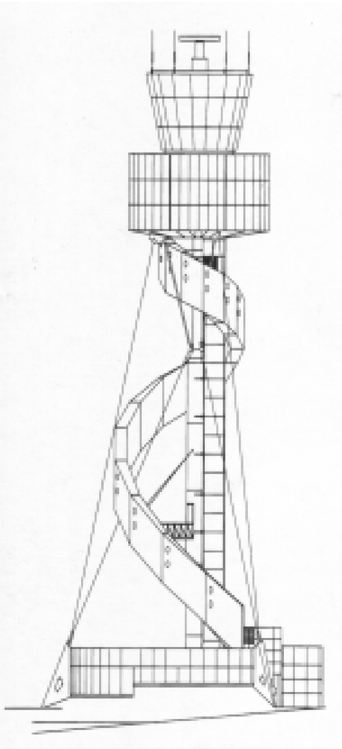
Steel lights up S

This case study was written at the time when OneSteel was part of BHP. In that context, in some instances within this case study, reference may be made to BHP.



Airport control towers are the lighthouses of the 20th century. The new control tower under construction in Sydney will have dramatic impact as a symbol of the airport and in civic design terms. The tower, located next to General Holmes Drive, is being built for the Civil Aviation Authority as part of the parallel runway project.

As air transport has become more elaborate, the traditional squat brick control towers have evolved to taller steel frames and in the most familiar form, tall cantilevered concrete shafts with a large bubble on top, using the technology of water towers. In designing for Sydney, this convention was challenged. A cantilever out of the usually swampy ground of airports and another cantilever at the top encourages sway, while the massive loads of water towers do not apply. As there must be a lift, services and emergency stairs, the shaft is grossly oversized for the loads involved.

Sydney's unique control tower consists of an observation cabin with all round visibility achieved by angled frameless glass and minimum columns. This design has only one central column from which the roof cantilevers, stabilised by stainless steel rods in the glass joints. Perimeter air traffic control consoles enable controllers to survey the parallel runway systems, the first time this has been done in Australia. Above the cabin is the surface movement radar sensor and a corona of aerials and lightning conductors.

Below the observation cabin is the main deck, designed as six pods, like a cloverleaf. Accommodated are electronic equipment and plant rooms, staff rest area, toilets and management office. The overall height of the structure is 45 metres and at the base is a circular building with plantroom, standby generator, uninterrupted power supply, equipment rooms, staff amenities and management offices. The geometry of the design is based on an equilateral triangle or tri-star plan with a slim central column in which services run, supporting a steel strutted and cantilevered platform and braced by post-tensioned steel rods to three points on the base building. This ensures the most rigid, sway-free structure with the advantage of prefabrication for rapid construction. To maintain the visual clarity of this stayed-mast structure, the lift runs on the outside of the central column and the escape stair moves in a large spiral, well away from it. The effect is a striking one, demonstrating advanced technology appropriate to its purpose and its associations with aircraft technology. All of the construction is lightweight, prefabricated and weather-protected, essential for the extreme, terrain exposure of its location. This solution arose from a reassessment of the logic of the conventional towers.

In the early stages of design three structural systems were considered. A free standing concrete tube was ruled out for aesthetic reasons as the proportion of the height and the necessary tube diameter proved not to be attractive. For cost reasons a steel lattice tower was not acceptable, the solution, a stayed tower combining steel and concrete is structurally efficient and economical.

Driven end bearing piles were required to support the Base Building and the tower which stand on 3-4 metres of fill over soft natural ground with rock at 2Om. Some of the piles were required to resist tension and were located to tie down concrete buttresses resisting the tower guys. The buttresses are of reinforced concrete 5 metres high and are intended to be dominant for architectural reasons as well as serving a structural and construction function.

Conventional reinforced concrete construction is used in the 30 metre diameter Base Building. A suspended slab is over the pile group and concrete columns support the roof slab. A curtain wall encloses the building.

