Parramatta Square Precinct

Australian Construction Achievement Award 2023

Technical Paper

Built OBAYASHI walker

Parramatta Square Precinct

Built in joint venture with Obayashi (BOJV) was engaged by developer Walker Corporation and Parramatta Council to deliver their vision for one of Australia's largest urban regeneration projects including four commercial towers, civic hub and public domain for the new $2.8bn Parramatta Square precinct.

Establishing Parramatta as Sydney's second CBD, the works included commercial/ retail builds and fitouts, interconnecting basements, integrated transport access and public domain works.

The precinct comprises of Walker Corporation's premium commercial buildings 3 Parramatta Square (3PS), 4 Parramatta Square (4PS) and 6&8 Parramatta Square (6&8PS) all designed by leading architecture firm, Johnson Pilton Walker, and Parramatta Council's civic hub and library known as PHIVE designed by Manuelle Gautrand Architecture in conjunction with DesignInc and Lacoste + Stevenson.

Each building had their own innovative and expertly tailored design and construction methodologies, as well as Design Excellence, development applications and assessments. There was also the challenge of creating interconnections between each building through shared basement levels, a transport interchange, public domain and connecting skybridge and podium.

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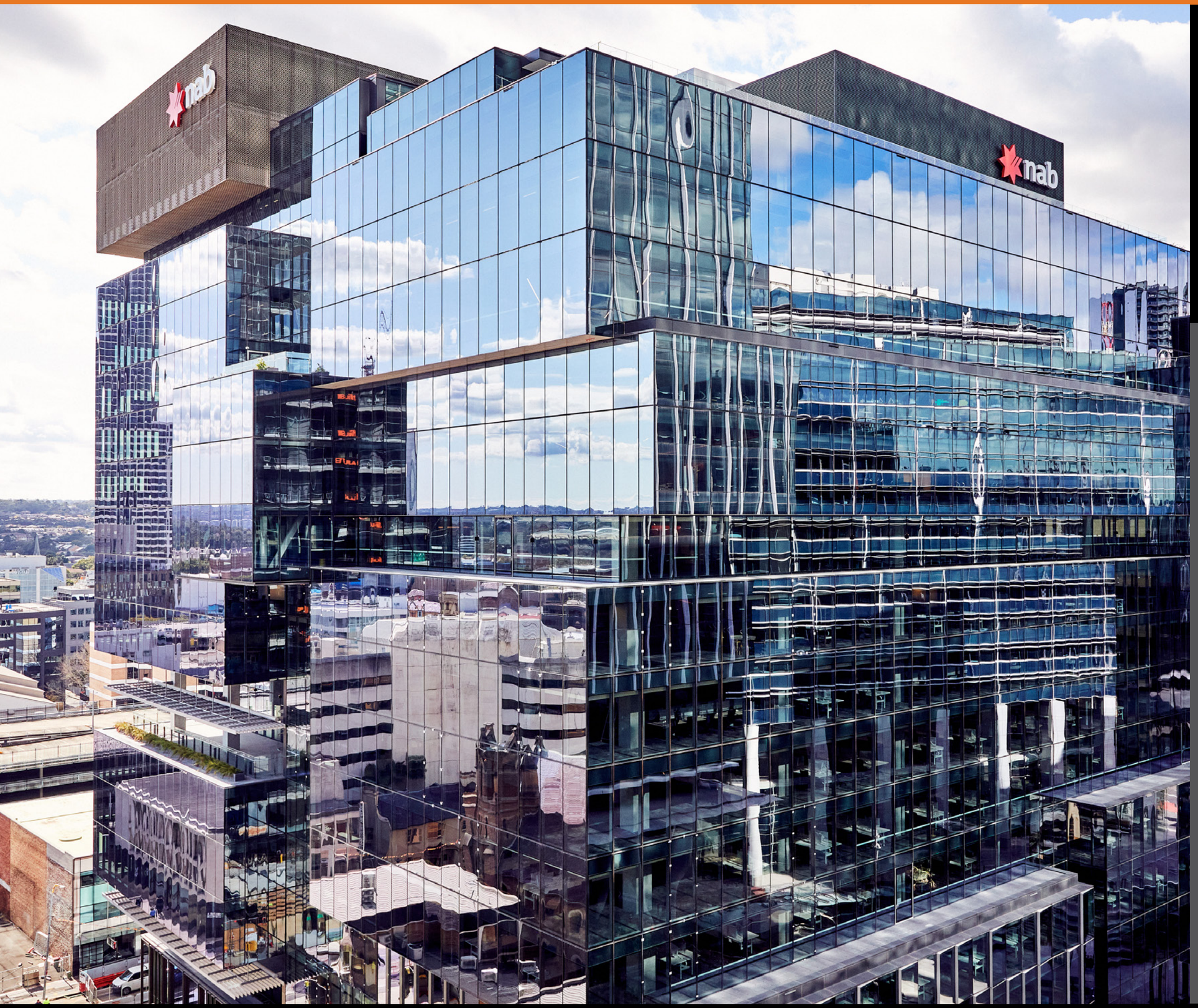
The Vision

As a developer renowned for urban transformation, Walker Corporation's vision for the Parramatta Square precinct was to collaborate with Parramatta Council to anchor a second major commercial hub for Sydney, attracting top corporate and government organisations and job opportunities to Sydney's west and creating a bustling city that is accessible via public transport, with the standard of amenity on par with the Sydney CBD.

Parramatta Square has since attracted anchor tenants including National Australia Bank (NAB), Property NSW, plus Westpac, Deloitte, KPMG and ABC. The addition of PHIVE has brought with it a new civic library and council and community facilities giving locals and visitors a space to connect, collaborate, shop, dine and enjoy social and cultural experiences.

Spread over three hectares, Parramatta Square accommodates an ever-growing workforce of 24,000 office workers, while also giving back to the local community through public domain spaces and the library. It has created new and improved accessibility, with a new thoroughfare through to Parramatta Station transport interchange and easy access from surrounding streets.



3 Parramatta Square

3 Parramatta Square is the second of Walker Corporation's commercial office towers delivered as part of the integrated precinct at Parramatta Square. The build involved a 17-storey geometric, floor-to-ceiling glass structure with atrium, interconnecting staircase, glazed rooftop and bespoke integrated fitout for National Australia Bank (NAB).

Key features of the project include:

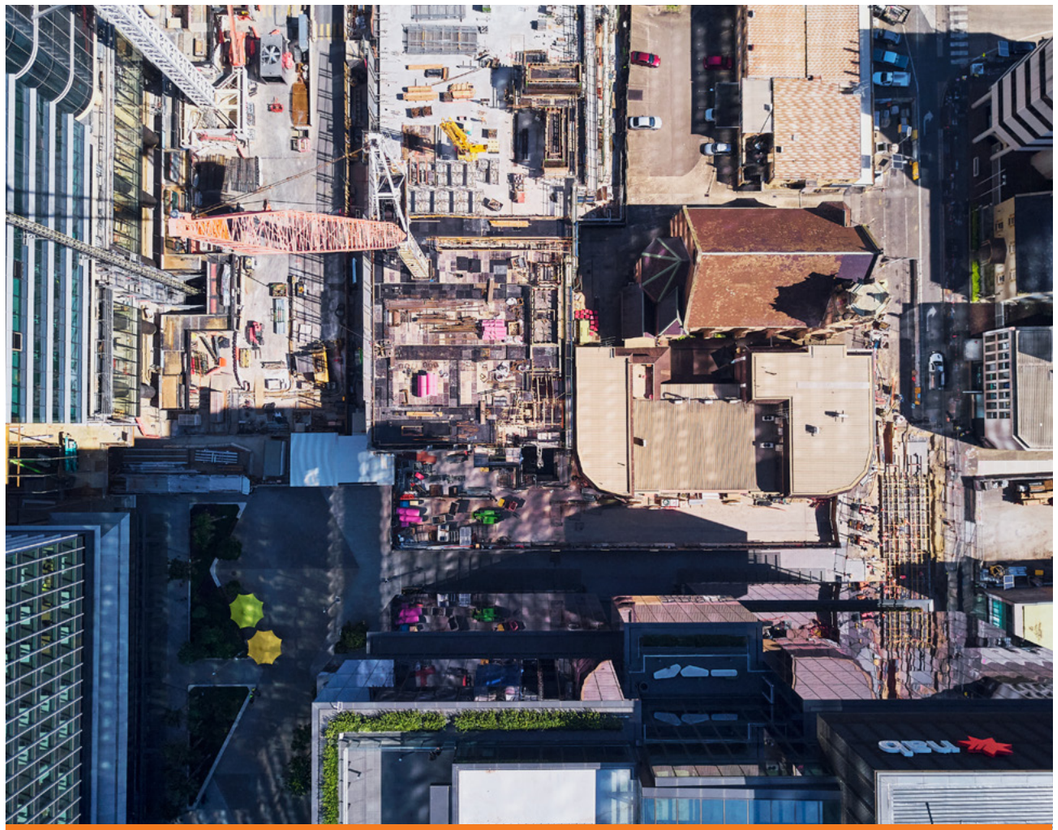
- 43,000m² of A-Grade commercial office and retail space
- Fully integrated fitout office space from Levels 1 - 13
- Basement carparking within the precinct "super basement"
- Roof and basement plantrooms
- Base build warm shell fitout to Levels 14 - 16
- Full height central atrium with glass lifts
- Hotel grade end-of-trip facilities meeting stringent Green Star requirements
- Storage and facility management rooms
- Shared dive ramp entry with the existing 2 Parramatta Square building
- Public Domain space to the full perimeter of the building to integrate with adjacent finished spaces
- The finished building provides 43,000m² NLA, 200 car spaces, 20 motorcycle spaces, 430 bike storage spaces and 700m² retail space.
- Typical basement footprint – 4,532m²
- Typical tower footprint – 2,900m²
- 6 Star Green Star Rating

