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STRUCTURAL INNOVATIONS IN ATLASSIAN CENTRAL: PIONEERING HYBRID TIMBER HIGH-RISE CONSTRUCTION IN COMMERCIAL DEVELOPMENTS

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ABSTRACT: Hybrid timber and concrete structures are known for their structural, environmental, and prefabrication advantages but are underutilized in premium commercial high-rise developments in Australia. The Atlassian Central project in Sydney, designed by BVN and SHoP architects, represents a significant and world-leading advancement in this field. Co-owned by Atlassian and Dexus, Atlassian Central is a 39-level, 57208 sqm commercial tower aiming to reduce upfront embodied carbon by 50% during construction, operate on 100% renewable energy, and achieve substantial operational energy savings through considered climatic engineering solutions and significant 'park' zones of naturally ventilated floorspace. The general tower structure is a hybrid timber structure developed in partnership with project engineers Eckersley O'Callaghan and TTW. It is comprised of seven 'habitats', each four stories high and contained within a structure of steel framed 'mega-floors' and load-bearing perimeter diagonal frame 'Exoskeleton'. The intermediate floors of each 'habitat' are constructed from mass timber and are supported at each Megafloor. The lower seven floors of the tower use a different structural strategy designed to transfer the loads of the Exoskeleton structure and façade back to the concrete core and two primary columns. This approach minimises the footprint of the building and retains the legibility of an existing heritage building on the site. This paper will explore in detail the key design features of the Atlassian Central hybrid timber strategy, identifying opportunities and advantages and addressing design and construction challenges. The findings illustrate the feasibility and benefits of hybrid timber structures in commercial high-rises, highlighting timber's potential in facilitating sustainable commercial development in dense urban environments.

KEYWORDS: Hybrid Timber Construction, High-Rise Buildings, Prefabrication, Sustainable Design.

1 – INTRODUCTION

The Atlassian Central project in Sydney, designed by BVN and SHoP architects, marks a significant innovation in hybrid timber construction. Atlassian Central is a 39-level, 57208 sqm commercial tower co-owned by Atlassian and Dexus. [1] Upon completion, it will stand as the world's tallest hybrid timber building.

The project aims for a 50% reduction in upfront embodied carbon compared to conventional premium commercial buildings, to operate on 100% renewable energy, and to achieve substantial operational energy savings through advanced climatic engineering, including significant 'park' zones of naturally ventilated floorspace. Atlassian Central's hybrid timber structure is fundamental to achieving these targets and will be explored in detail in this case study. It is composed of multiple four-storey timber framed 'habitat' structures, steel composite 'Megafloors', and an enveloping steel 'Exoskeleton'.

Figure 1: View of Atlassian Central from Central Station

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Figure 2. View from public square.

This case study will detail the structural methodologies utilised in Atlassian Central, addressing the technical challenges and solutions implemented during design and construction. The findings will contribute to the ongoing discourse in timber engineering, showcasing the feasibility and benefits of hybrid-timber structures in commercial high-rise applications, and further establish the potential for timber to play a central role in the future of sustainable commercial development in dense urban environments.

2 – PROJECT DESCRIPTION

The new Australian headquarters for Atlassian, Atlassian Central, is taking shape in the NSW Government's much anticipated new tech precinct, Tech Central. Co-owned by Atlassian and Dexus, with Atlassian as the anchor tenant, the new commercial and hostel building will be home to over 5000 people within commercial spaces and 137 room hotel when complete.

At 39 storeys high, Atlassian Central will be the world's tallest hybrid timber building [2]. With a mix of outdoor and indoor spaces, the project uses an energy-efficient approach that features natural ventilation and large planted terraces providing its inhabitants access to planted gardens.

2.1 SITE AND CONTEXT

The Atlassian Central site sits adjacent to Central Station's Devonshire tunnel entrance, placed between a range of rail infrastructure and heritage significant sites (Fig 3.).

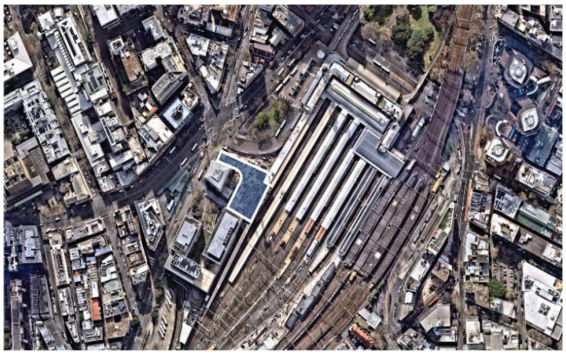

Figure 3. Aerial image of central station, highlighting site.

