St Marys Integrated Project Office

Sydney, Australia

1.0 Introduction

The St Marys Integrated Project Office (IPO) is a temporary 200-workstation design office created to support Sydney Metro for the design and construction of six new metro stations connecting St Marys railway station to the future Western Sydney Aerotropolis. Serving as a hub for the project teams, the IPO will facilitate effective collaboration in the construction of Critical State Significant Infrastructure (CSSI). Robert Bird Group (RBG) was engaged by Built on behalf of Sydney Metro, with RBG's role encompassing the structural design of the building, including detailed design of foundations, a hybrid structural steel frame and cross-laminated timber (CLT) floor panels. The most challenging and important feature was designing the structure to allow for dismantlement at the completion of the project, so it could be relocated and reconstructed for future metro projects, reducing construction waste and keeping materials out of landfill. The overall characteristics of the building consisted of a facade featured glazed curtain wall, four commercial levels, an outdoor terrace, internal access stairs and a lift.

Image Source: Built Australia

2.0 Project Brief

At the project's inception, RBG received a brief from Built, outlining three main components:

- The structure needed to be structurally efficient and sustainable.
- Achieve an accelerated construction programme to meet Sydney Metro mobilisation to site.
- Enable the structure to be dismantled and relocated at the completion of its intended use.

Upon receiving the brief, RBG commenced conceptualising ideas on how to design and document the building structure to meet the project requirements. We worked closely with the project consultant teams and Built to ensure that critical decisions were made early in the 10-week design phase.

Our first task was to study the project tender design scheme and alter the building structure accordingly. Early on, we identified an elevated steel frame building with CLT floor panels as the most economical construction solution. This choice of material satisfied all three components of the project brief.

Once the construction materials were determined, RBG proposed altering the geometry of the building grids to match standard steel member stock lengths. This adjustment minimised material waste and allowed steel members to feed straight into fabrication beam lines, decreasing fabrication times. As a result, the project instantly saved around 10 tonnes of structural steel, equating to an approximate saving in steel tonnage of circa 11%.