Construction Methodology

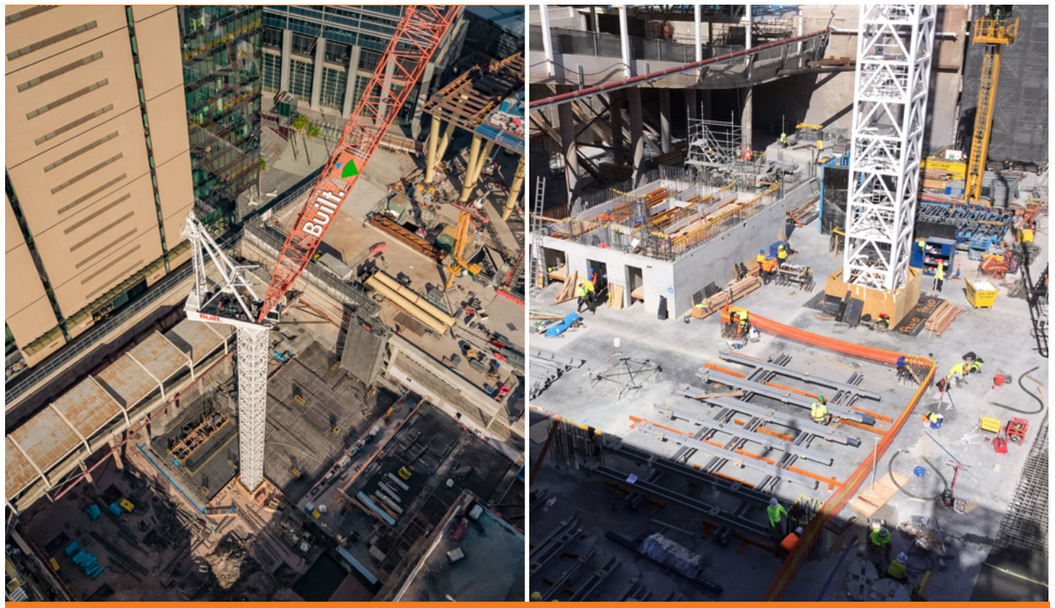
The delivery model for 3 Parramatta Square and in fact the whole precinct saw Walker Corporation undertake the site retention and bulk excavation works ahead of the main contractor appointment. This meant the usual lead time allowed to develop a detailed design and allow construction to commence was significantly shortened and BOJV had to design and then construct almost immediately. Within this start-up phase the critical focus was on the establishment of Tower Crane base and the main core pad in order to establish a jump form system.

While the jump form was being established, the in-ground works, pad footings and slab on ground activities continued. A key element during the initial phase of works was the basement hydrostatic slab waterproofing task, which involved a fully waterproof mat being placed below the slab on ground.

The basement suspended structure consisted of post tensioned band beams with Bondek slabs. There were temporary shoring bracing measures installed by the civil contractor which were required to be left in place until the main structure had been constructed and achieved strength. At this point the temporary support structures could be removed.



Tower crane and main core pad aeiral view



Inground works, foot paddings and slab on ground establishment

The main tower levels were also constructed in post tensioned concrete using conventional table forms and Bondeck infills. Other key features include:

- The floor plate was divided into four concrete pours
- The project utilised crane liftable column shutters to form and pour the columns “up” so a consistent class-two finish could be achieved on the off form exposed columns
- Perimeter screens provided edge protection to both the outside edges and also the full extent of the internal atrium
- Internal formwork hoist used to cycle formwork up the building
- Jump form ahead of slabs with stair cores being completed for early stair access to the leading work fronts
- Retractable loading platforms for additional formwork cycling capacity
- Man and materials hoist located inside the atrium providing access to the lead deck directly from the site accommodation on B2

The most important process to ensure successful installation of the façade systems was agreeing and approving a façade prototype/Visual Mock-up (VMU) as this allowed the procurement and manufacture of the systems to be undertaken and ensure that the façade was available to be installed on site once the floors had been made available. The VMU prototype was fast-tracked early in the project to avoid delays in the approval and sign-off of the tower and podium façade manufacture. This allowed BOJV to have façade landed and stored in Australia prior to the programmes need for these systems. This allowed the team to ensure that the building was watertight early in the programme to allow the integrated fitout to also commence early in the programme.

Services rough-in for the building and the fully integrated fitout occurred as soon as the formwork stripping had been completed and back propping cleared.

3PS Interconnecting stair installation

Central Atrium

The atrium was designed to draw natural light into the public areas of the building and encourage employee engagement within NAB. BOJV identified at the design stage that one of the greatest design challenge in constructing the atrium would be providing access to the various atrium work fronts. This recurring theme saw us develop solutions that offered value to the client, took up minimal space and could safely be installed.

Due to the site constraints, BOJV had to develop a methodology to erect a tower crane and twin man and materials hoist within the central atrium, which left very little room for the permanent atrium features, being glass lifts, feature stairs and escalators. All installations, both temporary and permanent, were designed into the project to test the space provisions and our ability to remove the temporary works without compromising the permanent works.

A further complexity was that due to the presence of all of the temporary and permanent installations within the atrium, there was also no room for a scaffold to be built, meaning the team were required to be innovative in order to complete the works. BOJV came up with a number of solutions that allowed the atrium to be delivered, without an over reliance on temporary structures and scaffold, which meant the client saw the benefit in our costings and programme.

One opportunity for innovation was resolving the constructability of the interconnecting feature stairs. The stairs consist of structural steel frames, aluminium wall and soffit cladding, timber treads and risers, illuminated handrails and tactiles. BOJV's solution was to prefabricate and assemble the stairs and crane them in fully clad. This eliminated a substantial amount of on-site work resulting in only the timber treads and handrails being installed onsite.

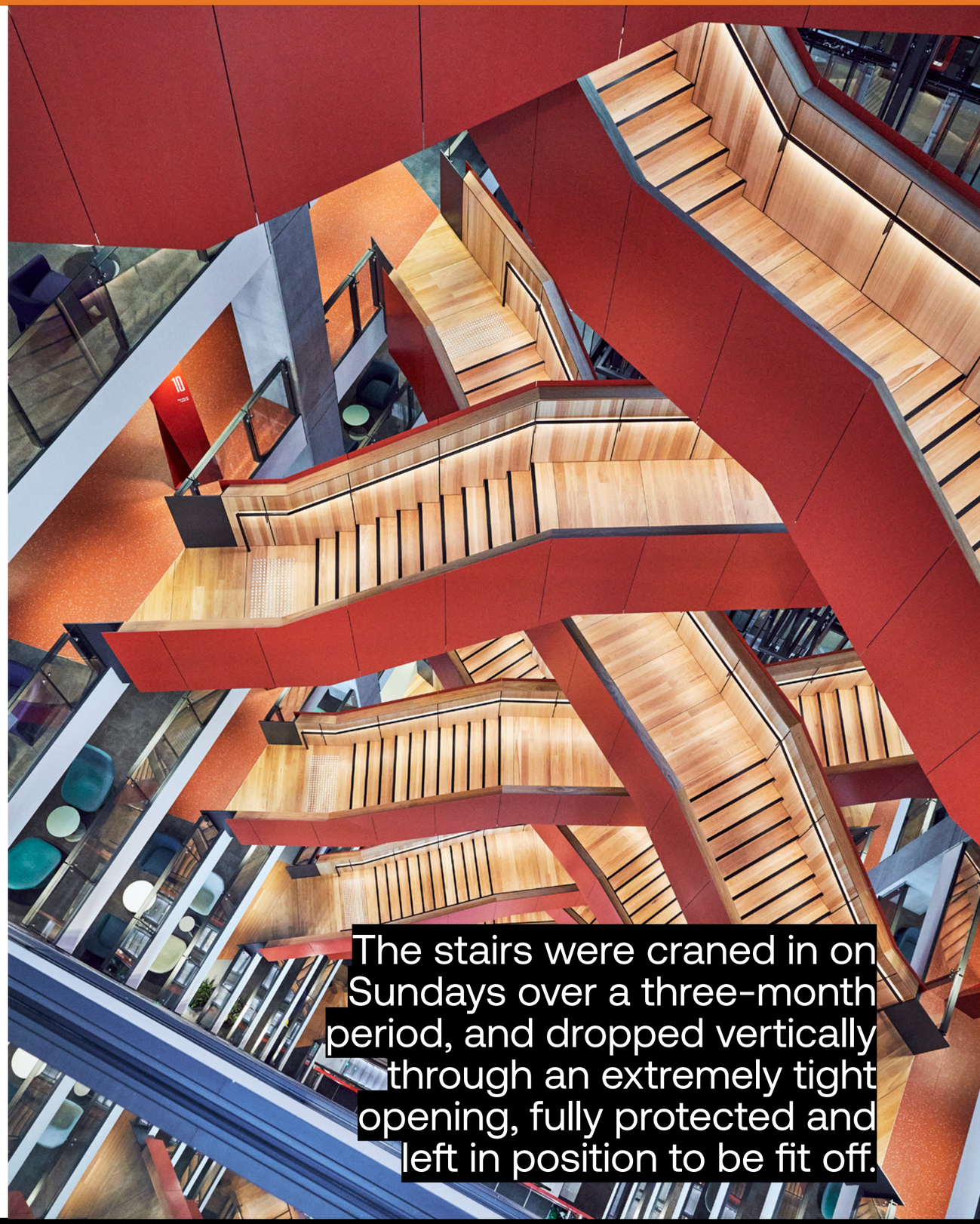
The stairs were craned in on Sundays over a three-month period, and dropped vertically through an extremely tight opening, fully protected and left in position to be fit off.

Adjacent balustrades were pre-procured offshore with little margin for error.

The lifts required two cranes working in tandem to angle the 15m long stairs in order to lower them through the core of the building, alongside the internal lifts and hoists, and set them in place. The benefit of prefabricating and dressing the stairs was that adjacent works could continue and the need for scaffolds was eliminated. This saved time and labour on site and allowed the team to complete an important design feature for the client to a very high quality.