The site is on Gadigal Land of the Eora Nation, original custodians of the land for estimated tens of thousands of years. Prior to European settlement, Aboriginal uses of the Central Station site were of gathering and ceremony. A significant trade route ran through the area, in part due to rich natural resources and water sources. [3]

Figure 4. Photograph from Central Station showing Inwards Parcels Shed, (left) and Parcels Post Office (Centre) c. 1910s

Sydney's Central Train Station has operated near-continuously since its opening in 1855. The current Central Station buildings were completed over 150 years later in 1921. The majority of the Central Precinct is now considered State Heritage Significance. One such building, the Former Inwards 'Parcels Shed' sits in the centre of the Atlassian Central Site. The Former Parcels Post Office, currently the Adina Hotel, sits in the neighbouring site to the west (Fig. 3). Together they represent the history of Australian postal services in the area (Fig. 4), both requiring careful preservation in any future developments.

2.2 TECH CENTRAL

Atlassian Central is the first step in creating Australia's first 'Innovation Precinct', integrated into the heart of Sydney's Central Station area. When complete, Tech Central will provide "25 hectares of space for established and start up tech companies, with an ambitious vision to

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change the world through new thinking, creativity and technology." [1].

Atlassian Central represents not only a building enabled by new, sustainable, technology, but through aspirations of its main tenant, the first of a strong technological community [4]. Leveraging strong adjacencies to large tertiary education institutions, research institutions, and key transport hubs, it is poised to be Australia's "largest urban renewal program, hosting one million workers within a 30-minute travel radius, and 25,000 STEM graduates within a 2km radius." [1]

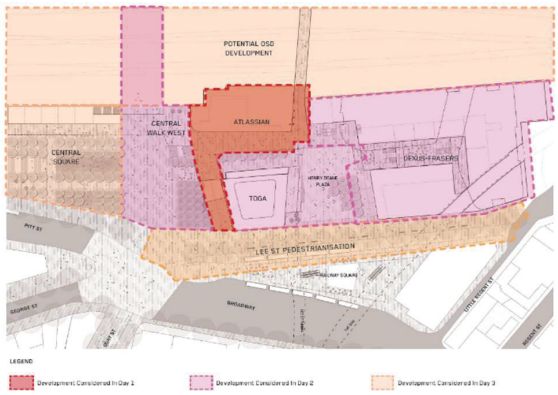

Figure 5. Future Staging as a part of Tech Central and Western Gateway Plan:. 'Day 1' Atlassian Central (Red); 'Day 2' Redevelopment of Southern Site, potential redevelopment of public Henty Deane Plaza and Adina Hotel (Pink); 'Day 3' Development of Central Square and Potential OSD (Salmon).

The broader vision of Tech Central is described in the Central Precinct Strategic Framework (CPSF) [3], a plan prepared by Transport of NSW, a major stakeholder for all associated developments. The CPSF describes the Atlassian Central Site as both a technological hub, and a gateway for later stages, including new public squares, and bridges across central station to connect surrounding suburbs.

Atlassian Central provides a sustainable and heritage conscious response, reflecting the future of the precinct at civic and building scales. Atlassian Central must consider all potential developments that may have an impact on it in the immediate and long-term future (Fig. 5).

2.3 BRIEF

Atlassian Central's brief reflects ambitions and controls at site, precinct and state significance scales. Each require careful understanding, negotiation, and coordination to satisfy competing requirements. As a result, the brief included a range of pre-work to support a feasible response to the range of goals. Structural case studies and environmental strategies were developed to provide design constraints for each competition entrant, enabling each to create a unique and original design.

Atlassian Central had to respond to both the current context, and the future context of Tech Central. The heritage brief required that the design respond to the presence of the Parcels Shed to celebrate heritage significance, acknowledging construction would require the Parcels Shed be carefully dismantled, and reassembled as the building's lobby.

As a part of the future, the project must respond to the Eastern City District Plan [5], most critically, the actions that support a low-carbon Sydney. These included:

- Action 68: Net-zero emissions by 2050, of which Atlassian Central set as a Day 1 target once complete.
- Action 69: Increase renewable energy generation, energy and water efficiency. Atlassian Central set to reduce operational energy use by 50% when compared to a traditionally operated building, including the use of Building Integrated Photovoltaics (BIPV) into the façade.
- Action 72: Employ a low-carbon and resource efficient construction methodology. Atlassian Central targeted a 50% reduction in embodied carbon, and waste reduction strategy for sub-structure, super-structure and façade.

In each case, the Atlassian Central brief exceeded or pre-empted environmental performance targets and milestones set as precinct-wide actions. In addition to minimisation of environmental impact, the workplace brief set high expectations for flexibility, functionality and occupant wellness. Wellbeing was described as providing thermal and environmental comfort, with access to nature and natural ventilation.

In combination, the performance goals and site constraints directly informed an integrated, innovative and climate responsive design.

2.4 DESIGN RESPONSE

The design had to respond and navigate each set of requirements, without compromise, directly influencing the architectural, structural, and environmental strategies.

Atlassian Central is split into three main elements as shown in Fig. 6: the mega frame, primary structure for the tower; The 'habitats' created from mass timber structure, functionally seven separate structures built

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between steel framed ‘Megafloors’; and the façade affixed to the Exoskeleton.

