposed for the site. The structure was founded on piles in challenging ground conditions. Alterations undertaken on the existing structures involved the use of lightweight structural steel framing to minimise additional loads imposed on the existing footings.

Mudgee Art Gallery

MUDGEE, NSW, AUSTRALIA
CLIENT: NSW GOVERNMENT



Located in Mudgee, central New South Wales, the Mudgee Art Gallery is an integral component of the newly developed \$8.1 million world-class arts precinct, which serves as a platform for nurturing the town's abundant arts and cultural legacy.

BG&E collaborated with the NSW Government to deliver the Mudgee Art Gallery, which aims to showcase the work of local talent and attract some 691,000 visitors to the region annually.

Our highly skilled team provided civil, structural, and construction engineering services to enable the adaptive reuse of an existing municipal building with heritage characteristics into a modern regional art gallery.

BG&E's technical expertise supported the distinctive architectural features, including

moveable internal partitions and a stepped roof and facade. All structural modifications of the existing building upheld best-practice heritage design, preserving the original building for future generations.

Flood design work was also provided, which encompassed the new and existing buildings and the surrounding street works.

The Mudgee Art Gallery answers the community's call for a facility that proudly features local talent and shares the region's rich cultural history.

Oxford Street Hotel

SYDNEY, NSW, AUSTRALIA
CLIENT: BOSTON GLOBAL



In 2022, a \$200 million revitalisation project for Sydney's Oxford Street was given the green light. West's Olympia Theatre at One Oxford Street in Paddington is one of three heritage blocks that received approval to be transformed from a heritage cinema into a boutique hotel.

Oxford Street Hotel required flexibility in design to accommodate latent and changing site conditions. The project comprised top-down construction, including plunge columns, slabs confined within retained heritage walls, and a construction platform. Temporary works challenges were exacerbated by restricted site access.

BG&E provided a structural engineering assessment report for the building plan approval, alongside structural and facade design services to retain the heritage facade.

The successful retention of the heritage facade required significant strengthening, demolition, and temporary works, while navigating the complexity of Busby's Bore - a heritage Sydney Water asset that passed through the centre of the site with an unknown location.

To overcome this challenge, we refined the foundation design and made on-site modifications to the shoring piles with rock anchors to accommodate the ground conditions, neighbouring properties, the existing structure, and Busby's Bore, to mitigate any potential impact on it.

Plumbers Workshop

SYDNEY, NSW, AUSTRALIA
CLIENT: ROSE GROUP



Based in the Local Government Area of Concord, the former Mortlake Gasworks operated from 1883 to 1990, during which time it provided the surrounding community with considerable employment. The heritage building has been retrofitted into a modern residential building that consists of 14 exceptional homes, designed to revere the buildings heritage and unique industrial style.

BG&E provided structural engineering and materials testing services, including investigation and existing structural assessments. Our team also contributed to the preliminary and detailed design, and the construction phase.

The key aspects of the works included:

- Repurposing the 1850's masonry structure.
- Installing new light-weight floors.

- Installing a new mansard roof.
- Seismic assessment of existing masonry elements, using in-situ test results.
- Strengthening of existing foundations.
- Verification of existing concrete floor.

This former gas fitters' workshop in Breakfast Point has been revitalised and certification of the redevelopment was achieved by applying a performance-based design approach.

Rosebery Engine Yards

ROSEBERY, NSW, AUSTRALIA
CLIENT: GOODMAN



The Rosebery Engine Yard project by Goodman is an adaptive reuse development – transforming the existing engine yard into a modern, sustainable hub that features boutique commercial workspaces, showroom, and food and beverage spaces for lease.

BG&E oversaw the structural design and upgrades for existing heritage structures and industrial features, which encompassed retaining the timber framework, existing windows, original sawtooth roofing, and exposed brickwork.

Slated to be completed in 2024, the project aims to revitalise the site, incorporating sustainable and modern design principles to create a vibrant environment that caters to both business and community needs.

The project is targeting 5 star ratings for NABERS and Green Star Design and As Built v1.3.

Tramsheds Harold Park

SYDNEY, NSW, AUSTRALIA

CLIENT: MIRVAC



Originally constructed in 1904 as the Rozelle Tram Depot, this site has been revitalised and transformed into a vibrant multifunctional hub known as Tramsheds Harold Park. It now serves local and international visitors as a European inspired food hall that also features a community centre, community garden, and a flexi-space, dubbed Artisan Lane, which houses an industrial sized kitchen and communal seating area.