Further complexity was added during the design phase with the fire engineering requirements. Neither the architect nor the client wanted fire curtains or glass bulkheads around the atrium edge to control the spread of smoke. The solution necessitated detailed fire engineering and modelling of every floor to demonstrate how smoke was being managed on the fire affected level without it spreading via the atrium to adjacent floors.

Another innovation opportunity tackled by BOJV was the glass lifts. A bank of four glass lifts travel from the ground floor to Level 16. These are supported by structural steel frames. The challenge was to find a way to construct the support structure and commence



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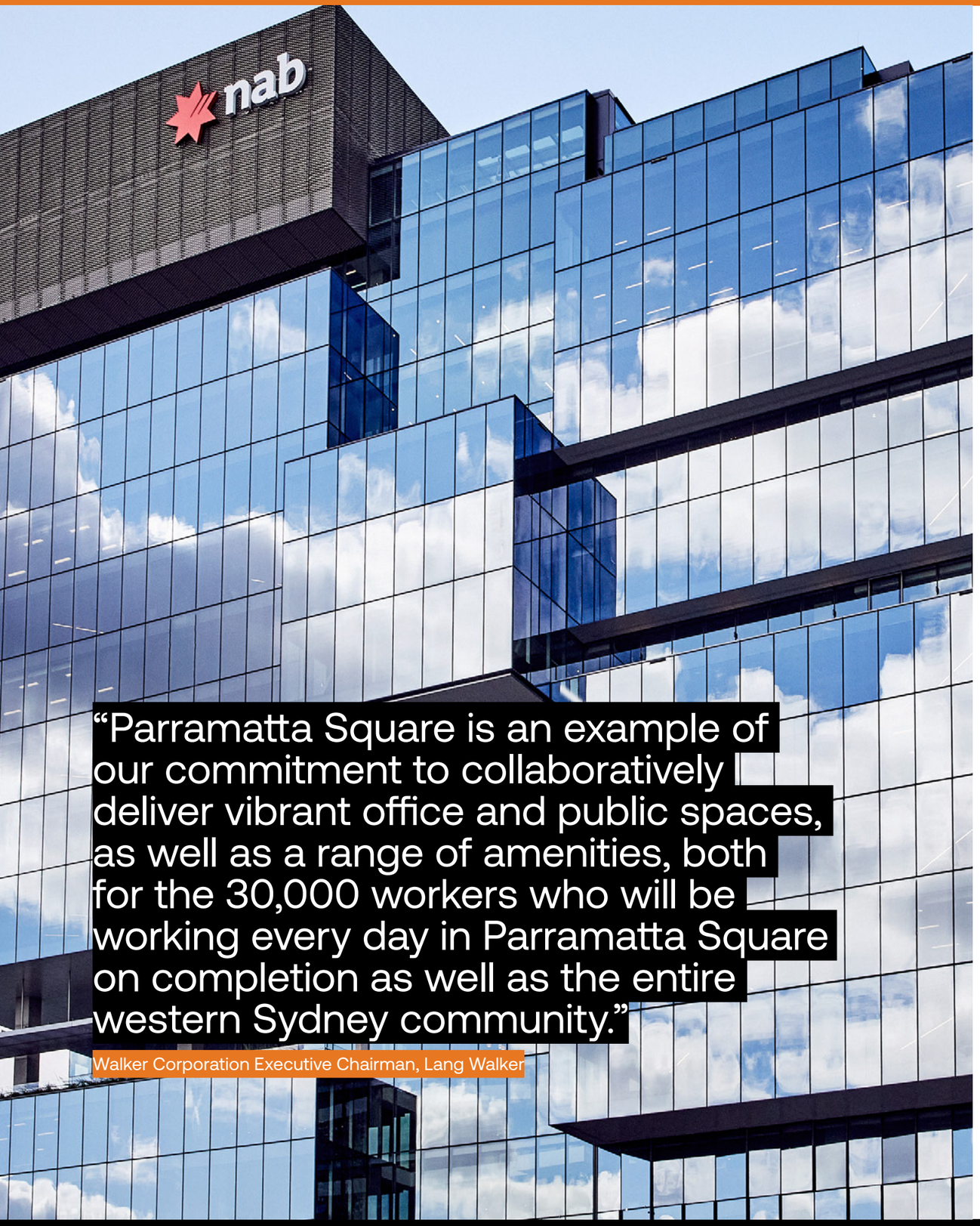


“Parramatta Square is an example of our commitment to collaboratively deliver vibrant office and public spaces, as well as a range of amenities, both for the 30,000 workers who will be working every day in Parramatta Square on completion as well as the entire western Sydney community.”

Walker Corporation Executive Chairman, Lang Walker

building the lifts while not being weather tight above.

BOJV came up with an innovative solution whereby a mid-span weatherproof deck was constructed to allow works to continue below, even in wet weather. The deck consisted of 10Kpa rated combination structural steel, scaffold, plywood and tarpaulin. This type of installation is usually installed in a closed lift shaft rather than an open atrium.

Façade & Western Pop Out Feature

The 3 Parramatta Square façade portrays the image of rectangular boxes being stacked irregularity upon one another. This made for a very complex and highly detailed design especially at junctions where three planes of façade would meet. To ensure the façade was watertight every junction on the job was modelled, particularly the three-way junctions, and mocked up off-site, prior to procurement. This was the most important process to ensure installation on site would meet both the performance requirements and the design intent.

Due to the geometry and shape of the façade, there were both design and construction challenges. The latter were met with edge protection, access, floor loading, under slab panel installs and external soffit installs, all of which had to be well thought out and planned.

These façade works also included the constriction of the “Western Pop Out Box”, a structural steel cantilever that is fixed to the Level 10 and Level 13 concrete slabs. To build the cantilever, a temporary steel platform that cantilevered 12m over the building’s main access/delivery driveway was built from Level 9 as a temporary catch deck so that the team could build the entire pop out box without affecting works or access below. Once the box was completed, the platform was removed, and façade patched in and around.

3PS facade and western pop-out construction

4 Parramatta Square

4 Parramatta Square (4PS) – the first of Walker Corporation's buildings to be built – includes a 43-level commercial office tower comprising four basement levels, 34 tower levels, and five podium levels including various retail offerings and through-connection between the expansive public domain and northern end of the city and Parramatta Station.

Key features of the project include:

- Basement carparking with vehicle connections to 3PS and 6&8PS basement
- Roof, high- and low-rise plantrooms
- Fully integrated commercial office space
- Podium levels office spaces
- End of trip facility
- Storage and facility management rooms
- Reconstruction of Darcy St from Station St to Church St
- Connections into a Live Western Concourse in Parramatta Station
- Construction of the public domain to Parramatta Square
- 6 Star Green Star Rating

The finished building provides 66,000m^2 NLA, 1,000m^2 GLAR, 240 car parking spots and 4,000m^2 of retail space.

- Typical basement footprint – 5,000m^2
- Typical podium footprint – 1,200m^2
- Typical tower footprint – 2,714m^2

4PS also delivered Stage 1 of the public domain which provides direct connection via the 6,000m^2 space to the existing Church Street Mall that will serve as an important place for people to meet, work, learn and connect.

Construction Methodology

The first stage of the works encompassed detailed excavation but with a primary focus on the core raft and tower column footings to allow the establishment of the core jump form system and the erection of the jump start structure.

Upon the handover of the first area by the early works contractor, BOJV commenced the detailed excavation of the core raft to expedite the establishment of the jump form system. Upon the completion of the FRP of the core raft, the jump form system for the core was constructed which signalled the commencement of the main structure.

Whilst the jump form was being constructed, the focus shifted to the balance of the in-ground works such as tower column footings, in-ground services and the hydrostatic slab on ground including the necessary extensive waterproofing works.

During the tender process with Walker Corporation, BOJV developed a strategy to deploy a jump start structure to the tower which would save circa 3-4 months in programme and meet the target move in date for the anchor tenant. Upon the establishment of the jump form system, a dedicated man hoist was installed to provide vertical access to the working deck of the formwork system.

The main tower levels were constructed using conventional table-form systems to the band and edge beams with bondeck infills for the slab areas. The project planning for the tower structure was based upon a six-day cycle starting from Level 9 to the roof. In order to achieve the six-day cycle, the typical floor plate was broken into four pour per floor to ensure continuity of the trades across the floor plate.

The jump form system was designed and constructed with trailing shutters to include the lobby slabs which were poured ahead of the typical floors. The advantage of including the lobby slab within the jump is in providing stretcher stair access to the working deck via the permanent fire stair within the core.

Formwork hoists were utilised within the tower footprint and strategically positioned to efficiently recycle the table-forms and formwork propping up

4PS jumpform system and form work hoists

the building. As the table-form system is recycled up the building, temporary propping was installed and then progressively removed once the slabs have gained appropriate concrete strength.

The most important process to ensure we were successful in the installation of the façade systems was agreeing and approval of a façade prototype/ VMU as this allowed the procurement and manufacture of the systems to be undertaken and ensure that the façade was available to be installed on site once the floors had been made available.

The VMU prototype was fast-tracked early in the project to avoid delays in the approval and sign-off of the tower and podium façade manufacture. This allowed BOJV to have almost 19 floors of façade landed and stored in Australia prior to the programme need for these systems. This enabled the team to ensure that the building was watertight early in the programme to allow the integrated fitout to commence early in the programme.

Services rough-in for the base building and integrated fitout commenced at the first typical commercial level once sufficiently clear of back-propping. Wet-trades and dry trades started immediately following the commencement of service trades which focused from the core risers out on to the floor plates. Basement, lower ground floor level and the commercial lobby services and fitout works commenced upon stripping of formwork in these areas.

