A sky and streetscape spectacular

Deutsche Bank Place at 126 Phillip Street Sydney

A new benchmark in building design, precision detailing and quality delivery has been set by Bovis Lend Lease on a Sydney central business district commercial office tower. Bovis Lend Lease was contracted by the developer, Investa Property Group, to project manage the design and construction of this ground breaking development for a base building contract of $235 million.

Designed by the world renowned London architect, Norman Foster of Foster and Partners, and collaborating architects, HASSELL, the building is located at 126 Phillip Street on the corner of Phillip and Hunter Streets. It has 31 levels of premium commercial office space with three levels of plant above and two basement levels below ground with a loading dock and parking for 78 cars.

Troy Uleman who was HASSELL's project architect said, "the dynamic architectural aesthetic is created by the glass façade of the western atrium and the architectural roof feature. Visually the architectural roof structure needs to be read in conjunction with the south face of the building which steps back in 3 rises from level 28, creating outdoor terraces on the upper levels and allowing sun access into Martin Place. The structure presents at every third level. This was a proportional decision as we believed we needed a vertical orientation to the building giving it presence with its neighbours."

The building delivers its innovative features through several key elements. These are the remote service cores, the column free floor plates spanning 21 metres, the atrium enclosing the panoramic lifts, the fire engineering approach and the construction of the architectural roof feature.

The main entrance to the office tower is off Hunter Street via a large open public space known as "The Assembly". This space sits under the first floor plate of the building at level 4 and is split into 3 areas by a water feature and allows pedestrians to short cut from Hunter Street to the Phillip Street pavilion on the south end of the building. At 65 x 21 metres across, the assembly is more rectangular than square with speciality retail shops along the eastern face and provision for art displays on the deep set southern wall.

Large revolving glass doors lead off this space to the lift lobby which rises an impressive 15 metres to draw down daylight to the foyer from the atrium. The office floors start at level 4. Troy Uleman said that the foyer is both tight and discrete."It is entirely built in glass allowing views across Phillip Street. The glass panoramic lifts activate the street and allow people walking around to experience almost the whole of the site."

In a departure from traditional design the core, housing fire stairs, toilet facilities and all building service risers, is on the western face of the building, remote from the office floor plates.

Steel has been used in three distinct areas of the project: the structural steel-framed glass clad lift atrium and the lobby; the distinctive architectural roof feature at the apex of the building, destined to become a Sydney icon; and in the unique maintenance systems with their cantilevered arms.

The atrium structure

The impressive 147 metre high atrium rises through 37 levels and is design innovation at its best. It creates a high level of visual transparency to Phillip Street and gives light and life to the building creating a spectacularly interesting streetscape.

The north-west elevation shows the iconic architectural roof feature. The structure presents at every third level giving the building presence with its neighbours.

The atrium acts as a buffer zone, protecting the office areas from the western sun while admitting daylight into the building and drawing air from the floor plates up through the atrium. It houses the panoramic lifts and the commercial floor lobbies. The 16 glass lifts are configured linearly in 3 stepped banks - low, medium and high rise. The lifts, each with a 16 passenger capacity, rise up and down carried on an exposed structural steel framework, constructed from OneSteel 200UC sections. The lower sections are manufactured from 350 grade steel with 300 grade in the upper sections.

The lift installation is unique in that it is not housed within a solid or walled lift shaft but within the open steel framework and lobbies that are enclosed on both sides by floor-to-ceiling glass walls.