BG&E provided structural engineering and materials testing services, specifically:

- Assessing the condition and potential re-use of the existing steel roof structure.
- Detailing of the refurbishment requirements of existing structural steel beams to be re-used.
- Detailing of in-ground services concealed within the structural floor slabs and steel columns.
- Future-proofing suspended on-grade slabs for future retail reconfiguration.
- Detailing of new steel trusses and columns to match the previous dilapidated heritage steelwork.
- Designing a 20 metre span steel arch pedestrian bridge.

In delivering the scope of works, the facade was temporarily braced/propped during construction while the existing steel roof was demolished.

Our highly skilled team also undertook site testing on the existing heritage steel including hardness testing to determine the type of steel, yield, and tensile strength. The heavily pitted and corroded sections of the existing heritage steel beams were strengthened and refurbished offsite and transported back to site.

The building is located on both bedrock and deep alluvial fill, hence complex underpinning of the heritage masonry walls and footings were required.

Staying true to the heritage building's roots, Tramsheds has been carefully restored and is a shining example of an authentic, highly considered heritage restoration project.



*Tramsheds Harold Park –
Sydney, NSW, Australia.*



Quay Quarter Tower

SYDNEY, NSW, AUSTRALIA
CLIENT: AMP CAPITAL

BG&E provided structural and construction engineering services (including permanent and temporary works) and materials testing services (including highly complex modelling and analysis) to Quay Quarter Tower (QQT) - a highly sustainable commercial vertical village that is recognised as the largest adaptive reuse project in the world.

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.

Features:

- 52 stories and five basement levels.
- 220-metres tall.
- Eight-metres floor to floor.
- Eight to 15-metre column grids
- Composite columns (concrete filled steel tubes).
- Composite floor construction.
- Demolition of approximately one-third of existing floor plate over full height of building to allow significant floor plate extension works.
- Irregular/varying floor plate up the building – no “typical” floors.
- Extension and strengthening of existing core for lateral stability.
- Raking columns forming part of complex transfer structures with columns being hung from the roof across 20+ floors.

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

The global recognition bestowed upon QQT is a testament to its remarkable achievement. It was awarded the 'World Building of the Year' at the 2022 World Architecture Festival (WAF) in Lisbon and received 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.

The upcycle of the existing AMP centre tower into QQT has set a new global standard in adaptive reuse, bearing testament to an ambitious team, innovative design, and technical engineering excellence – with the result being a saving of over 12,000 tonnes of embodied carbon when compared to the traditional demolish and rebuild route.



*Quay Quarter Tower –
Sydney, NSW, Australia.*



Olderfleet

MELBOURNE, VIC, AUSTRALIA
CLIENT: GRIMSHAW

Located at 477 Collins Street in Melbourne, Olderfleet is an enormous premium office building spanning 58,000sqm.

The 40-storey tower seamlessly integrates a modern commercial structure with one of the city's most important pieces of heritage architecture, the Olderfleet buildings.

BG&E's facade team provided the facade design and engineering services, including reviewing the facade documentation, testing of the facade, visual mock-ups, and site inspections.

This modern workplace destination includes smart technology, leading sustainability elements, end-of-trip amenities, a cocktail bar, business lounge, several dining options and an in-house concierge.



St Mary's Cathedral

PERTH, WA, AUSTRALIA

CLIENT: PETER QUINN ARCHITECTS

St. Mary's Cathedral, a heritage building at the heart of Victoria Square in Perth, has a rich history. Originally built in two stages, in 1865 and 1930, it underwent a significant redevelopment in 2006. This renovation included the preservation of the existing structure and the addition of new elements both above and below ground.

Today, St. Mary's Cathedral stands as a true architectural gem, featuring a striking curved design and an impressive second spire - ensuring the building remains a hallmark of architectural elegance.

BG&E provided structural engineering for the \$35.2 million redevelopment, which encompasses a multi-functional basement level and a new ground level assembly area. The basement works comprised in-situ, reinforced concrete framing, and the new assembly area included the mixed use of structural steelwork and precast concrete. A significant amount of the structure was precast.

The partial demolition of the existing cathedral required the use of complex, permanent retention systems for the existing foundation and wall elements.



WA Museum Boola Bardip

PERTH, WA, AUSTRALIA

CLIENT: WESTERN AUSTRALIA STATE GOVERNMENT

The WA Museum Boola Bardip formally opened on 21 November 2020 in the Perth Cultural Centre, the State's premier cultural hub which houses its scientific and cultural collections.