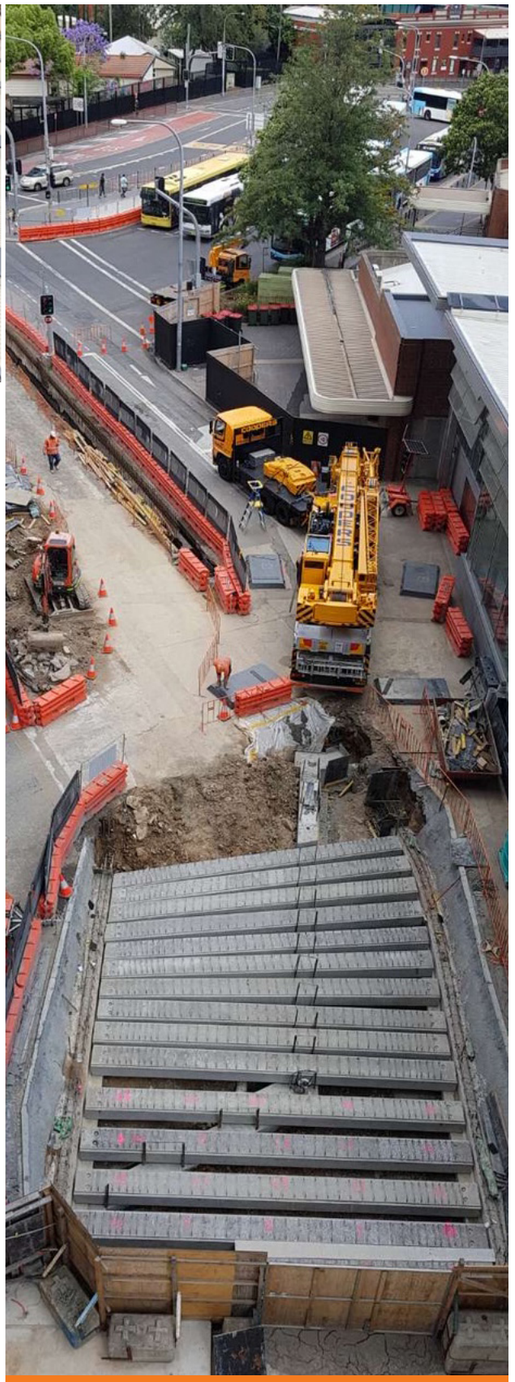
Construction of Darcy St and Accelerated Basement Works

To ensure productivity for both the early works contractor and BOJV whilst both were operating simultaneously on site, the team separated the construction traffic. This simple initiative improved traffic congestion, safety and productivity.

BOJV's methodology was based upon these key principles and as a result we undertook the following two initiatives:

The first was to create an elevated roadway suspended from the retention wall along the southern site boundary. This roadway was constructed to replace the old Darcy St roadway linking Smith St to the east with Church St to the west, which was reclaimed/lost as part of the excavation. BOJV established during the early excavation stage of the project a temporary steel platform/roadway to Darcy St. This platform/roadway allowed BOJV's construction vehicles to enter the site via Darcy St to a staging/materials handling area located on the future 6&8 Paramatta Square site and leave via Church St un-impeded by the early works contractor's construction traffic which utilised the Macquarie St frontage. BOJV further developed this solution to allow the temporary roadway to be incorporated as part of the permanent replacement of Darcy St in the completed development.

BOJV also fast tracked the construction of the public carpark structure between 4PS and 3PS to facilitate the materials handling area for the project. Initially this staging/materials handling area was accessed via the existing University of Western Sydney ramp from Macquarie St. Once the 4PS basement entry had been constructed off Darcy St, construction traffic was diverted to this entry via the loading dock.



Elevated roadway (Darcy Street) suspended from the retention wall

Creating the Opportunity for an Additional Floor

Very early on in the design development of the building, BOJV offered Walker Corporation the opportunity to create additional office space within the current building footprint and overall approved building height. This opportunity was created via the reduction in the office floor plate floor-to-floor height by 100mm on every level (reducing the floor-to-floor height from 3.85m to 3.75m across 28 floors) plus the reduction in floor-to-floor height across two plantrooms by 1m. The combination of these two moves meant the overall height of the building dropped by 3.8m hence creating the opportunity to add a full additional rentable floor back into the building and creating an additional 2,400m^2 of NLA.

Jump Start

BOJV created an innovative structural steel 'jump start' methodology for 4PS, removing four months in programme over a conventionally bottom-up methodology and saving the client time and money. Reimagining the structural design for the building allowed BOJV to take advantage of the impressive podium level design to reach the typical floors early, removing a total of six suspended levels plus the 1.5m thick hydrostatic slab off the critical path. At the time of its construction, this nimble jump start technique was the biggest jump start in Australia and the first of its kind with inclined columns. Based on the success of this methodology, BOJV implemented the same jump start at 6&8 Paramatta Square to again reduce the build programme.

Above: 4PS flnal floor-to-floor height at 3.75m . Opposite: During and after construction of structural steel jump start methodology at 4PS

PHIVE
Parramatta Square

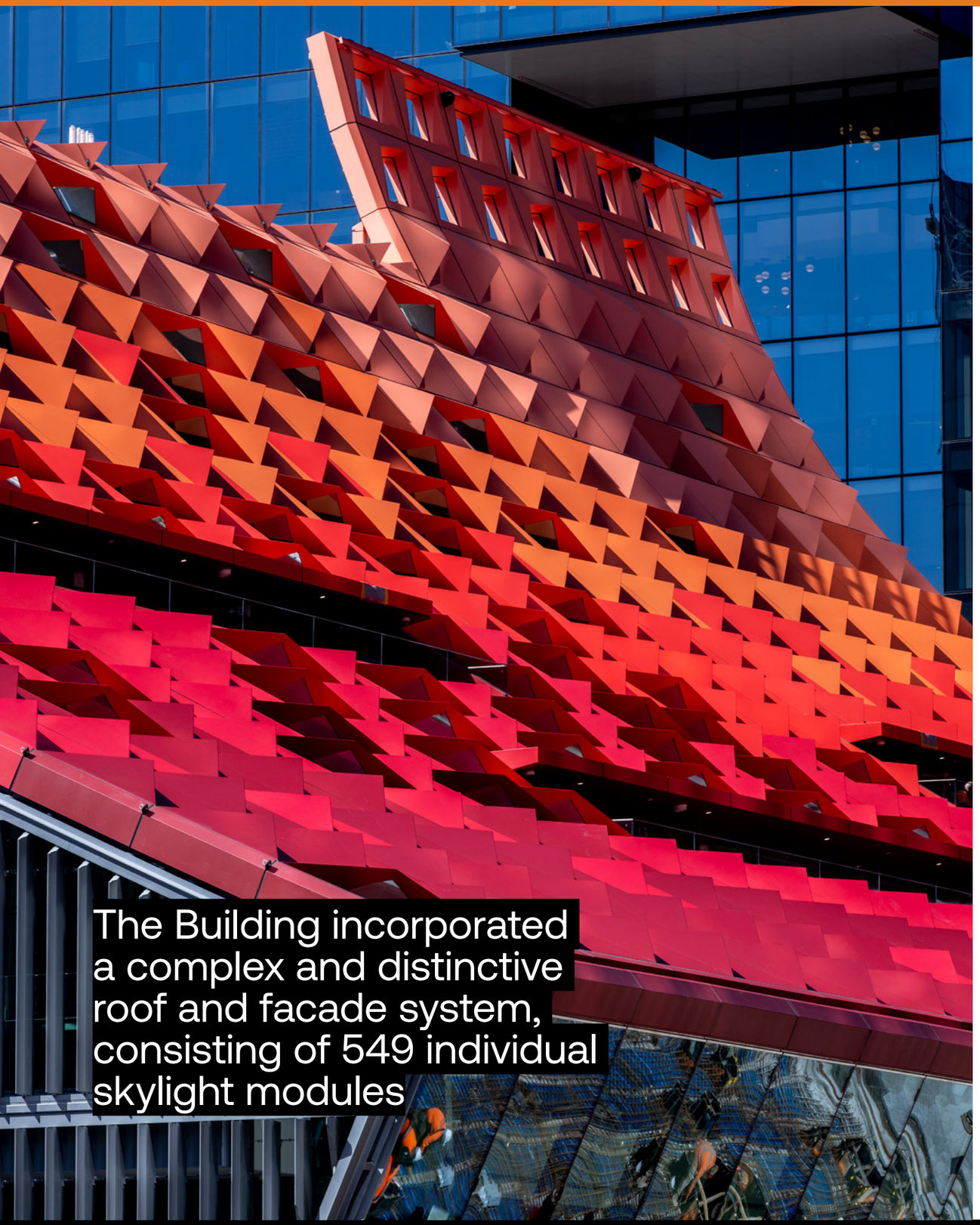
PHIVE Parramatta Square is a $130m, six-storey building comprising a new civic library and Council Chambers and community facilities, as well as two below-ground levels, for Parramatta Council. The design of PHIVE was chosen through an international design competition and awarded to French architect Manuelle Gautrand.

The build incorporated a complex and distinctive roof and façade system, with the roof consisting of 549 individual skylight modules, integrated together within a structural steel roof framing arrangement.

Built was also able to take the concept design for the building and modify it to allow for the building to achieve net zero operations from day one and become one of Australia's most sustainable local government buildings. Built's sustainability initiatives and uplifts were ultimately behind our success in wining this job.

Key Features:

- 6-storey civic hub and library
- 2-storey basement level integrated into the precinct car park
- Discovery Centre on basement level
- Integrated wellness studios, tech labs, meeting rooms, sound recording studios and maker spaces
- Café space
- Roof lighting display system
- Net zero carbon in operation
- 6 Star Green Star Rating



The Building incorporated a complex and distinctive roof and facade system, consisting of 549 individual skylight modules

Cantilevered structure of PHIVE against the neighbouring buildings

Construction Methodology

Construction began with the demolition of the original structure on site which included removing unknown in-ground contamination, services, and existing building structures to progress the excavation works. Many archaeological artefacts were found and removed, most of which are now on display in the completed library. A 10t, original brick mural was also removed, intact, from the old council building, laminated with concrete bonding and repurposed in the brand new, completed building.