Architect:
Place Studio

Contractor:
Built

Client:
Sydney Metro

CLT Supplier:
XLAM

CLT Installer:
Savcon

Structural Steel:
Proline Steel

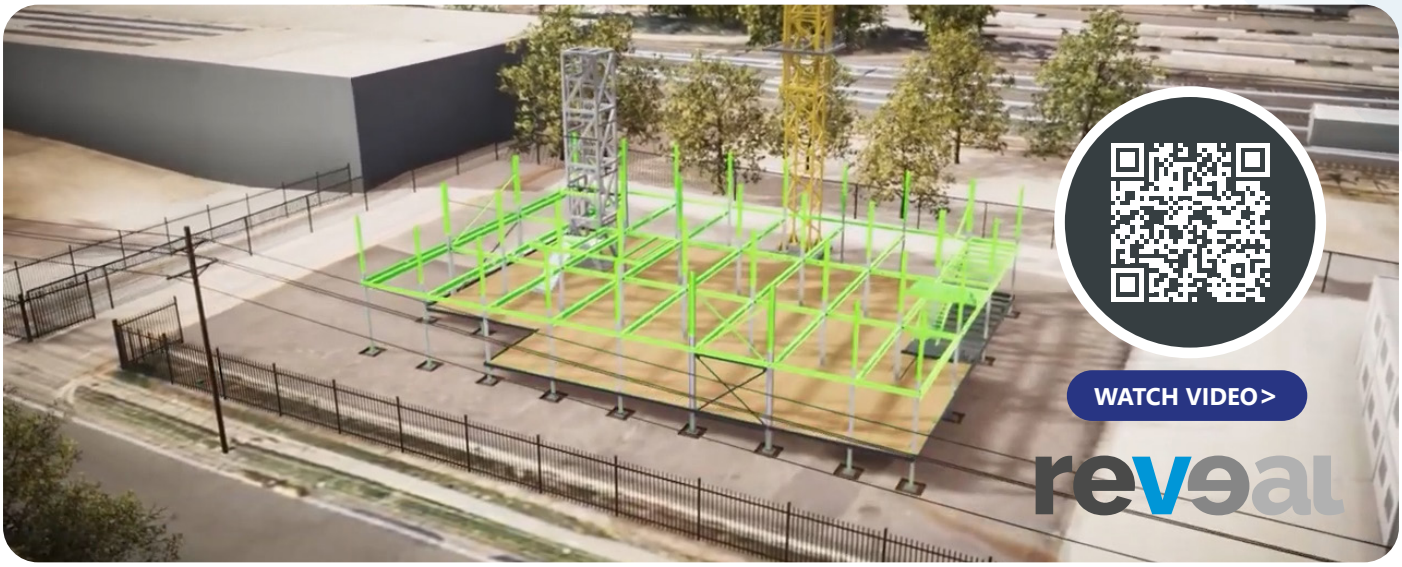
Construction Value:
$16M AUD

3.0 Design and Construction Phases

A critical aspect of the project brief was designing the structure to achieve an accelerated construction programme. To accomplish this, RBG utilised the following items in the design:

- Elevated ground floor structure: eliminating the need for excavation, allowing services to be reticulated under the building in a sub-floor.
- Consistent structural steel framing: the use of simple bolted connections across all levels facilitated rapid construction and will simplify future dismantling and reassembly.
- RBG's expertise in temporary and permanent engineering: our capabilities were critical in determining the most efficient design and erection methodology, reducing the need for temporary works and minimising overall material wastage. We designed a full-height lift shaft as a single piece assembly to be erected first, allowing each level to be constructed and braced off the lift shaft. This eliminated the need for any temporary bracing and allowed for safe dismantling, with the lift shaft being the last piece of the building structure to be removed, ensuring stability throughout the disassembly phase.
- Collaboration: during the concept phase, we worked closely with Built to develop an erection methodology and construction sequence, which was then documented in our internal visualisation software, 'Reveal'. This collaboration allowed Built to develop their construction programme with subcontractors and effectively manage overall site operations during construction.

During construction, all building elements fit seamlessly together, aided by the aforementioned items. This enabled Built to complete the total superstructure (structural steel frame and CLT floor panels) within just 25 working days. The lift core of the structure was erected in a short time frame of only 4 hours. These efficiencies and well-executed tasks allowed Built to achieve an accelerated construction programme to satisfy Sydney Metro project requirements.



