International House Sydney

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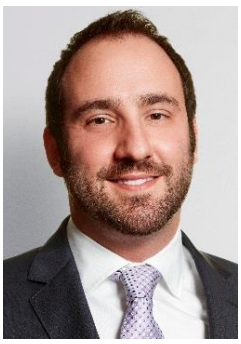

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1. Introduction

Standing at the entrance to the Barangaroo precinct, International House Sydney is Australia's first engineered timber commercial office building. On top of a concrete podium deck, the structure is entirely glulam timber beams, columns, CLT floors and walls to the roof over level 6.

Figure 1: International House, Sydney

Barangaroo is a new gateway to Sydney's CBD, with over 80 retail outlets, bustling laneways, wide walkways and dramatic waterfront promenades. International House Sydney is set to become a design icon at the entrance to one of the city's most visible locations.

2. Why Timber?

International House Sydney is located on the eastern shores of Darling Harbour, formerly a docklands area for Sydney until stevedoring operations were moved to port Botany and Port Kembla (south of the City) as the city grew. The area has a history of timber construction, with the old wharves and many of the warehouses built from timber during the time of port operations.

Figure 2: Hardwood logs excavated from the Barangaroo site

As well as the links to the historic past of the site, there are key benefits to using engineered timber that align to the Lendlease core vision and values, and which will make International House Sydney a landmark building. These benefits are:

- Safety: This is our number one priority. Removal of hot works from site, reduction in dust, vibration and noise, minimal back-propping during installation; all of these advantages of mass timber help to keep our site safe.
- Sustainability: Particularly reduction in water use, embodied carbon, reduced transport emissions, and benefits to the health and wellbeing of future inhabitants through quality of the finished environment; all of these benefits aim to make our building sustainable.
- Community: The building is located in the CBD, surrounded by existing tenants and owners. The lower construction noise, significantly reduced truck movements and reduced construction time frame results in a far lower impact on the surrounding community.
- Innovation: Modern mass-timber design provides new ways for us to provide a point-of-difference solution for our customers.

The above benefits align to the Lendlease vision to create the best places.

2.1. The Lendlease timber journey

Solid timber technology is not new to Lendlease. In 2012 Lendlease built Forte in the Melbourne docklands area, at the time the tallest CLT apartment building in the world. In 2013, in partnership with the City of Melbourne and Places Victoria, Lendlease built the Library at the Dock, Australia's first 6-star Green Star public building. Both of these projects harnessed the lightweight, safety, aesthetic, speed and sustainability benefits of engineered timber.

Figure 3: Forte (left) and Library at the Dock (right)

International House Sydney is the next development in our engineered timber journey.

3. Design – key elements

The International House Sydney CLT and glulam structure rises from a single level concrete deck which houses the ground level retail space and plant. Above Level 1 the structure is entirely timber; beams, columns, floors and walls (core included) are all timber, with stability provided by the glulam braced bays on the four elevations.

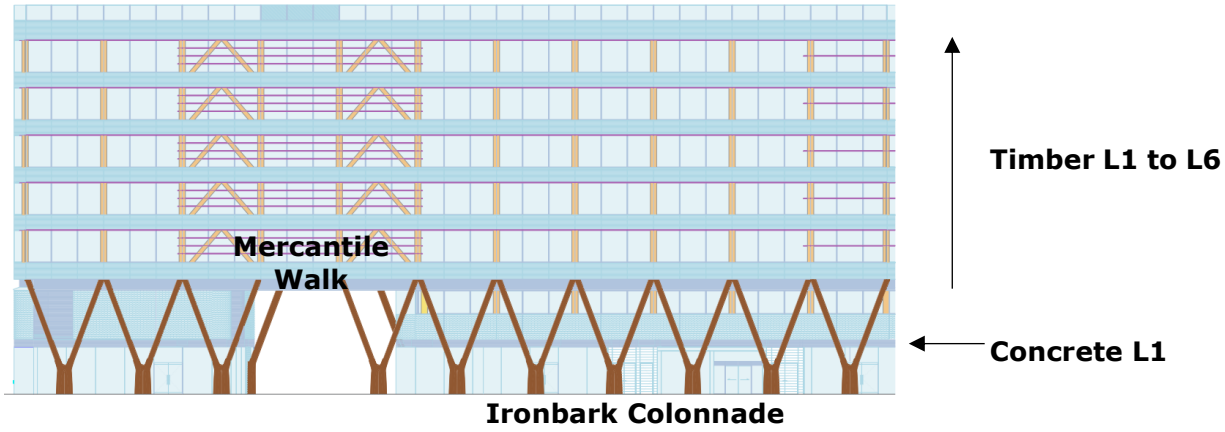

Figure 4: International House Sydney structure – east elevation

3.1. Site constraints

Considerable site constraints dictated the design of International House Sydney. These were:

