AUSTRALIAN CONSTRUCTION ACHIEVEMENT AWARDS 2017

161 SUSSEX STREET REDEVELOPMENT

TECHNICAL PAPER

MULTIPLEX

CONTENTS

ABSTRACT

- Client: GL Investment Co Pty Ltd
- Completed: December 2017 (Final Stage)
- Contract: Early Contractor Involvement (ECI), Design and Construct (D&C)

The 161 Sussex Street Redevelopment project involved the expansion of the existing operating hotel into an upmarket tourism and convention destination. The development included the refurbishment of the existing hotel, construction of a new Convention Centre, construction of a new 27-storey hotel/ commercial tower, and a 2-storey addition to the existing northern tower to deliver a new rooftop bar overlooking Darling Harbour.

This technical paper focuses on the innovative design and construction strategies implemented by Multiplex to deliver the new Convention Centre component of the development despite challenging constraints that included building across the Western Distributor freeway, ensuring uninterrupted operations of the existing hotel and the extensive design and planning initiatives that were undertaken to deliver this iconic world-class conference and event destination on time and fully endorsed by the Client, stakeholders and hotel management and operations alike.

PROJECT SUMMARY

The 161 Sussex Street Redevelopment project involved the refurbishment of an existing operational hotel into an expanded upscale tourism/convention destination. The project included:

» Construction of a new podium building supporting 3,450m^2 of event space spanning both the north and southbound carriages of the Western Distributor freeway

» Construction of an adjacent 27 storey hotel / commercial office tower spanning the southbound carriageway and providing an additional 222 hotel rooms over 14 floors plus 7,400m^2 GFA of commercial space over 9 upper floors

» Refurbishment of the existing hotel

» Reinstatement of and connection to heritage buildings along Sussex Street

» New upmarket rooftop bar offering an exciting tourist and leisure destination overlooking Darling Harbour

» Upgrade of roads and pavements adjacent to the hotel

The project was completed with minimal disruption to the 600–700 hotel guests staying in the existing hotel each night and remarkably, the hotel remained operational throughout construction, successfully maintaining average occupancy at 88%.

Despite the complexities of working over the Western Distributor and adhering to strict 3–4 hour windows for completion of works above the closed carriageway, there were no disruptions to the 80,000 vehicles that commute via the Western Distributor daily, and zero complaints were received.

CONVENTION CENTRE

ENABLING WORKS

161 Sussex Street is a highly constrained site, bordered on the north by converging Western Distributor and Sussex Street, on the west by the Western Distributor, on the east by Wheat Road and Sussex Street terraces, and with the fully operational hotel immediately to the south.

Extensive enabling works were required to allow for construction to safely commence. Wheat Road was diverted west to create a site compound directly adjacent to the Western Distributor which minimised Wheat Road disruptions. The diversion of Wheat Road was carried out in consultation with landowner SHFA over two stages to maximise the number of available bus parking bays at any given time.

The existing pedestrian stairs were demolished through a series of night work shifts. Following the two stages, an A-class hoarding was installed to create a safe construction zone. RMS granted approval to install a 5 metre high screen alongside the Western Distributor which allowed for piling works to take place during daytime hours on the western side of the new convention structure.

The design of the structure required foundations to be located in the area between the north and south bound carriages of the Western Distributor. To accommodate for a piling rig, a temporary shoring structure with driven piles was installed to protect the Western Distributor. This allowed for excavation to install a stable piling platform without undermining the RMS asset.

PRECAST DECK

DESIGN STRATEGY

One of the key challenges for the project team was the design and installation of the Convention Centre structure over the north and southbound lanes of the Western Distributor. Multiplex collaborated with the client and consultant teams to develop the concept design into a solution that considered the safety and construction risks, while taking into account the limitations imposed by RMS, restricting working hours to only 4 hours per night, 5 nights per week.

Multiplex engaged a precast subcontractor specialising in bridge design as the highly complex precast planks were required to conform to stringent RMS bridge codes as no code existed for the construction of building structures over RMS assets.

The design solution was a prestressed inverted T-beam with transfloor infill that met the following criteria:

» Achieved 10KPA live load rating once installed, without topping

» Met the stringent RMS structural criteria as well as the stringent project deflection and acoustic criteria

» Were able to span across the Western Distributor up to 20 metres without propping

» Allowed structure to cantilever 2.5m past the supporting headstock on Wheat Road, thereby deleting a difficult junction of in-situ and precast detailed on the tender set of documents
» Achieved the required 4-hour fire rating to the hydrocarbon fire curve as the Western Distributor is a dangerous goods route
» Reduced structure dead load by use of trans floor infill section, therefore more efficient structure
» Reduced transport costs again by use of trans floor infill sections
» Provided the flexibility of installing the convention deck incrementally within restricted night hours

The development of the installation methodology was an integral part of the design process, ensuring the plank design suited the proposed install sequence and associated safety requirements.