The name 'Boola Bardip' pays homage to the local First Nations people's history and deep connection to their country. In Whadjuk Nyoongar, it means 'many stories,' reflecting the rich cultural heritage of the land where the museum stands.

BG&E provided structural and civil engineering services for this important building where stories are shared. The dramatic design links contemporary architecture with the historic and heritage-listed buildings, creating a visual landmark for the State. Column-free gallery spaces are elevated 15 metres above ground over clear external pedestrian areas of 40 metres x 50 metres, and over the top of an existing heritage building, requiring a long span and cantilevering structure.

DETAILS:

- Gallery floors were designed for total imposed loads of 14.5 kilopascals and 120 kilonewtons concentrated loads with stringent deflection and vibration acceptance criteria.
- Gallery floors comprise composite steel floors spanning 20 metres on two, two-storey high fabricated structural steel trusses. These trusses are located within wall lines and vary in depth - between seven metres and 15 metres.
- The trusses span up to 45 metres with a 17 metre cantilever where the new building is located over the existing heritage building.
- To minimise overall steel tonnage, high-strength 450-grade steel plate was used in the trusses.
- Columns are a mix of reinforced concrete and composite steel/concrete.



*WA Museum Boola Bardip –
Perth, WA, Australia.*

General Post Office (GPO)

PERTH, WA, AUSTRALIA

CLIENT: BROAD CONSTRUCTION



Australia Post undertook a \$20 million transformation of their historic General Post Office (GPO) building in the city centre. Originally completed in 1923, the GPO is a heritage landmark building in Perth - located in the city's central business district, its imposing stone facade is in the Beaux-Arts style.

The development connects to the William Street train station and includes seven floors of commercial space, as well as ground-floor retail of approximately 1,000 sqm.

BG&E provided structural engineering services for this significant civic space, which included a new atrium roof over the top of an existing light well, sky bridges linking the atrium at four

different floor levels, demolition of the original lift shaft, construction of a new shaft with three lifts, and the associated upgrade of the building's services.

The design followed similar principles to those deployed at the GPO redevelopments in Sydney and Melbourne.

His Majesty's Theatre

PERTH, WA, AUSTRALIA

CLIENT: WESTERN AUSTRALIAN DEPARTMENT OF CULTURE AND THE ARTS

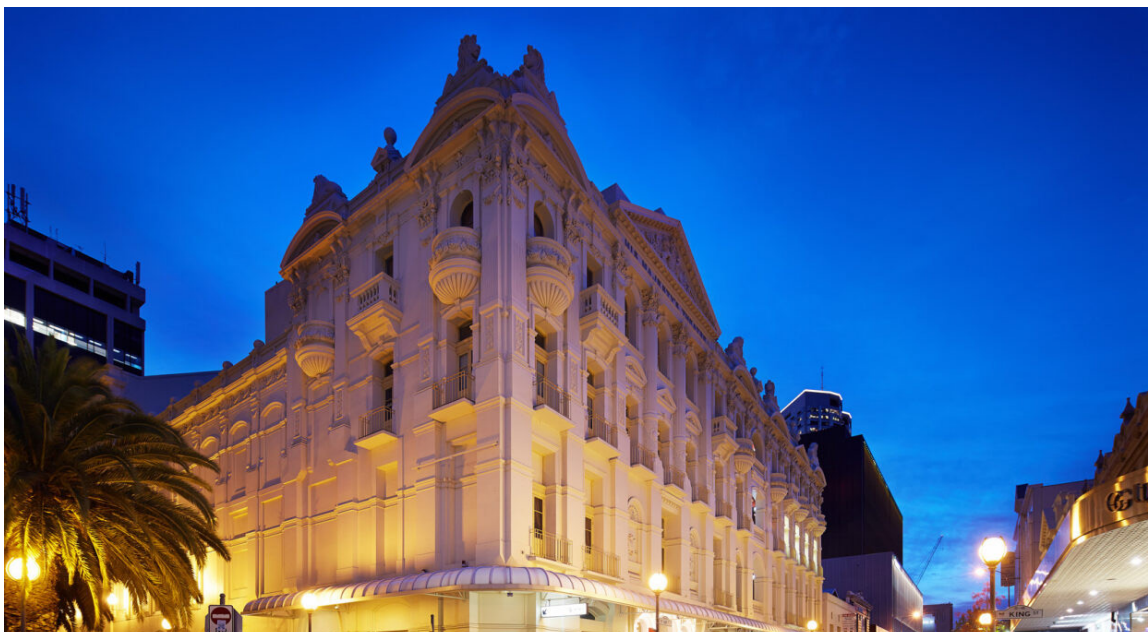
BG&E was engaged as structural engineers for the complete facade restoration works. The entire site is included in the Register of Heritage Places. Our team worked to carefully consider the age and nature of construction, with the preservation of the authentic fabric taking precedence over any cosmetic considerations.