- Service risers: The basement to the entire precinct, designed and built well in advance of the international house scheme, was designed to suit a typical concrete office building. Service routes and strategies were defined early on to suit a concrete column and slab layout and required adaptation of the timber structure to suit.
- Building height: Planning conditions on building height compressed floor to ceiling heights, restricting service reticulation and dictating penetrations through principal beams.
- Access walkways: Mercantile Walk, a key entrance to the Barangaroo precinct, passes directly through the lower levels of International House.

Figure 5: Mercantile Walk access to the Barangaroo precinct

- Construction space: The site is bordered by Hickson road to the east and the three International Towers buildings to the west. To the North and South, pedestrian bridges to the Barangaroo precinct enclose the site to within metres of the façade line.

3.2. Reclaimed Ironbark Colonnade columns

At the very entrance to International House Sydney, the first sight of the building for visitors is the grand timber colonnade. The ironbark timber used for the colonnade column fabrication is recycled from disused rail bridges in Queensland, some of which was from the iconic Hornibrook bridge in Brisbane.

Figure 6: The Ironbark Colonnade

The ironbark columns are 420mm x 420mm in cross-section (colonnade), and 500mm x 500mm in cross-section (Mercantile walk), with the longest length 6400mm. The columns are designed as a compound section to Eurocode 5 using shear rings and through-bolts to join four quarter-sections.