Rising through the Base Building to a height of 22 metres is a 2.5 metre diameter segmented precast concrete shaft. The shaft face is truncated to provide a running surface for the external lift. From the top of the concrete shaft extends an 1100 mm diameter steel tube 11 metres high. Combined with three radial struts, this supports the Main Deck and the Observation Cabin.
The six pods of the Main Deck radiate from an 8m diameter ring beam supported from the radial struts. Rectangular in cross section (80Ox300 mm) it is made up from 40 mm flange plates and 12 mm webs. Cantilevered from the ring beam are a series of radial tapered floor beams fabricated from standard OneSteel 8O0WB122 welded sections, which support a 140 mm slab on 1.0 mm Bondek. Steel was ideally suited to the Main Deck construction. This part of the structure was assembled at ground level and then hoisted in a single 34 tonne lift to its final position, using a 400 tonne mobile crane at 22m radius.
Above the main deck, the Observation Cabin sits on a composite concrete and Bondek slab on steel beams. For acoustic reasons the roof of the cabin is also a composite slab supported by steel beams

cantilevered from the central column. Overturning of the roof is prevented by 18 stainless steel tie rods of 16 mm diameter. These connect the roof to the floor and are outside the glass on the line of the vertical silicone joints between the glazing and allow for maximum all round vision.
The slenderness of the shaft system, under the influence of the cantilevered Main Cabin, required an external stabilising system. This was achieved with struts and guys. Steel gusset plates at the interface of the steel tube and concrete shaft, support the lower ends of steel pin-ended struts (355xl2.7 CHS). The struts radiate outwards and upwards to support the ring beam at the floor of the Main Cabin. Both ends of the struts are stayed back to a single stainless steel clevis plate connected to the concrete buttresses. The design of the guys was governed by stiffness to control lateral deflection of the tower. This was achieved with 80 mm diameter rods manufactured from 350 grade steel. This stabilising system is repeated at 120 degree intervals around the tower.
Turnbuckles are located at the lower end of the guys to allow for initial connection to the clevis plates. Located slightly higher than the turnbuckle is a complete penetration butt weld which connects the 80 mm diameter carbon steel guy to an 80 mm diameter stainless steel rod which becomes part of the turnbuckle mechanism and terminates with pin connections at the clevis plate. In this way maintenance requirements for the clevis pin assemblies are eliminated in the coastal environment. The weld

Above: Tower guys connecting to concrete buttress through clevis plate.

Top left: The tower during construction.

ydney Air Traffic

procedure for the butt weld was specified by Sandvik Australia Pty Ltd, the stainless steel suppliers. The clevis plates were manufactured from stainless steel up to 40 mm thick in grade SAP 2205.

The clevis plates were designed with a sliding connection to the buttresses to allow, final tensioning of the stays. Hydraulically operated "Hydranuts" were used to anchor and stress the stay rods. Manufactured by Technofast Industries in Brisbane, these allow simple monitoring and adjustment of the forces in the stays.

Prefabricated and preclad rectangular box truss units, with steel stair components assembled inside were delivered to site and erected to form the emergency spiral stair exit. The box units are torsionally rigid and are supported at Main Deck level and Base Building roof level, with two intermediate supports which also provide emergency escape walkways from the lift shaft to the spiral stair.

Structural members in the Main Deck and Observation Cabin were given a Fire Rating Level of 90 minutes. This was achieved with conventional sprays and intumescent paint. For architectural purposes, steel within these areas left exposed was protected with Firetex intumescent coating from IGC Fire Coatings.This provided the necessary fire protection and a base for a normal paint finish.

Client:	Civil Aviation Authority
Project & Construction Manager:	Incoll Management
Architects:	Ancher Mortlock & Woolley Pty Ltd
Structural Engineers:	Ove Arup & Partners
Builder:	Amacon Constructions
Fabricator:	Ferrcom Pty Ltd