The building's design included non-typical floor plates, with every floorplate designed differently to the next. This led to extensive design consultations with the full consultant team to ensure details were resolved prior to arriving to the construction phase.

The structural element with the highest complexity on the project was the Level 4 cantilever slab over the Town Hall heritage building, adjacent to PHIVE. Built undertook numerous design and engineering sessions during the tender phase and obtained expert engineering advice to understand more clearly and explore construction options associated with this cantilevered structure. Built developed an alternate structural design and methodology to construct this cantilevered structure without impacting upon the Town Hall below, developed with a strong emphasis on Safety in Design principles and ensured that the overall structural and architectural envelope was maintained.

The alternate design and construction methodology was developed to eliminate the need to create penetrations through the Town Hall heritage building. This ensured that the new cantilevered structure of PHIVE would not impact in any way the significant and intricate heritage ceiling within the Town Hall building. To construct the slab over the void at level 4, additional steel beams were utilised. The steel beams were preassembled in a pair and the cantilever zone decked and fixed with handrails and then lifted onto the formwork as a unit

Internal view of skylight modules at PHIVE

The northern façade and the building's overall boundary were also challenging aspects of the build. The northern façade pops out 1.5m to the boundary and as a result, the team had to use man boxes and boom lifts for its installation. Built had to leverage our relationships with our neighbours on the northern boundary, Holdmark Property Group and St John's Anglican Cathedral, as well as with our own team in the public domain site at 6&8PS, to allow the facilitation of the façade install.

COVID-19 impacted the project on multiple levels. Parramatta was considered a hot spot for some time and in addition, the pandemic impacted supply chains causing a delay to materials deliveries. These implications led to the challenge of the building not being weathertight in time to begin our fitout works. The team improvised a solution whereby a temporary roof was installed and waterproofed to temporarily compensate for the late façade.

Digital Engineering was used on a weekly basis to ensure coordination of trades, structure and architecture. The building had low floor clearances and Digital Engineering and modelling was used to ensure we could fit all the services in while taking into account the architecture of the building.

Modularised Roof

The roof design of PHIVE was something that had never been seen before. The building has unique geometry, with a ski slope-shaped, articulated roof. This roof is made of 549 individual skylight modules which have been integrated together and installed in a series of 4, 3 or 2. To create the building's wave-like shape, a gridded steel structure was constructed at the edge of each inset slab and connected to create an endoskeleton support system. The panels were then lifted via temporary plates and fixed into place.

These modules were then lifted onto the building using a unique lifting frame to achieve the slope of the roof through the use of tower and mobile cranes and further installed using elevated work platforms from below, removing need to get on top of the roof to fix off these panels.

A challenge was presented when the shipping of the roof materials was delayed due to COVID-19. Rather than staggered deliveries, the roof and façade materials all arrived at once. This had a knock-on effect to the works, requiring Built to use both the tower crane and additional mobile cranes to install the roof, with two teams needing to work concurrently on the install. The teams worked from east and west, meeting in the middle and mitigating the risk of crane booms overlapping while maintaining the panel sequence installation.

Prefabricated Spire:

A prefabricated element of the build was the 17m x 5m-high steel spire on the eastern elevation. This frame was prefabricated on the ground, in the Leigh Place loading area over a duration of approximately three weeks. We over clad this structure with the same articulated roof panels as the building itself and lifted the spire as one prefabricated element. Once in place, the spire was bolted off with a series of temporary connections and then permanently fixed off with full strength welding to two of the primary rafters.

Sustainability:

Originally targeted for a 5 Star Green Star rating, Built put forward a 6 Star Green Star pathway during the tender phase, which Parramatta Council agreed to. Natural ventilation was not an initial part of the design concept and through leveraging the buildings unique design and roof, we were able to put forward a natural ventilation solution in lieu of mechanical cooling and heating for 60 per cent of the year. This design concept was achieved within Parramatta Council's budget and led the way for further innovations on the job, including a solar PV system and removal of the dependence on natural gas. Through these sustainability uplifts, the building is now committed to a renewable electricity supply and has achieved net zero operations from day one.

PHIVE's sustainable building features include automated louvres on the southern and eastern façades which enable mixed-mode ventilation to the building, enabling the majority of the building's spaces to be naturally ventilated.

- A variable refrigerant flow system and rooftop condensers instead of gas boilers and chillers. This removes the need for gas and cooling towers. No cooling towers also means that potable water consumption is reduced by 70 percent.
- A mixed mode ventilation system which uses a combination of natural ventilation from operable windows and mechanical heating and cooling. An energy recovery ventilation heat exchanger will pre-heat or pre-cool air coming in and out of the building. These reduce the building's total energy by 35 percent.
- The building management system is linked to the Bureau of Meteorology and two local weather sensors to ensure optimal operation of the mixed mode ventilation system and the energy recovery ventilation system.
- An electric domestic hot water system and thermal storage will provide the hot water needed for the building's end of trip facilities and kitchenettes.
- To reduce the energy demand for domestic hot water, a hot water ring main delivery system was not included in the design. This means water will not be continuously heated and pumped around the building. Instead, local electric units generate hot water to taps that are rarely turned to hot.
- A 13-kW solar PV system.

Above: Non-typical floorplate of PHIVE's Library. Right: Automated louvers enabling mixed-mode ventilation

6&8 Parramatta Square

At 55-stories, 6&8 Parramatta Square (6&8PS) is the tallest commercial tower in Western Sydney and has the largest commercial office building in Australia by GFA at 132,520m^2.

BOJV was selected again to construct 6&8PS after working collaboratively with Walker Corporation's team to develop an alternate structural design concept for this towering building.

Key features of the project:

- 132,520m^2 GFA
- 55-stories
- Interconnected basement
- 4 level basement carpark
- 18m atrium entrance lobby
- Low rise, mid-rise and roof plant rooms
- Campus up to L29 (140m)
- Tower is up to L53 (243m)
- Integrated link at LG to Parramatta Train Station
- Public domain space
- Skybridge connection with 4PS
- 6 Star Green Star Rating

Construction Methodology:

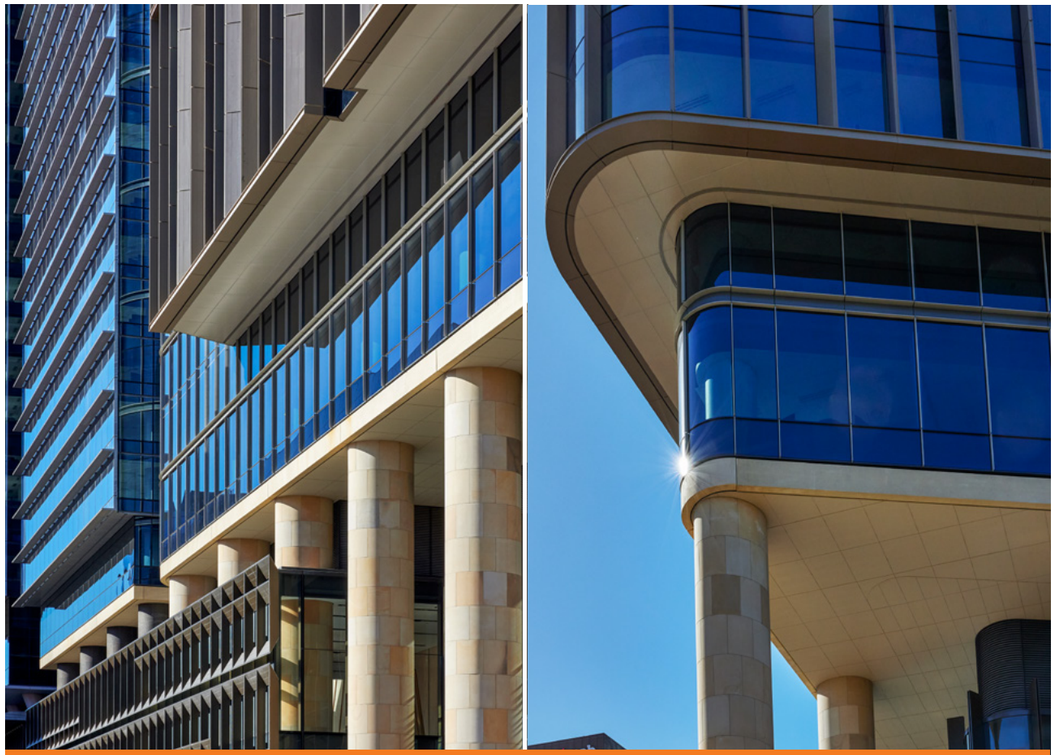
The incredible scale and foundations of 6&8PS meant the building had to be designed differently to any other commercial tower.

Through initial investigative works, BOJV's team uncovered a large dyke beneath the west core of the building. To ensure the building would remain unaffected by the dyke's presence, the team created a solution whereby more than 200 slabs were installed through the slab and the core raft to prevent the building lifting in the event of flooding, and to ensure stability of the basement slab.

The structure of the building consists of a hydrostatic foundation slab with a jump start steel basement and podium structure that is shared cross the 6&8 towers. The two towers consist of separate reinforced concrete cores topping out at level 29 and level 53 with post tensioned concrete slabs and an outrigger transfer structure across levels 26 to 28 to allow the structure to tolerate high lateral wind loads at height.