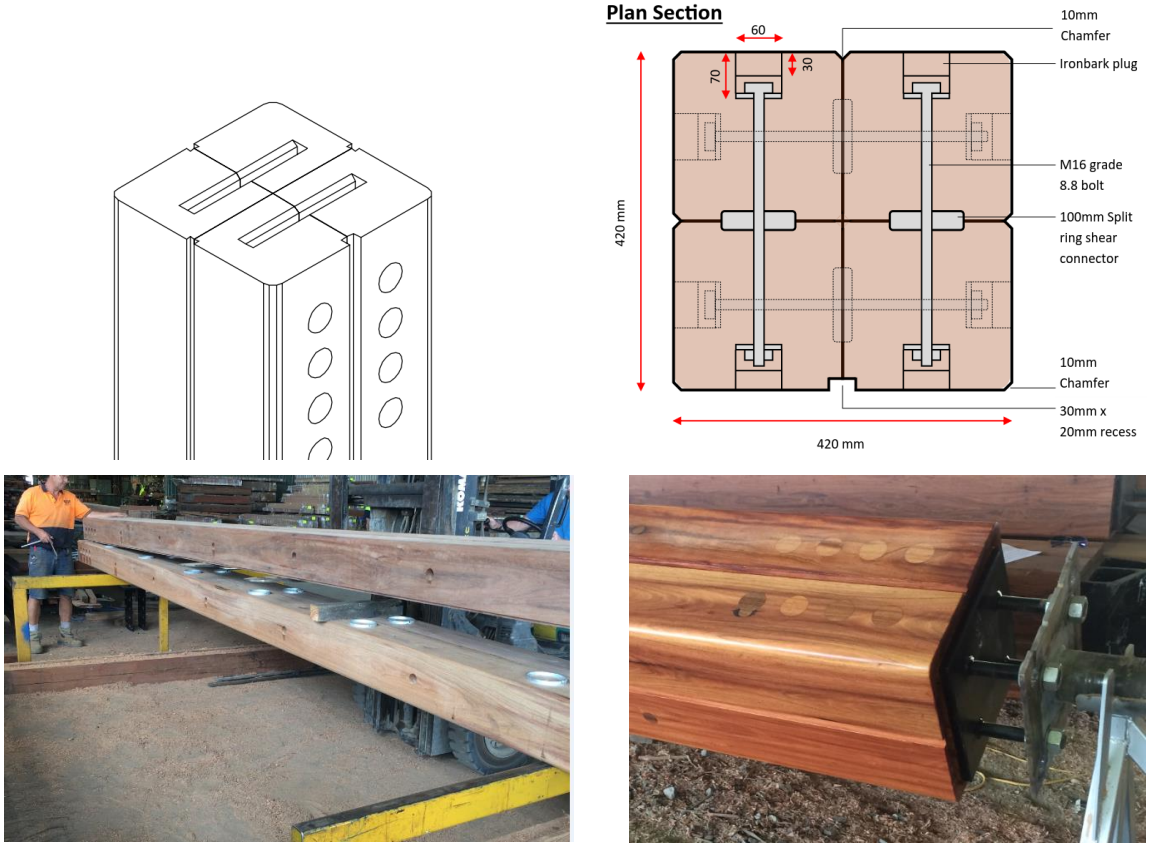

Figure 7: Ironbark column arrangement (top left), cross-section (top right), fabrication (bottom left), finish (bottom right).

3.3. Services integration and beam penetrations

Floor-to-floor height restrictions and incoming service locations dictated that an innovative solution to the beam design was required for service distribution. Working in collaboration with our supply partners (Stora Enso and Hess Timber) and MPa Stuttgart, an LVL-glulam hybrid reinforced beam solution was developed to overcome the challenge of service distribution.

Two bands of LVL are sandwiched vertically within the softwood glulam in the cross section (480mm x 800mm overall). Finite element analysis was used to examine the stresses in the laminated beam arrangement, and verify the stress distribution in the glulam and LVL layers around the penetration zones. Hand checks were then carried out to verify that stresses were within limits for both the ultimate and fire limit cases.

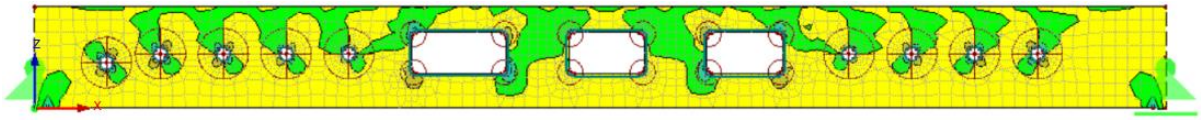

Figure 8: Beam analysis extract from the finite element model showing service penetrations

The penetrations provided in the beams are significantly larger and closer spaced than that currently documented in the design codes, for instance allowed in DIN EN1995-1-1/NA to Eurocode 5. The analysis was therefore verified by testing on trial beams carried out at MPA Stuttgart.

Figure 9: Beams in situ on site during installation of the services

The physical test results indicated that correlation with the finite element analysis was favourable and, with the strengthening LVL layers, the penetrations did not influence the load capacity of the beam in a detrimental manner. Ultimately the longer span beam design is governed by deflection (serviceability) considerations, however testing proved that the load carrying capacity of the reinforced beams was approximately 1.7 times greater than the applied load of the office floor structure.

3.4. Façade

A fully glazed curtain wall system is being used for the façade of International House. Close collaboration with the façade contractor enabled recesses and pockets to be left in the slab edge to conceal the façade bracketry and allow flexibility for install. Similarly, fixing points of cladding brackets to columns were coordinated to avoid dowel joints and splice connections of the principal structure. Sharing the 3d manufacturing model with the façade contractor and collaborating on the key interfaces greatly aided this process.

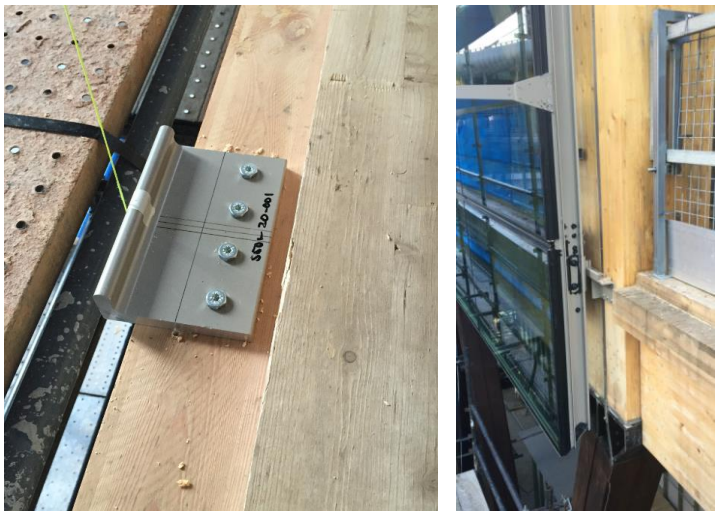

Figure 10: Façade slab edge bracket (left), column bracket and first façade panel installed (right)