Structural engineering services were completed following an extensive investigation of the original building materials and the structural system, complicated by the fact that the building fabric and the modified natural fabric had often been changed and added to over time. As a general principle, the maintenance and reconstruction works were

completed on the basis that any replacement of material or items was done by replacing like-with-like. Preferably, the new item was to be matched to the one it was to replace in terms of material, style, pattern, finish, and colour. This included reconstruction of the Juliette balconies and ornamental floral features.

The repair work did not introduce materials and components that were not part of the original fabric of the building. If a feature had to be replaced, it was replaced with a replica.

Managed by the Perth Theatre Trust, His Majesty's Theatre is a beacon for residents and visitors to soak up performing arts from some of the world's leading theatre companies.





The Old Pickle Factory

LEEDERVILLE, WA, AUSTRALIA

Located in Leederville, the original warehouse building, built in the early 1960s and locally known as the Pickle Factory, was a two-level administrative block that comprised an expansive warehouse space suspended over storage areas on the ground level. This heritage structure was repurposed into an industrial chic event space that can hold up to 400 people, situated in the heart of the burgeoning arts hub, The Pickle District, in West Perth.

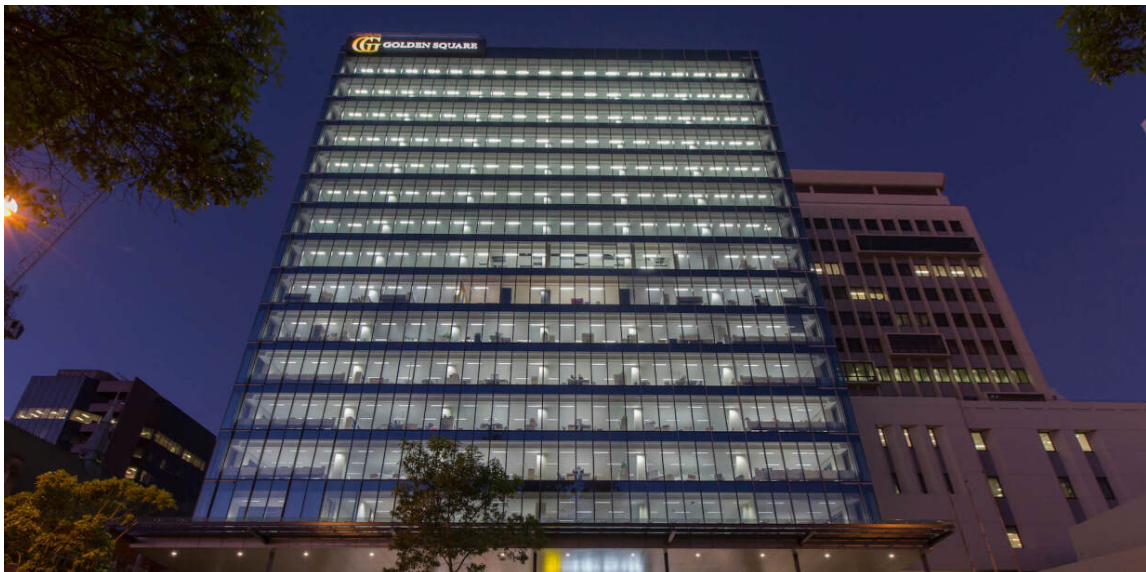
The architectural planning for the building depicted extensive refurbishment of internal spaces, including a double-level restaurant and bar proposed for the existing warehouse space, and a new floor void which creates stair access

to the repurposed storage area. The external envelope of the building received significant upgrades, including the replacement of the existing roof cladding and additional large operable windows.

BG&E provided structural and materials consulting services for the project, including the specification of inspections, testing regimes, and the analysis and design of strengthening measures to accommodate the proposed modifications and ensure the building is compliant with the current design standards - including the permitted threshold load assessment for seismic actions.

32 St Georges Terrace

PERTH, WA, AUSTRALIA
CLIENT: GOLDEN GROUP



32 Street Georges Terrace is a unique project involving the redevelopment of the existing May Holman Building to enlarge the available floor area and convert the building into a contemporary office facility.