The lift structure is set between the two cantilevered concrete service cores and is free standing within the atrium space. Each of the cores is permanently anchored to the sandstone bedrock. This was essential to maintain final installation tolerances of the structural steel lift frame. The low, medium and high rise lift banks are installed and supported by an open structural steel cellular framework. The lift lobbies are attached to the sides of the concrete service cores by Teflon coated sliding cleat-plate connections. At each level pin connected pontoons provide access onto the main floor plates. Each of the lift cells was designed to provide ease of repetition in detailing, fabrication and erection. The whole structure was constructed from 1,000 tonnes of OneSteel structural steel members. Substantial coordination between the architect, structural engineers, façade subcontractor and lift subcontractor early in the design phase was essential to resolve the final detailing of the exposed atrium framework. The detailing was done by 3D AccuDraft, using Bocad software, and

all shop drawings transmitted electronically via a secure project website. 3D AccuDraft's Chris Saltana said that without the software the work would have taken a team of around six detailers. Using the Bocad program one man did the job.

Foster and Partners' Architect and Project Director, Sven Ollmann, based in Australia for this project said that Phillip Street is an example of a very successful co-operation between architect and engineer. "We envisaged a subtle structure that would maximise daylight penetration and focus the eye on the space and movement rather than a forest of connection details between different profiles. They gave us exactly what we had hoped for and more. The steelwork has a simplicity to it that couldn't be better suited for the job. The engineers have managed to design this structure from basically one single off-the-shelf profile for the main structural element, and it's slender too. It is elegant and simple, and we all know how hard that is to achieve."

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The contract fabricator for the atrium structure, Nepean Engineering, worked closely with Bovis Lend Lease to achieve the optimum outcome. Frank Moyes of Nepean said that: "the tight tolerances specified meant the structure had to be jig built. These had to come out to a minimum tolerance of 1 millimetre on the diagonal after welding."

Because the atrium steelwork forms an integral part of the architectural concept, the fabricator was required to install the steel structure without any onsite welding or site adjustments. All rectifications were done in the workshop and brought back to site.

"In all, the steelwork took 18 months to fabricate and erect. It was a difficult and challenging job but had a very positive spin-off in that the specified quality and tolerances delivered improvements in performance and workmanship, and that was a real advantage," said Frank Moyes.

The building frame

Several components make up the building frame. Lateral stability is developed by the moment resisting frame that is formed by linking the remote, anchored cantilevered concrete cores with the concrete frame formed by the tower columns and floor plates. The structural steel lift frame relies on the building frame for its stability and is attached to the frame at each level to restrict the horizontal movements, while facilitating vertical movements by guided Teflon coated bearing surfaces.

Architectural roof structure

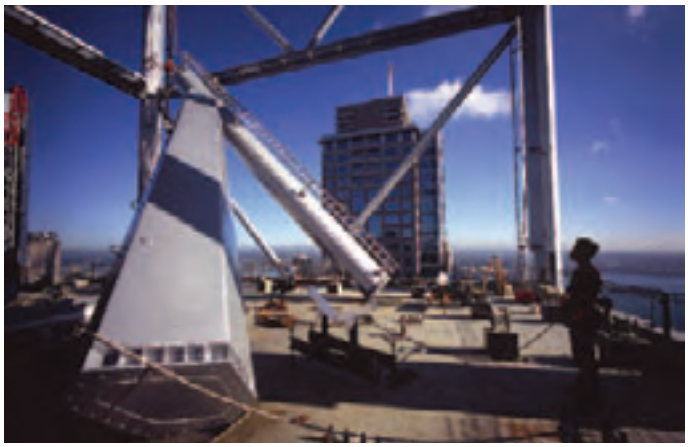
Described by engineer Rocco Bressi, Bovis Lend Lease's Project Structural Engineer on 126 Phillip Street, as an "architectural complement", the architectural roof structure has been designed to enhance the aesthetic appeal of the building and give it height and balance.