CONSTRUCTION STRATEGY

Typically, the precast plants were 23–25 metres in length and 15–22 tonnes in weight. All planks in areas 1 and 2 (refer Figure 2) were installed during night hours with closure of the Western Distributor, as per the following hours:

» The north or south bound WD full road closure were Sunday to Thursday, 11:00pm–4:30am. The first hour was set-up and the last hour was pack-up – leaving 3.5 hours working time.
» The north or south bound WD partial lane closures were Sunday to Thursday, 10:00pm–4:30am. The first hour was set-up and the last hour was pack-up – leaving 6 hours working time.

All works to install the precast planks in Area 3 took place during regular working hours as there was a B-Class hoarding over the Distributor to protect road users.

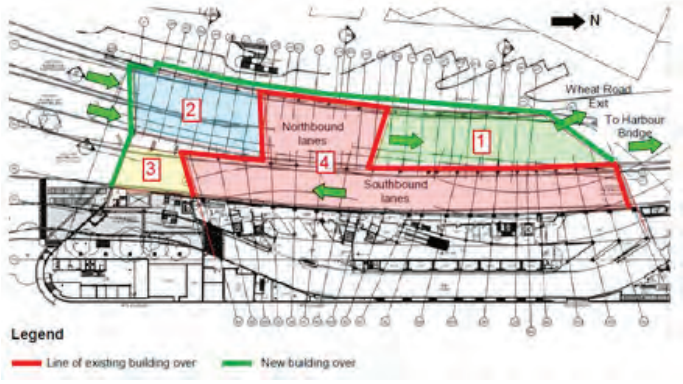

Figure 1 Precast planks were installed in areas 1,2 and 3

Due to the restriction in night working hours, the project team determined that site tower cranes (Favco M1280D and M860) would be the most efficient installation method for the precast planks, as mobile crane establishment and de-establishment would have consumed a large portion of time each night. Further, this installation method also removed the risk of multiple mobile crane setup locations on the RMS asset.

The design of the Convention Centre meant that two most southerly precast planks were over the lifting capacity of a single tower crane. Consequently the project team had to plan for a dual lift, using both the tower cranes installed over the existing hotel lift cores. In order to mitigate safety risks prior to the installation of the two most-southerly precast planks, a crane lift study was conducted and the site team carried out 5 dual lift installations of precast planks (within the capacity of a single tower crane) as practice runs.

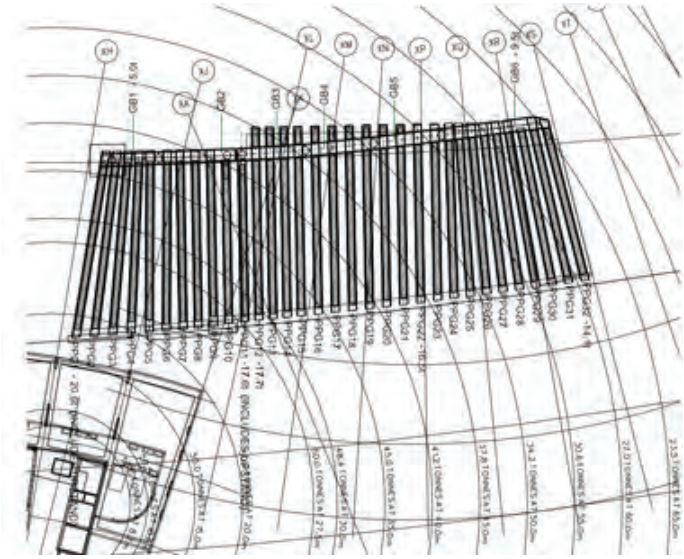

Figure 2 Crane lift study

Due to the high-risk nature and complexity of the precast installation, a total of 5 high risk workshops were held prior to works commencing. During those workshops, a number of key issues were identified and control measures established:

» A secondary storage yard was set up in Port Botany to ensure deliveries ran smoothly
» A plank identification system was implemented so that the Multiplex supervisor and crane coordinator could identify each element and relate to the lifting certification documentation provided by the precast subcontractor
» A series of exclusion zones were identified to be established and maintained as installation progressed, it was also agreed that planks

would come with fence panels preinstalled to minimise working on exposed edges

» Similarly, all planks had prefixed rope access points and lines installed to allow harness points for Multiplex crane crew and precast riggers during the infill of the transfloor elements of the system (refer Figure 3)

» For the install of the precast planks, access was gained to the supporting headstocks via Peri scaffold system so that planks could be landed safely by Multiplex crane crew with limited exposure to a leading edge (refer Figure 4)

» Nightly prestart meetings with all construction workers and staff working each shift to clearly identify truck routes and exclusion zones for that particular night.