Post-tensioning slabs were used to minimise the possibility of future long-term deformation that is often found in conventionally reinforced concrete slabs. Not only did these post-tensioned slabs use less steel reinforcement, they also saved on cost and space within the high-rise building, allowing for thinner, longer slabs to be poured while maintaining structural strength within the building. Temporary movement joints were used to make allowance for the movement of the two structural cores during construction phase. This allowed the building structure to 'move' along this joint up to level 23,

Reinforced concrete cores of towers 6&8



6&8 jump start: Triple height steel columns to Level 1

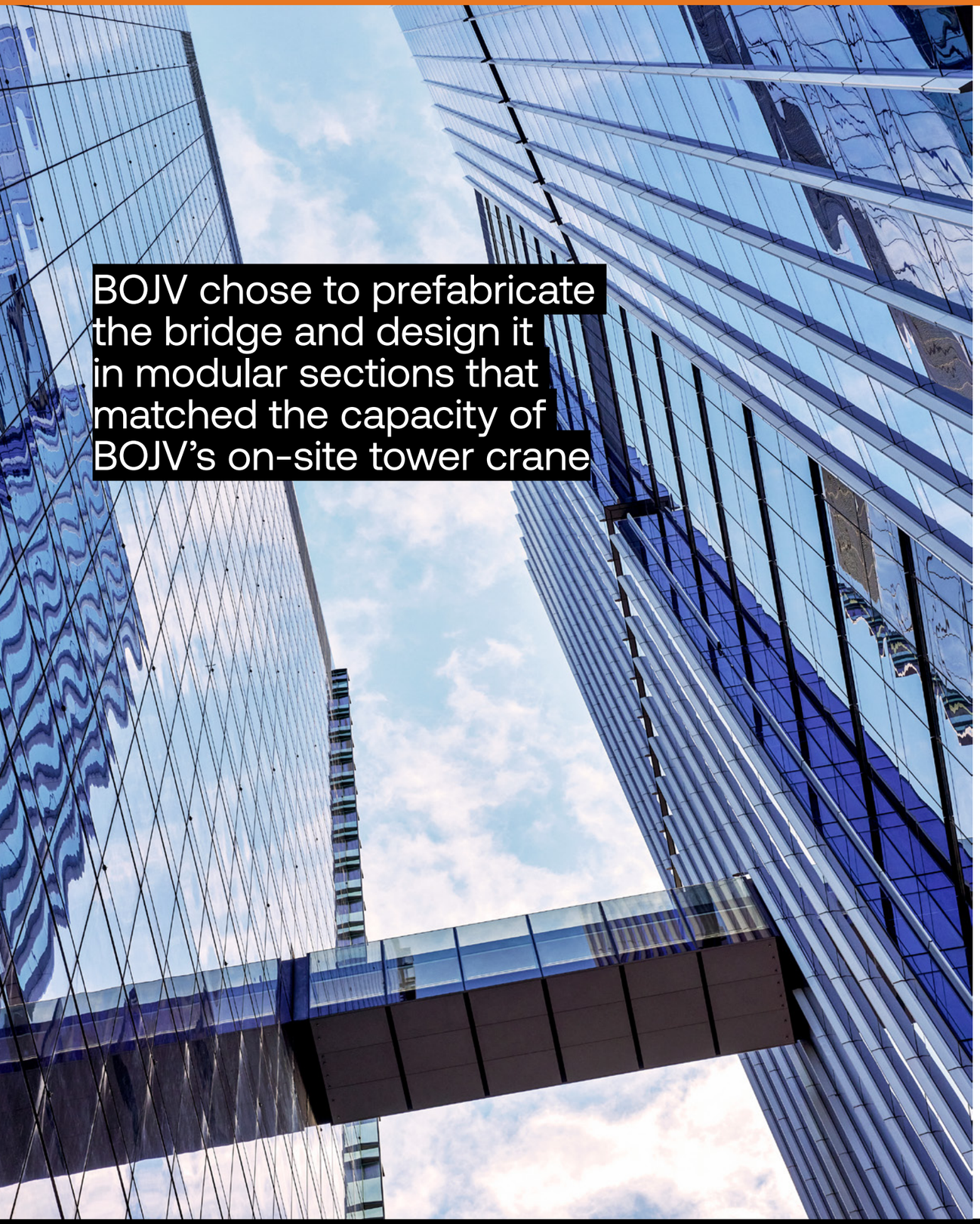
to prevent damage/cracking in the floor slabs. The slab on one side sits on the concrete corbel with steel allowed to slide within dowel tubes on the other side. Once the structure structure was completed, the dowel tubes were filled with grout, which locks the structure together permanently.

Using learnings from BOJV's work on 4PS, the team initiated construction using a jump start. This installation of triple-height steel columns allowed the team to essentially jump the structure to the Lower Ground Floor, and then again up to Level 1. This enabled construction to start the typical cycles of the slabs and then drop back to infill the basement and podium slabs off the critical paths, ensuring the programme remained on track. In order to install these columns safely and efficiently, the team used 3D modelling to model the installation using cranes to lift the steel. The modelling allowed the team to identify clear pathways through which to install each column weighing up to a maximum of 25 tonnes each.

Achieving target NLA within heigh restrictions:

Towards the end of the tender period, Walker Corporation was in discussions with Council over the height of the building, as it was concerned the tower would overshadow nearby public amenities. BOJV's solution to having to potentially remove an entire floor of the building was to instead remove half a floor and redistribute to the building in other ways, keeping it within Council's height limitations while also retaining the overall GFA desired by Walker Corporation.

BOJV also redesigned the highly condensed plantrooms to achieve more net lettable area for Walker Corporation. The incorporation of outriggers within the plantroom created challenges for placement of plant equipment and installation. This therefore involved coordinating off-site fabrication of major structural elements, critical to the precinct, and in doing so creating more certainty across time and quality that can be achieved within a controlled environment. Elements could then be brought to site in large sections where they were bolted together and placed accordingly.



BOJV chose to prefabricate the bridge and design it in modular sections that matched the capacity of BOJV's on-site tower crane

Skybridge installation:

Property NSW, who have taken up tenancy within both 4PS and 6&8PS required the ability for their workforce to cross between the two buildings via a foot bridge. This bridge concept was not factored into the original planning of 4PS or 6&8PS and was requested by the client during construction. BOJV had a very limited time to design, engineer and procure the componements. It needed to be installed off the critical path of the structure, but prior to the instalation of the curtain wall facade and removal of the 6&8PS tower crane.

This bridge needed to be installed into 4PS retrospectively at Level 11 - into a completed building and a live environment - therefore required detailed consideration and planning of the structural, safety and design constraints.

It was also necessary for the installation of the bridge to take into account the scale and design of the two buildings themselves. As the bridge created a link between two completely separate buildings, BOJV also had to solve a number of fire engineering challenges.

To be able to meet the tenant's requirement, BOJV chose to prefabricate the bridge and design it in modular sections that matched the capacity of BOJV's on-site tower crane. A robo-rigger - a hook attachment to the tower crane which uses inertial and gyroscopic forces to rotate and control the load - was utilised, allowing for loads to be controlled and spun using a wireless remote. A lift study was also required for each element, to ensure each lift was achievable and safe.

The design and installation of this bridge presented a real challenge for the BOJV team. They leveraged complex refurbishment experience and BOJV's extensive understanding of working within large, live environments to deliver a successful result.

Find out more about the Skybridge Installation **here**.

Outrigger System:

At 55 storeys, and as the highest commercial structure in the area, a key redesign element undertaken by BOJV following the tender award was to introduce an outrigger structure to mitigate the risk to the building in the future from major lateral wind loads.

The team utilised 3D modelling to engineer a solution to the lateral wind forces that would impact the building because of its height. The design engineered outrigger structure on levels 26-28 to fortify the building's core and brace it against these large lateral wind loads.

The structure incorporates highly stressed concrete walls independent of slab structure incorporated to mid-level plantroom to allow movement. The walls transfer load from the core to six mega columns up to 1800dia which in turn transfer load to the foundation with PAD footings up to 7m x 4m x 2.4m deep.

The outrigger walls originally envisaged to have nil penetrations which was not feasible in a plantroom. BOJV redesigned the structure to accommodate 2m x 2m maximum opening and fitting services and the egress opening was like a puzzle.

Fulfilling the Vision

Each building that forms part of the Paramatta Square precinct, had its own individual complexities as well as shared challenges, such as site constraints and material handling, risk mitigation through the creation of safety-centred methodologies, tower crane coordination and more.

The project also included construction of a new connection to Parramatta Station and temporary road and ramp alongside the rail corridor on Darcy Street to enable works and reduce impact on the community.

A total of 6,000m^2 of public domain was also included in the scope of the entire project, which involved staggered handovers, integration between building programmes and intense stakeholder management between not only tenants of these buildings, but of those surrounding, such as Sydney Water, Western Sydney University and Parramatta Council.

Collectively, Parramatta Square was delivered within the agreed timeframes and costings including variations as agreed with Walker Corporation and taking into account major disruptions including the COVID-19 pandemic. BOJV also value engineered solutions to mitigate not only risk but also to benefit both costings and programme, such as with the delivery of the atrium staircase in 3PS, jump start methodology for 4PS and 6&8PS, redesign of services to enable more NLA and retrofitting an interconnecting sky bridge between 4PS and 6&8PS.

Infrastructure provisions

As 4PS was the first of the five buildings to be completed, a large number of critical infrastructure provisions were required. These infrastructure provisions were primarily provided within the reconstruction of Darcy Street to the south of the project.

They were:

- High voltage power feeds to 4PS
- Infrastructure for high voltage feeds to 6&8PS
- Telecommunication infrastructure including diverse pathways for 3, 4, 6&8PS
- Towns water mains for 3, 4, 6&8PS
- A precinct fire control room, pump room, fire booster cupboard and hydraulic room for the precinct
- Stormwater to Darcy and Smith Streets

These works posed a challenge because Darcy St is built partially over the basement of 4PS, hence all services needed to be constructed between the top of the 4PS basement and the final finished levels of Darcy St. Prior to commencing the construction, the basement had to be fully waterproofed then backfilled by up to three metres of soil to create the new levels of Darcy St and align with the interface levels of Parramatta Station. Once the levels had been established, the service infrastructure for the precinct were installed and then the final road and footpaths were constructed to the final levels. The coordination of these additional works happened in parallel with the construction of the 35-level 4PS overhead.