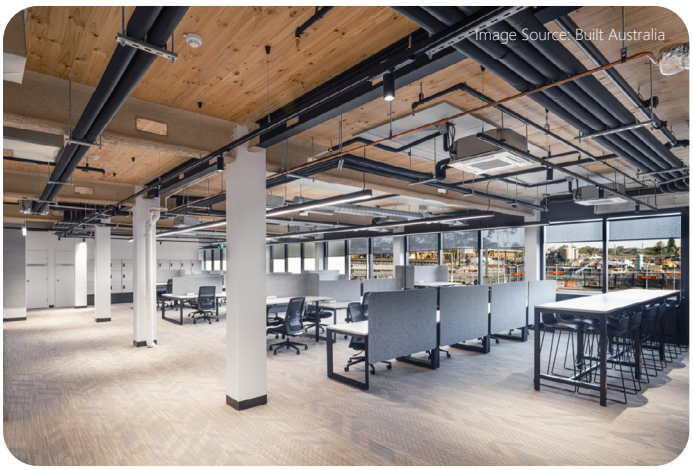


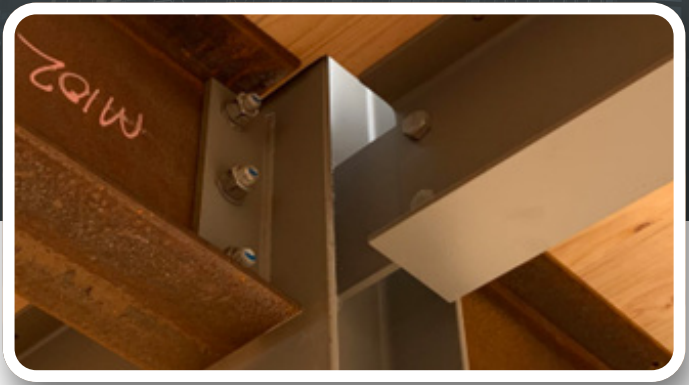
Image Source: Built Australia

4.0 Creativity and Innovation

The innovative design of the IPO reflects a commitment to both functionality and sustainability - a product of RBG's creativity and innovation. The hybrid structural steel frame and CLT floor panels were carefully chosen to support the building's temporary nature while ensuring it could be easily dismantled and repurposed for future projects. Typically, structures are rarely designed with consideration for how they will be dismantled at the end of their service life, let alone how they can be reassembled at a different location.

The project brief's requirement for the building to be dismantled and reassembled led to innovative solutions. This included creative approaches to how the steel members needed to be fixed together. If connections were complicated or required site welding, future phases of the building would not be feasible. RBG designed the structure with consistent connections throughout, which posed challenges in ensuring minimal variation in steel connections under various loading conditions.

It was not until the construction phase that the benefits of standardising all connections became apparent. This approach sped up the steel erection process, allowing the accelerated programme to be comfortably met and highlighting the project's creative thinking and forward-planning design.



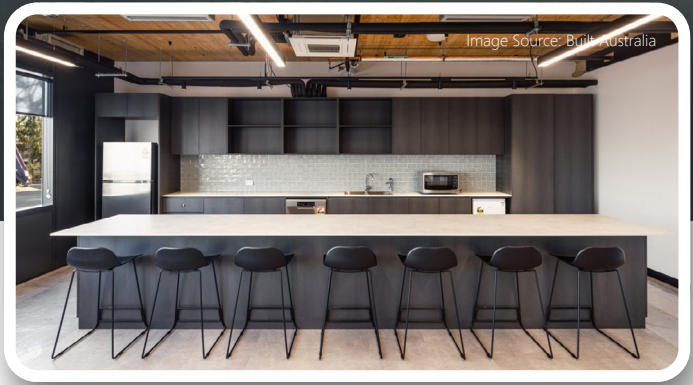


Image Source: Built Australia

5.0 Sustainability

Sustainability was a key consideration in the design of the IPO. Our structural framing was ingeniously designed to allow for disassembly and reassembly, enabling the building's reuse on future metro project offices instead of constructing new facilities. The design brief required a design life of 50 years, assuming reassembly every 10 years. We ensured that floor beams, column sizes, connections, and CLT floor panels were identical throughout the building to facilitate easy relocation and reconstruction. The lift core was fabricated and erected in a single piece to minimise erection and simplify construction by reducing loose members.

This approach not only reduces material wastage but also exemplifies how temporary structures can be designed with long-term sustainability in mind for relocation and reuse. The cradle-to-gate carbon (Modules A1-A3) of the superstructure was measured to be 563 TCO2-e. Assuming five lifecycles for the building, this design saved 2,534 TCO2-e on the cradle-to-gate carbon compared to a series of standard single-use temporary like-for-like structures using prime materials.

Early involvement allowed the building grids to be set out according to stock lengths of structural steel members, thus minimising steel wastage. It was calculated that 11% of the overall steel tonnage was saved compared to the reference design, equating to a reduction of 33.5 TCO2-e cradle-to-gate, or a 6% decrease in the superstructure's carbon footprint. RBG and Built worked effortlessly together to ensure the most economical structural scheme was developed from the outset, focusing on minimising temporary works, material wastage and maximising efficiency.

6.0 Built Environment and Heritage

Typically, project site offices consist of a series of demountable buildings and/or double-stacked shipping containers placed within a site compound. This IPO is the first of its kind, providing a fully integrated project office that can be dismantled from one project and reassembled at another, retaining all the key elements of a commercial building and significantly enhancing the built environment where project teams work and collaborate.