3.5. Sustainability

International House Sydney aims to achieve a 6-star Green Star (equivalent to Green Mark or LEED Platinum) on completion and will be the greenest building in the Barangaroo precinct.

Significant dematerialisation was achieved through removal of ceilings and wall finishes and embracing the exposed timber aesthetics. Only the bathroom walls and ceilings are covered with a finish – all other elements, including stair balustrades and fire hydrant cupboards (using a clear glass door as a feature), are exposed timber.

Other initiatives such as solar panels on the roof, LED lighting and blackwater treatment further enhance the buildings sustainability credentials.

4. Project Delivery

The International House Sydney structure was assembled by a self-perform team of eight Lendlease carpenters and labourers, plus a crane crew.

4.1. Pre-assembly of components

Due to the space constraints on site and the opportunity to optimise crane time, the decision was made to prefabricate elements in a separate area of the Barangaroo precinct and bring them to site as a completed piece. This decision was made prior to packing the timbers in Europe so that the elements for preassembly could be unpacked separately without impacting the main build.

Figure 11: Pre-assembled lift core (left), braced bay lifting (middle), and installed braced bay (right)

The timber lift cores and braced bays were all pre-assembled either off site or in pre-assembly areas and lifted into position as monolithic elements. This optimised the use of the main crane and increased the speed of the floor installation.

4.2. Floor cycles and learning lessons

As not one member of the installation team had any previous experience with CLT and Glulam structures, a learning curve was observed that improved dramatically throughout the build. This was amplified by the complexity of the lower levels of the building and the raking ironbark columns, however installation rates improved from 8 elements per day at the start to 33 at the peak. At the end of the build, one floor of structure (approximately 1300m^2 including all glulam beams, columns and CLT walls) was completed per week.

A floor cycle of one floor per week is comparable with the equivalent concrete building, however this does not account for (or acknowledge) the significant site constraints which prevented the timber installation crew from installing faster, nor does it account for the savings in follow on trades. Services trades were following directly behind the timber crew working on the next floor above. On the concrete equivalent building this would be blocked for two floors below until formwork was removed – this allowed for significant programme gains.

The overall outcome from the erection of the timber has been a success for the site team. The lessons learnt are immediately being applied to our next project and the final installation rates have endorsed the value of the prefabricated timber product.

4.3. Safety

Safety is Lendlease's first priority and we seek to operate incident and injury free. We can proudly say that throughout the construction of the timber structure at International House Sydney there were no injuries sustained to any of the installation crew or other site attendees.

5. Conclusion

International House Sydney has been a spectacular success for Lendlease. The project is a testament to the successful collaboration between the Lendlease team and our timber supply partners. Interest from tenants and investors has been extremely favourable, and it will not be a long wait before the next International House is built in Australia by Lendlease.