All of the buildings within the precicnt are linked by a “super” basement. This facilitates seamless vehicle connections and minimises disruption to surface roads with only two entry/exit locations for all four of the buildings.

Railway connectivity

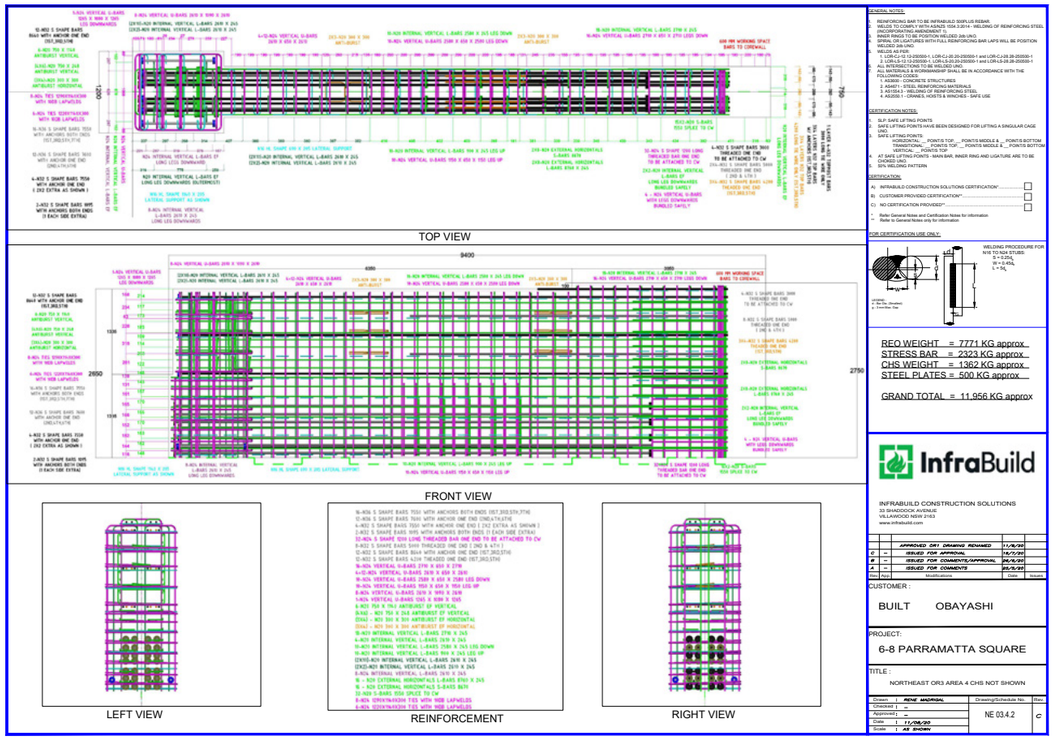
The 4PS development immediately fronts the Parramatta Station Western Concourse. As part of the project, the final design encapsulated a construction of a new connection to the Parramatta Station off the western concourse which offered connectivity to the precinct and the new Parramatta Square public domain and commercial precinct.

The modifications completed as part of the Parramatta Station works included:

- A structural break through to the diaphragm wall of Parramatta Square and the western concourse
- Modification to the Parramatta Station façade including structural modifications to the façade structural steel
- The creation and lifting of the DDA lift landing within the western concourse
- Extension of the pedestrian stairway from the western concourse to Darcy Street
- Completion of all finishes to the western concourse which directly adjoin the breakthrough including the modification of all services and the installation of a new fire roller shutter to provide fire separation between the two developments.

BOJV coordinated these activities while maintaining the operation of the western concourse 24 hours a day. Parramatta Station is the third busiest railway station in NSW and to enable the works to be completed, BOJV had to redirect some 10,000 commuters in the morning and afternoon peak in alternative pedestrian routes from the station to their places of business to allow the construction works to occur. Collaborating with Walker Corporation and through extensive stakeholder engagement with Sydney Trains, Transport NSW, Sydney Buses, Sydney

Proximity of the towers to Parramatta Train Station



DE: Structural outrigger plans of 6&8PS

Coordination Office and other key stakeholders in Parramatta, BOJV was able to successfully complete the works and open the new western concourse break through by the 4PS completion date.

BOJV had dedicated community consultation requirements and also had to manage interfaces with the Parramatta Light Rail construction. To ensure we had clear lines of communication with all stakeholders involved, we had regular consultation sessions with local council for the management of local roads and footpaths and this extended into detailed planning for the staged completion and opening of each of the buildings and their public domains.

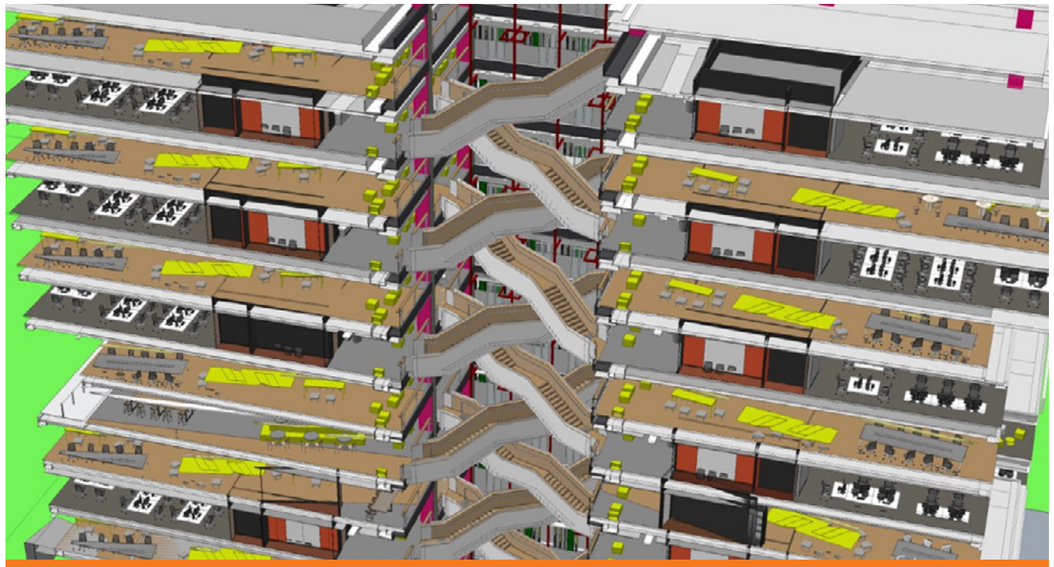
Digital Engineering

BOJV leveraged a number of Digital Engineering (DE) tools that allowed the entire precinct to capture maximum value while mitigating significant risks. It also provided a valuable training and development opportunity to upskill the project team, subcontractors, consultants and suppliers.

The use of 3D and 4D Modelling, Point Cloud Scanning (PSC), and Automated Reporting and Insights was embraced across the project's supply chain – with inputs generated from different clients, consultants, suppliers and subcontractors.

These tools enabled BOJV to redesign highly condensed plantrooms to create alternative space uses and achieve more net lettable area for Walker Corporation as well as coordinate off-site fabrication of major structural elements critical to the precinct to create more certainty for programme delivery.

Modelling also facilitated the coordination of site delivery, sequencing and installation methodologies across structural steel, some lifts weighing up to 25t, to provide clear accountability and certainty with an improved risk profile across safety, programme, resourcing and quality control.



3D modelling of stair installation at 3PS

Overall, the precinct could not have efficiently been designed and constructed without the use of DE. This included:

Planning the effective utilisation and design of building areas:

- The 6&8 commercial tower mid-rise plantroom, the biggest in Australia, had a number of layers of services coordinating around the structural outriggers. DE enabled the redesign of the plantroom to facilitate an overall reduction in square meters. This allowed the client to achieve more net lettable area.

Major structure elements coordinated for off-site fabrication:

- Jump start structures for towers 4 and 6&8 which included composite columns allowed for a condensed delivery program.
- Outrigger System for towers 6&8 which ensured the structural stability of the building to withstand strong lateral wind and seismic loads at such a height.
- 3D & 4D modelling was used to plan the crane movements and sequencing of the works at towers 6&8 for the installation of the jump start steel columns and outriggers – with structural lifts weighing up to 25t.
- 3D modelling was used for the stair installation and crane coordination at 3PS.

Other ways DE effectively aided the completion of the project was through:

- Increased confidence and safety across the project in coordination of designs and site installation methodologies.
- Facilitated transparency in project design status across the entire project team to enable early identification and intervention for delays and overall clear accountability of stakeholders to keep pace with the design process.
- Improved project programming with more effective planning of designs and installation conversion by allowing all parties to review and workshop in the model before implementing on site.

Sustainability

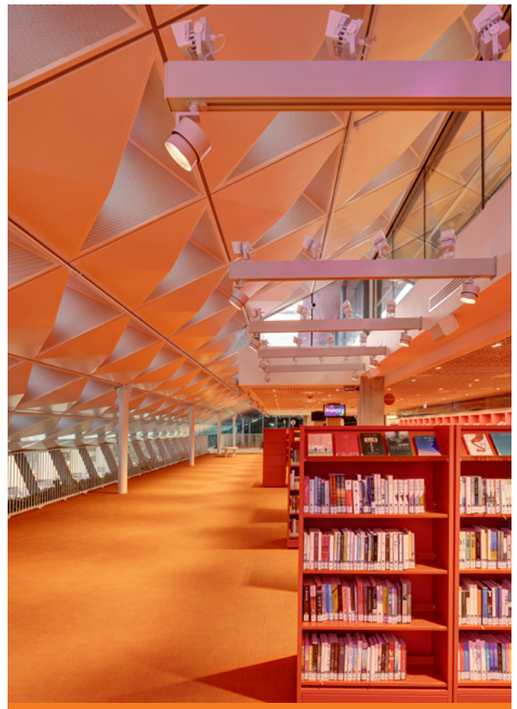
Walker Corporation was committed to building a sustainable precinct for Parramatta Square and set an initial target to achieve a minimum 5 Star Green Star rating for the four towers. BOJV implemented lifecycle assessments into the design phase of each building, working with Walker Corporation, Parramatta Council, architects and consultants to identify ways to improve sustainability outcomes and uplift each of the buildings to a 6 Star Green Star rating. In addition, the entire precinct has recently been certified to 5 Star Green Star under the Communities rating.