Figure 3 Workers on harnesses install the transfloor panels

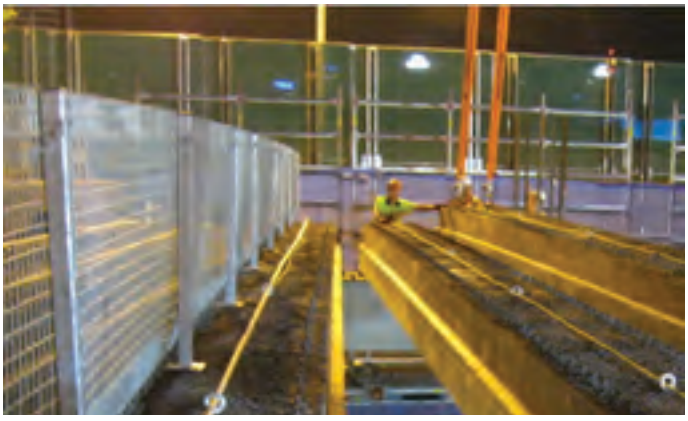

Figure 4 Precast planks installed from Peri scaffold system

STRUCTURAL STEEL TRUSS AND ROOFING SYSTEM

DESIGN STRATEGY

The Convention Centre saw tooth roof involved steel truss members positioned 8 metres above the floor deck and a layered roof system to cater for the high acoustic rating of the function rooms below.

At the earliest stage of the project, the Multiplex team recognised that this could have significant safety issues given its size and its location above the Western Distributor and the resultant need for work to be undertaken at height. In a highly collaborative and best-for-project approach, the structural engineers, architects and Multiplex design team solved this problem and created a design that required almost no work at height.

As the Convention Centre design is determined by the curvature of the roads below, the original design had the trusses on the southern end following the road geometry with chords designed along radial rather than parallel lines.

Our specialist engineer proposed reversing the design, so that all the trusses were uniform and the gutters of varied width followed the road's geometry. This decision meant that the roof could be assembled on the precast deck.

Bolting the prefabricated elements together on deck eliminated the critical risks involved in working at height. In addition, the uniform trusses only required a single jig for lifting rather than the multiples necessary for the original design.

CONSTRUCTION STRATEGY

Following a number of high risk workshops and close coordination with the structural steel and roofing subcontractors, a solution was developed that allowed the structural steel trusses to be installed on the mezzanine slab using a steel jig that fits all trusses.

The roofer was then able to access the assembled trusses on the slab (instead of eight metres in the air) to install all possible components of the roof system which includes three different types of insulations, corrugated roof sheets, top hats and fixings.

In order to test the proposed techniques, a prototype was prepared at the structural steel fabricators yard. A full truss bay was assembled on the steel jigs and the roofer installed five metres of the roof system, including all gutters and ridge capping so that the system could be tested for leaks.

The prototype was then inspected by the architect and acoustic engineer, as well as all the main roof supervisors, and their feedback was incorporated in the final installation on site.

Figure 5 Structural steel fabricator's off site prototype mock up.

A detailed roof installation sequence and methodology was then developed to simplify the installation of the Convention Centre saw tooth roof system. The methodology aimed to nominate a work area on the mezzanine slab where the assembled trusses would not be lifted over workers. The process also had to be detailed accurately to ensure the sequence of truss assembly enabled space for installation and that erected members were always structurally stable. The methodology was then presented to the subcontractors to ensure their feedback was incorporated.

Figure 6 Snapshot of the roof truss install strategy

All trusses were lifted progressively using the Favco M1280D tower crane over a period of nine weeks. Given the variance in length and weight distribution of each bay, an engineered lift study that included the weight of the roof system was carried out for each steel truss. This determined the most suitable lifting arrangement to avoid excessive deflection.

Once the truss was assembled onsite and the roofer completed the installation of the roof system, a risk assessment was conducted. The structural engineer inspected each truss on the slab prior to lifting and Multiplex collected lifting certificates and inspection and test plans (ITPs) from the structural steel and roofing subcontractors to ensure the trusses were correctly installed and safe for lifting. Once lifted by the tower crane, each truss was secured in its final position by use of elevated work platforms.