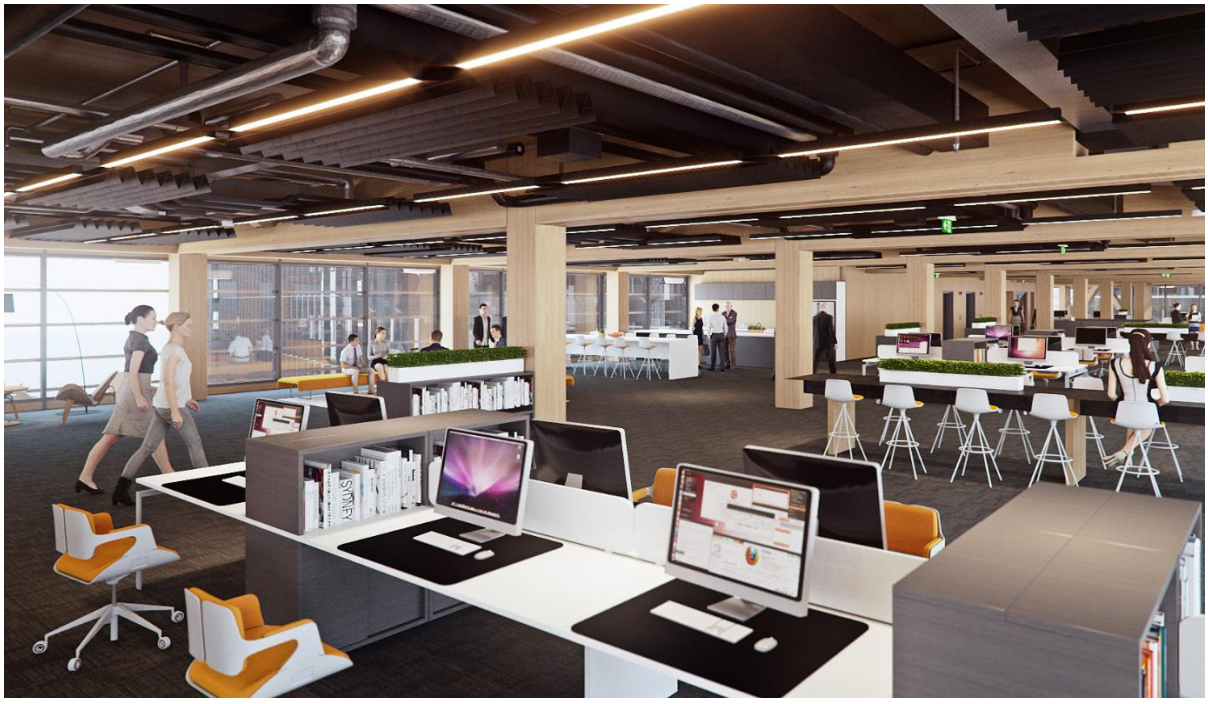

Figure 12: CGI impression of finished International House Sydney office space

6. Project information

6.1. Location

International House Sydney is positioned at the gateway to Sydney's new CBD precinct at Barangaroo on the southern shores of Sydney's iconic Harbour.

Figure 13: Location of International House, Sydney. Source: Transport for NSW, Barangaroo Integrated Transport plan, August 2012.

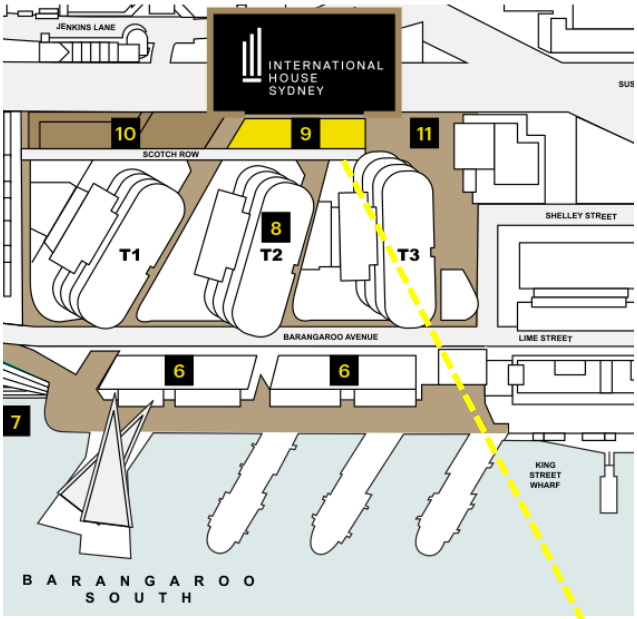

Figure 14: Location of International House, Sydney – precinct plan

Figure 15: Location of International House, Sydney – Darling Harbour view

6.2. Design Team and Suppliers

DESIGN TEAM:

Architect: *Tzannes*

Engineer (Timber): *Lendlease DesignMake*

Engineer (Concrete): *Arcadis (Hyder)*

Services: *Aecom/WSP*

SUPPLIERS:

CLT: *Stora Enso*

Glulam: *Hess Timber GmbH & Co. KG*

Ironbark Colonnade: *Australian Architectural Hardwood*

Façade: *Permasteelisa*