BG&E, involved from the concept stage, investigated several floor expansion options, initially considering demolition and rebuilding - however, this approach incurred significant costs. Ultimately the re-use of the existing building was determined to be the most cost-effective design solution, despite significant technical challenges as the existing building core required extensive re-planning and partial demolition.

The core strengthening process required partial demolition to enable the construction of the core that would suit the new structure. During this process, the stability of the existing

17-storey building had to be maintained. A carefully planned and staged sequence of core demolition and strengthening was developed so that only final and existing core walls were used to ensure stability during construction - without the need for additional temporary steel-braced 'wing walls' at the perimeter of the building, minimising cost.

The raft supporting the stiffened core needed strengthening to support the greater wind and seismic lateral loads imposed on it from the extended building footprint. This was achieved by dowelling into the existing raft and building on top of it creating a thicker and stronger raft, to increase its flexural and shear capacities.

A structural steel frame with composite slabs facilitated the efficient erection of the new floor areas in a constricted central CBD location.

Chancery Chambers

AUCKLAND, NEW ZEALAND
CLIENT: JASMAX

Built in 1924, Chancery Chambers was designed by a French-Canadian architect, J Sholto Smith of Mullions & Smith, and is believed to have been Auckland's first European-type dwelling.

Decades on, the building was restored in association with Mace Development Corporation and architect James Morrison, to reflect its 1920s origin. The building continues to have upgrade works undertaken to ensure it remains one of the city's key historical landmarks.

In 2020, BG&E provided structural engineering services, including a peer review of the detailed

seismic assessment of the eight-storey building and materials testing to confirm the building's properties. Drawing on our rich technical knowledge, we tested the existing structure to ensure there was no disconnect between the testing that was carried out and the information that was required for an effective structural assessment (which was identified as part of the original peer review). These types of assessments are critical for buildings in New Zealand as it is an earthquake-prone region.

Today, the building boasts several floors of commercial space, as well as one of the city's most prestigious venues for events, on the rooftop terrace.





The Doulton

LONDON, UNITED KINGDOM

CLIENT: THIRD.I GROUP

The historic 1980s Royal Doulton manufacturing site has been transformed by Third.i into The Doulton - a premium mixed-use building that boasts a health and wellness facility, private offices, three new storeys, and luxury apartments with floor-to-ceiling, double-height glass windows with views of the iconic London skyline.

BG&E provided materials, structural, and façade engineering services to the adaptive reuse heritage project - ensuring structural safety and performance enhancements while preserving 90% of the original building, resulting in a significantly reduced carbon footprint.

Due to limited information on the existing building, a key challenge of the project was understanding the structure's present behaviour and performance, in relation to the proposed design. To combat this, BG&E's

materials team combined destructive and non-destructive materials tests to ensure a comprehensive dataset for structural analysis. Using this data, our buildings team developed a Finite Element (FE) model that accurately replicated the behaviour of the existing building.

The testing included:

- Electromagnetic cover scanning to identify embedded reinforcement location and cover.
- Rebound hammer survey as per BS EN 12504-2:2021.

- Ultrasonic testing using a Surfer Ultrasonic Tester UK 1401 as per BS EN 12504-4:2021.
- Concrete breakouts using a rotary hammer drill.
- Concrete core sampling to assess the compressive strength.
- Concrete core sampling to develop a durability model based on chloride diffusion and carbonation.

The buildings and façade teams have been involved in The Doulton project since the concept stage, which facilitated the optimisation of the proposed design, innovative solutions to consultants' requests, and cost-effective proposals.

Notably, the façade team's material choices reduced loads on the existing structure, which eliminated the need for expensive strengthening works due to changes to imposed loads.

The building team optimised the structural layout, enhancing internal spaces for improved freedom and safety. A clever solution to maximise residential spaces involved transforming the north and south core walls into columns and strategically placing additional walls on residential floors from level two to level 17. A transfer floor was added at level one to restore the original load path on the substructure, avoiding intervention on the foundations.



*The Doulton –
London, United Kingdom.*

Premier House and One Cathedral Square (1CS)

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.

The revamped 216-bedroom 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.

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

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 CO2 compared to constructing a new hotel of the same size.



Premier House and One Cathedral Square (1CS) – London, United Kingdom.

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 1100 highly skilled people, in 15 offices across Australia, New Zealand, South East Asia, 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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