The IPO achieves several improvements to the built environment compared to a typical temporary project office, including:

- A more comfortable work environment for project teams relative to demountable building and shipping containers.
- Designated meeting spaces contained within a single building where project teams can collaborate.
- Comfortable site amenities for site personnel.
- A façade system with a glazed curtain wall that allows natural light to enter the building, unlike typical demountable buildings and shipping containers, which have minimal windows.
- Enhanced insulation, windows, doors, and roofing that minimise heat transfer, maintain indoor temperature stability, and further reduce energy consumption.

Due to the successful outcome of this project, we believe this building to be the first of its kind to allow sustainable structures to be built and integrated into the built environment. This structure should serve as a delivery model for designing and constructing commercial buildings in areas outside of high-density populations, with the capacity to be dismantled and relocated in and around emerging precincts such as Bradfield City Centre.

7.0 The Challenges and Resolution

Fire Rating: Fire rating of the building's structural elements posed a significant challenge for the feasibility of the structure. The two main construction materials proposed generally lack the inherent fire-resisting properties found in traditional construction materials like reinforced concrete and masonry. We worked closely with the project fire engineer to determine how to frame the structure for optimal fire-resisting design.

The CLT floor panels did not require any passive fire protection, as RBG consulted with the CLT supplier and fire engineer to determine charring rates that would rely on a reduced cross-section of the CLT panels during a fire event. This design philosophy recognised that when exposed to fire, CLT panels form a protective char that slows the reduction of the cross-sectional area, thus achieving the required fire-resisting period.

The structural steel beams were analysed and designed so that only the necessary beams supporting the floor required passive fire protection under the ultimate fire load case. The structural steel beams that were neglected under a fire load case are predominately the secondary floor beams that restrain the building columns at each level. This approach was justified by relying on the CLT floor diaphragm, which, even under a reduced section due to charring, would restrain the steel columns from buckling at each floor level. Further, the robustness of the CLT diaphragm was assessed to ensure that it met the overall building structure's requirements during an ultimate fire load case.

Floor Vibration: Due to the lightweight nature of the construction materials used for this project and the well-balanced floor spans, there were initial concerns that the floor structure might be too flexible, potentially leading to floor vibration issues. If the floor was susceptible to poor vibration performance, it could create a disruptive office environment and an uncomfortable workplace.

To address this concern, we performed a finite element analysis of the floor structure early in the design period. This analysis included a natural frequency assessment and advanced calculations to determine if the floor was a vibrational sensitive structure. The results indicated that the structure had sufficient mass relative to the floor spans, and vibrational effects were not a concern. This outcome was a relief to the project consultant teams, allowing the floor structure to remain efficient and lightweight.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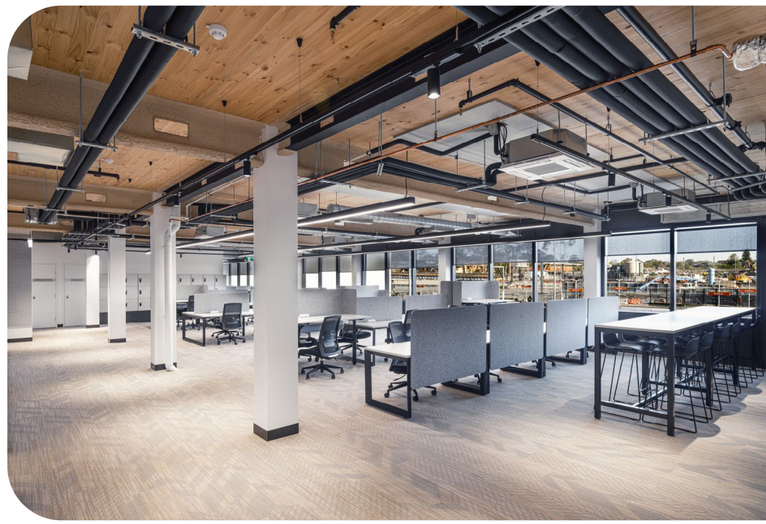

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