Not only were sustainability targets put in place for each building from the outset, BOJV also put forward sustainability improvements that benefited both the clients and end-users. One example of this includes the structural optimisation delivered in the tender re-design of 4PS that removed 33 per cent of the embodied carbon relative to the tender design with features including less concrete, lower strength concrete mixes in the core (with less cement), overall average cement replacement of 32 per cent across all mixes, a change from chilled beams to low-temp VAV removing significant quantities of copper and steel pipework and a change to the facade that removed over 60 tonnes of aluminium extrusion.

All of the completed commercial buildings in the Parramatta Square precinct have now been awarded a 6 Star Green Star rating. 3PS and 4PS both achieved 6 Star Green Star As Built ratings for the base buildings as well as major integrated fitouts with 6&8PS already achieving its 6 Star Green Star As Built rating and the major tenancy for PNSW is projected to achieve a 6 Star Green Star Interiors As Built rating. The precinct also targets very high NABERS Energy and Water ratings with 6 Star NABERS Energy (including GreenPower) and 5.5 Star NABERS Water ratings for 4PS, 5.5 Star NABERS Energy and 5.5 Star NABERS Water ratings for 3PS and 6&8PS still in the NABERS monitoring period.

PHIVE is one of the most sustainable government buildings in Australia. This building is one of Australia's first carbon neutral in operation buildings

National Sustainability Manager Claire Gallagher on site



Biophillic design of PHIVE connects nature to building occupants, dispersing natural light

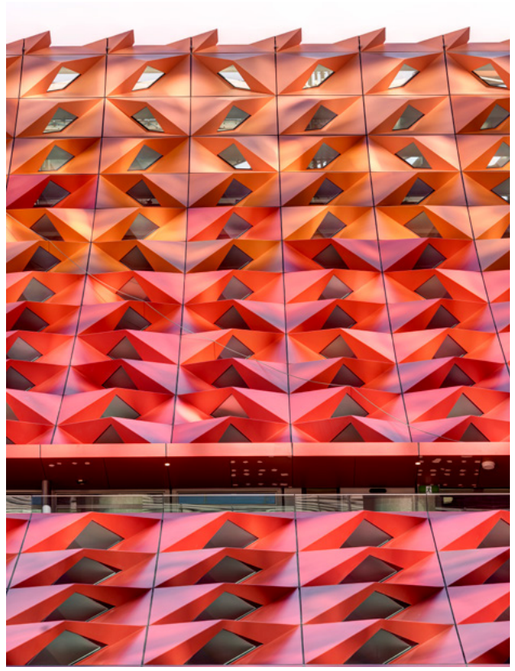
PHIVE, one of Australia's first carbon neutral buildings from day one.

from day one, with features including a complete redesign from the tender documents to take the building from a fully sealed, mechanically ventilated, gas boiler and cooling tower conditioned 5 Star Green Star design to a 100 per cent electric, waterless cooling system with mixed mode ventilation allowing natural ventilation to condition and ventilate the space for 60 per cent of the year, achieving a 6 Star Green Star rating. This has set a new standard for public buildings and the Biophilic design connects nature to building occupants to achieve a healthy environment that disperses natural light evenly and shades the interiors.

The BOJV team implemented a raft of sustainability measures across the entire precinct to achieve the most positive environmental impact as possible and continue to set the standard of sustainable achievements for commercial buildings.

The sustainability impact of the precinct includes:

- 44 per cent reduction in energy consumption
- 32 per cent reduction in water consumption
- 94 per cent diversion of waste from landfill



Health, Safety and Wellbeing

Built Worthy Site Behaviours

BOJV placed a strong emphasis on promoting a positive "one team" culture at Parramatta Square by implementing our dedicated health, safety and culture program across the project known as the Built Worthy Site Behaviours program. The co-created program developed by Built in conjunction with experts and the site workforce establishes a unique framework of behaviour that makes safety and health personal through mutual respect, open and honest communication, and individual accountability.

Before every project starts, the team develop a Project Charter in collaboration with clients and subcontractors. This is used to guide the project every step of the way and what site leaders are judged on and what people are rewarded for. As every project is different, clients are invited to discuss their expectations first and then workshop this with subcontractors to ensure everyone delivers it as one team. A charter is then developed and displayed on site as a commitment to what was agreed.

The Built Worthy Site Behaviours have been developed in collaboration with our subcontractors. These behaviours are the platform for how we operate and conduct ourselves on site and ensures positive and healthy interactions between everyone on site. It's an important way of ensuring everyone works together through the entire project toward best safety and quality outcomes.

Built Worthy Site Behaviours as seen on a typical site office at Parramatta

Staff engaging in regular health and wellbeing sessions

Wellbeing

BOJV has employed a dedicated Head of Health and Wellbeing and other professionals to help the workforce thrive through a range of initiatives and programs.

Built employees and their immediate families also had access to a free and independent Employee Assistance Program (Assure) for counselling and support such as managing stress and anxiety, relationship issues, financial planning and wellness. Subcontractors are also supported through the Foundo Blue program and the site regularly supported initiatives such as R U OK? Day to discuss suicide prevention.

Throughout the construction of the entire precinct, BOJV personnel were given access to a site office gym, multiple group training sessions with a personal trainer per week, including circuits, boxing, yoga and weights and improved site nutrition with fresh food and healthy snack/lunch options on offer daily.

Our Head of Health and Wellbeing, Haydn Masters, introduced an 8-week energy challenge which included one-on-one coaching for stress management, sleep, nutrition education, physical activity and exercise, meditation and habit changing education. He also introduced the Built to Finish Stronger Program as well as mental health presentations for leaders and mental health first aid training.

Site teams were given supplemental office lighting and thermal control (fans/heaters) and encouraged to keep a team social calendar with celebrations for key milestones, as well as lifestyle rosters accommodating personal commitments. We have also been proactive on the reduction of “dead-hours” and encourage team members to unplug after work deadlines.

Given the scale, complexity and constraints of the project, BOJV worked closely with all site stakeholders to ensure a positive, inclusive and safe environment on site. This included running drug and alcohol awareness training, superannuation and financial planning talks with Cbus, and occupational first aid and safety talks and programs. BOJV also worked to create a flexible rostering policy that allowed for construction workers to leave work after eight hours and provided a range of support during the Covid-19 pandemic to protect workers and keep them engaged and informed of the latest regulations related to testing, social distancing and hygiene.

COVID-19

Construction on the Parramatta Square precinct was in full swing when the COVID-19 pandemic hit. BOJV quickly adapted to both government restrictions as well as our own self-imposed requirements to ensure construction could progress with minimal disruption to our day-to-day operations. A COVID-19 management plan was put in place across all Built projects and at Parramatta Square this involved temperature testing on arrival, hand wash and sanitisation stations, staggered lunchbreaks, limits on the number of people in hoists and lifts and increased cleaning in site offices and amenities. Workers were also equipped with masks as well as Bluetooth Contact Tracing through wearable devices.

Diversity and Inclusion

The diversity of the workplace at Parramatta Square and across the business has been an ongoing area of focus for BOJV.

Throughout the construction of these five structures, more than 15,300 jobs were created, including 4,648 within Western Sydney and 167 for Indigenous workers.

BOJV committed to using local and Australian subcontractors and suppliers where possible and over the course of construction used a range of Social Benefit Enterprises including AWM Amaroo, TTF Manapan Furniture and WINYA Furniture, exceeding a total spend of $1.15m.

Over the lifetime of the project, BOJV prioritised the opportunity to train and develop new entrants to the construction industry. Over 500 apprenticeships and traineeships were inducted and upskilled across all projects. BOJV also employed new cadets and graduates to gain lifelong experience through on the job training and mentoring from experienced project team members. Opportunities for knowledge transfer was also leveraged outside the team by facilitating multiple site tours and presentations for university students through Western Sydney University and women in construction through the National Association for Women in Construction.

BOJV was able to achieve 15 per cent female participation on 6&8PS, along with also providing job opportunities to underrepresented people including trainees from disadvantaged backgrounds, people with disability and Aboriginal and Torres Strait Islander tradespeople. BOJV also contributed to promoting career opportunities for women in construction and other underrepresented groups, promoting team profiles, nominating team member for awards such as NAWIC and working with universities, not-for-profits and government programs including the NSW Govt Trainees program.

Social Impact

Project teams strengthened relationships from project to project throughout the precinct’s builds. This offered opportunities for staff to grow their careers, solve complex challenges and make a difference.

Volunteering opportunities with charity partner Re-Love

BOJV enlisted social benefit providers such as St John Ambulance and Borger Crane Hire on all of the Parramatta Square structures, along with local subcontractors and businesses, further solidifying relationships over the years spent together.

Aligning with local charities through various fundraising opportunities over the years, project teams also supported Parramatta Mission on an ongoing basis from 2018, donating goods, running site BBQs sponsoring events and raising more than $2,000 for local rough sleepers through one dedicated fundraiser alone.

The team also volunteered weekly for local charity ReLove to create homes for those in need. Together, BOJV and subcontractors supported 16 families in need and delivered more than 100 pieces of furniture to create homes.

BOJV also raised funds and awareness of International Day for Elimination of Violence Against Women and Legacy across the precinct and engaged in the “On the Move” campaign, providing Opal cards and shoes to support homeless people through the Wayside Chapel.


Built
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