The final design was an iterative process between the client, designers, authorities and subcontractors who needed to consider all of the criteria and constraints. The main factors which imposed constraints were:

- building grid and geometric forms of the building façade, properties and overall member sizes
- planning constraints such as height restrictions, sun axis planes and overshadowing
- coordination and consistency of finish and colour to match the aluminium façade chevrons
- unobtrusive or invisible structural connections
- assembly for maintenance and the support of specialist lighting
- environmental conditions and suitable corrosion protection systems
- wind, thermal and transient loading conditions
- lightning protection and earthing requirements
- structural integrity and serviceability
- dynamic response
- fabrication techniques and erection methodologies
- cost and time factors

The architectural roof feature is constructed from around 280 tonnes of mild steel plate of various thicknesses in an open lattice arrangement set by a grid pattern 9 metres wide and 12 metres high. The fabricated hexagonal and triangular box section members and cylindrical masts to the top of the building are primarily architectural. They complete a façade pattern on the building extending about 91 metres above the roof level to an overall height of 240 metres above ground level. Recessed end plate bolted connections are used to hold the various members together.

The tall masts are also fabricated with mild steel plate and are fitted with chain dampers to negate the possibility of the masts resonating with wind-induced motions. The structure is accessible only by maintenance workers and does not incorporate any heavy equipment.
The main members have been sized architecturally to achieve the desired statement. However, plate thicknesses were selected to simplify



The architectural roof structure was broken into a number of repeating modules for ease of transportation and erection. Lifting lugs can be seen on the left of this section. Bovis Lend Lease site designed a program to transport, lift and connect the very large steel sections to minimise handling damage.

construction and ensure an economical structure. Internal longitudinal and lateral stiffeners increase the effective sectional properties of the thinner elements. Standard plate thicknesses have been used wherever possible.

For ease of manufacture, delivery and construction, the structure was broken into a number of smaller repeating modules. These include K-joints, T-joints and X-joints and straight members. The plates are fully welded at the joints for adequate transmission of strength. The typical connection detail from the joints to the straight member uses recessed end plate and high strength tensioned bolts. This minimises the slippage that can occur, especially for cyclically loaded details.

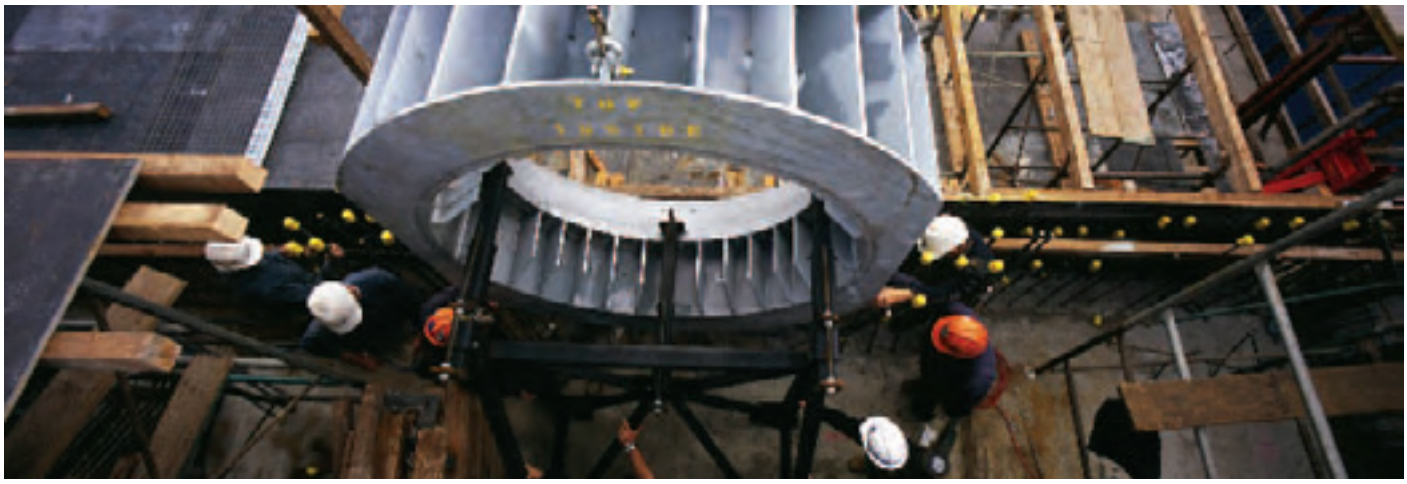
The individual plate elements forming the perimeter of the closed box sections and the cylindrical mast are connected with full penetration butt welds. For members with cyclical loading, structural purpose welds are used throughout while for members not subject to cyclical loading, more economical general purpose welds have been used. Gary Soo of Intercon Engineering, fabricators on the architectural roof structure, said that all the welds were carried out in the workshop and the structure delivered in sections to the site.