To further minimise the risk of working at heights, a certified temporary handrail system was installed around the perimeter of the roof trusses whilst still on the ground to allow for further work to be conducted at heights without the use of harness support systems.

Figure 7 Prefabricated structural steel roof trusses being lifted into place.

ECOLOGICALLY SUSTAINABLE DEVELOPMENT

FAÇADE DESIGN

During the early design phase, the western façade of the Convention Centre posed significant challenges with respect to a number of performance characteristics. These included noise from the adjacent expressway; expansive glazing orientated directly west, and having an internal space accessible to the public. The internal environment within the space needed to meet exacting acoustic, thermal conditions and be robust enough to accommodate high occupancy populations without damage to the façade elements such as internal blinds.

The developed solution was to develop an 8 metre closed cavity façade with a 200mm sealed cavity between the two glazing panels. Performance of the outer double glazing (DGU unit) allows internal operable blinds to retract when the solar gain is low and deploy then modulate to the most effective angle when exposed to direct sunlight during the course of the afternoon (refer Figure 8). After sundown, the blinds raise automatically giving occupants an unparalleled view of Darling Harbour until the following late afternoon. For the triangular glazing above the closed cavity façade, electro-chromatic operation increases opaqueness when the solar gain increases above the pre-set point (refer Figure 9).

Figure 8 Internal operable blinds between two glazing panels

Figure 9 Triangular glazing with electro-chromatic operation

MECHANICAL SERVICES DESIGN

The environmental condition within the two convention halls was a critical item for the client team. The brief was that the rooms could be divided using operable walls and the event either side of the walls could be significantly different within the limitations of the acoustic parameters. The project brief included the requirement for the space to be able to keep guests comfortable at dinner table or dancing at a party. The buildings unique position with a glazed façade facing west over Darling Harbour also required the consideration of the inevitable solar gain during the afternoons. In addition the system required the flexibility to have part of the room in operation and the remaining area in set back position to save on energy costs.

To meet the architectural design intent and maximise the ceiling height, the air conditioning system was unconventionally placed on one side of the room only, to eliminate any duct work in the ceiling space. Each bay of the conference area is served by a single air handling unit supplied with both chilled and heated water. The new chiller system installed was specifically selected to operate at high efficiencies, and the magnetic bearing high efficiency chillers complement the existing installation, providing effective life cycle cost return. The BMS controls EC fans to deliver the air into an air tight plenum into which was built three uniquely designed jet and perforated diffusers (refer Figure 10).

The jet and perforated diffuser combination allows the jet to throw the air the required distance from the east wall to the west façade and the perforations induce a slower moving air, which helped with the throw and allows the cooled air to drop from the ceiling. This system also removes the velocity of supply air which causes the most issues when guests complain about internal environments. The position of the jet diffusers modulates dependent upon the temperature of air they are delivering, the heads are 30 degrees below the horizontal for the delivery of warm air and rise up to be parallel with the ceilings as the temperature of the air lowers into the chilled water cycle. As the conditioned air warms against the inner surface of the façade it rises through buoyancy to the return intake above and taken back to the plant or discharged outdoors.

The system was tested in Europe to ensure its performance and considerable on site testing proved the reliability of the system within the space.

The northern hall has 12 air handling units connected to 12 air tight plenums, each containing three of the uniquely design diffusers, the southern hall has 8. The units are controlled against the area which can be subdivide by the operable walls achieving the clients design parameters by being able to deliver different temperature air to satisfy the event regardless of its location within the hall.

The testing undertaken included heating the halls to 30 degrees with a combination of electrical heaters and solar gain before energising the air conditioning system. Once engaged, temperature readings were taken at prescribed locations along with measurements of the air velocity. The result was the halls returning to a set point of 22 degrees within 30 minutes while minimal velocity was being detected. Finally fog tests were carried out to view the air movement within the halls verifying the even distribution and ensuring none of the air against the façade was “dumped” on the guests.

Figure 10 Air tight plenums containing three unique jet and perforated diffusers

Figure 11 Jets on eastern wall throw the conditioned air to the western façade

Contact

David Ghannoum
Regional Managing Director

Address

Multiplex Constructions Pty Limited
L22, 135 King St
Sydney, NSW 2000
Australia

Phone & Fax

T: +61 2 9322 2400
F: +61 2 9322 2001

Online

multiplex.global