The architectural roof feature has a painted external finish with no additional cladding. "The job was one of the more difficult we have done as the design called for so many pieces" Soo said. "Because of the nature of the paintwork a great deal of care had to be taken in transport and deliver to site. We manufactured special stands for transportation and the structure was painted before deliver to site. Paintwork was carried out by Seat Corrosion Control at Giovenco Industries at Ingleburn."

The external surface has been corrosion protected by a high performance coating system to meet a durability requirement (coating life to first major maintenance) of 20 years as defined in AS/NZS 2312 for a category D environment. The coatings are an International Protective Coatings paint system applied to a Class 2.5 abrasively blasted surface. The Interzinc 315 zinc rich epoxy primer is followed by Intercure 420 high build epoxy intermediate coat and finished with Interthane 990 Quicksilver, a metallic silver polyurethane to match the Alpolic® panels on the facade.
The Bovis Lend Lease site team, led by Vince Albanese and Toby Matthews, mindful of the difficultly of accessing the roof steel, designed a program to transport, lift and connect the very large steel sections with minimal handling damage, so as to almost engineer out the majority of site repairs to the coating system.

The end plates of the connecting members seal off the internal surfaces of the tubular sections so no internal corrosion protection was necessary. Miscellaneous items such as bolts, access grating and ladders were hot dip galvanised.

Steelworker in the "man box" high above the city. Connections from the joints to the straight members use recessed end plates and high strength tension bolts.



Fire engineering

An extensive fire safety engineering assessment was undertaken to verify possible alternative solutions to meet the performance requirement of the Building Code of Australia. The assessment covered the following aspects of the building design:

- structural fire resistance and compartmentalisation
- egress
- services and equipment
- atrium provisions.

One of the major benefits of this assessment was on the atrium where the structural lift framing members were constructed in non fire-rated steel as the framing components were located a significant distance from the fire load sources on the floors.

Above: Fixing the slew ring housing to the hub set between levels 35 and 37.
Below: A horizontal slew arm cantilevers over 31 metres beyond the stepped roof.

Maintenance systems

To clean and maintain the external façade of the building, three building maintenance units have been installed.

The pedestal-mounted unit supported on the roof of the north core at level 40 is a counter balanced and rotating double slew jib machine with a jib span of 16 metres. On level 37 the unit is supported from a set of parallel tracking universal beam rails located close to the perimeter on the floor. This unit slews and luffs to access the façade beyond the architectural roof feature framing. It is also designed to access the dedicated signage on the eastern elevation.

The third and largest external unit is supported directly from the building frame on the southern elevation of level 35. A 2 metre diameter and 800 millimetre long steel cylindrical stiffened hub is encased into the side of the reinforced deep beam-wall that spans 21 metres across the double height plant room floors, set between levels 35 and 37. The hub is then used to fix the slew ring housing from which triple horizontal slew arms are cantilevered to reach in excess of 31 metres beyond the stepped floors at level 28. This unit is not counterbalanced and relies on the structural mass for its stability.

Project team

Architect: Foster and Partners, London
Collaborating Architect: HASSELL
Project Manager: Bovis Lend Lease
Structural Engineer: Bovis Lend Lease
Building Contractor: Bovis Lend Lease
Steel Detailing: 3D AccuDraft
Steelwork Contractors: Nepean Engineering (Lift Framing). Intercon (Architectural Roof Feature), C&V Engineering (Misc Metalwork)
Fire Engineering: Stephen Grubits & Associates
BCA Consultants: Mackenzie Group
Protective Coating: International Protective Coatings