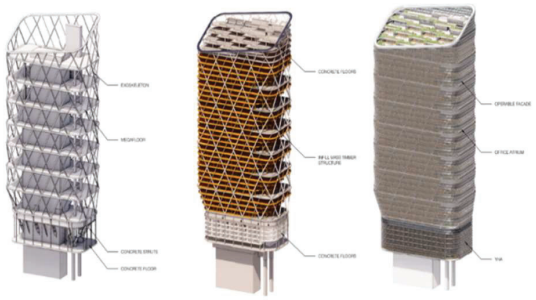

Figure 6. Mega frame, Habitats, and Façade.

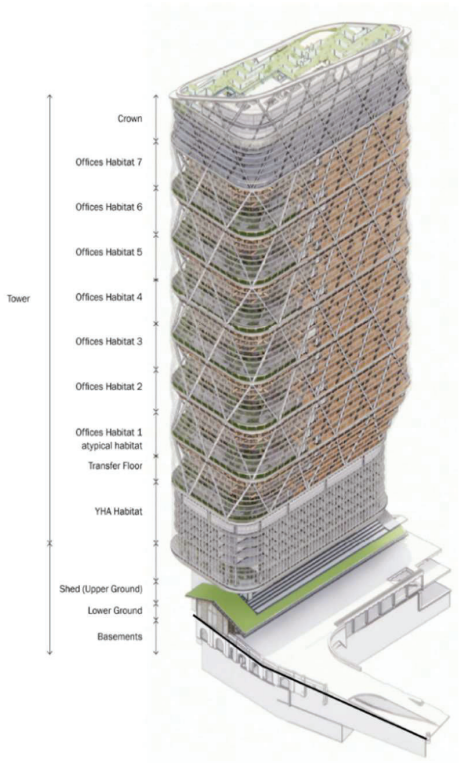

Figure 7. Vertical Hierarchy of Atlassian Central.

The lower 5 storeys of the tower will become the new YHA Central, a 137 room offering of hybrid accommodation. (Fig. 7). The integration of the YHA and commercial space is designed to encourage a lively and dynamic atmosphere. Located at Central Station, the new wider precinct will benefit from immediate access to multiple modes of public transport, cycle paths and pedestrian access. This high level of accessibility is a key factor in the success of the precinct.

The Atlassian Central development sits at the critical intersection of the Devonshire Tunnel, new metro linkages and Central’s third square. The project team has worked extensively with Transport for NSW, adjacent landowners, the City of Sydney, Heritage NSW and the NSW Department Planning, Industry & Environment to ensure all aspects of the precinct are considered in the design and public realm.

3 – HYBRID STRATEGY

To balance the required density and height with the environmental controls, it was necessary to utilise a hybrid approach. Timber alone could not reach the required height or navigate the complex ground conditions that demanded a small footprint at the public domain. The footprint was driven by a range of factors, including rail easements, access through the site, and to provide a sympathetic response to the heritage Parcel Shed that shares the ground plane.

Figure 8. Organisation and material diagram.

Atlassian Central employs the strategy of a Megaframe, a freestanding structure consisting of a reinforced concrete core and columns, widely spaced Megafloors to bear the weight of mass timber ‘habitats’, and a load bearing steel Exoskeleton.

3.1 STRUCTURAL STRATEGY

The Megafloors are a composite structure consisting of a steel frame as the primary structure, with thin concrete floors on metal deck permanent formwork, which provide the floor surface, planting zones, and fire separation between habitats.

Each Megafloor acts in combination with the Exoskeleton to transfer weight of the ‘habitats’ through

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to the core, and to the ground. An additional transfer structure in the YHA floors transfer remaining weight from the Exoskeleton to achieve the desired building footprint. The transfer 'struts' employed were concrete filled steel tubes to reduce fire protection measures, with steel acting as permanent formwork.

The Exoskeleton also hosts the façade system which is supported on steel transoms that span between Exoskeleton members, allowing the timber to be freestanding. The façade is a curtain wall incorporating a range of operable sections and building integrated photovoltaics to achieve thermal performance, energy requirements, and support comfort as defined in the climate strategy.

3.2 PROCUREMENT

As the timber used in Atlassian Central was considered as sequestering, the remaining carbon footprint was primarily in the concrete and steel structure. To maximise the carbon reduction, procurement of 'green' versions of those materials was critical, as their method of manufacturing affects the embodied carbon:

- 'Green steel' for profiles and reinforcement may contain high recycled content and are forged using electric arc furnaces or hydrogen blast furnaces. [6], [7]
- 'Green concrete' uses cement replacement such as fly ash and ground granulated blast furnace slag (GGBFS). [8]

The sourcing of all main structural members was carefully considered in reference to the carbon targets.

3.3 CONSTRUCTION SEQUENCING

The core is cast via conventional climbing formwork, also known as jump form. Temporary propping is used for the first Megafloor, up to level 7. The Exoskeleton is then attached to the Megafloor's edge and performs as supports for perimeter beams of the next Megafloor. Concrete is then cast on the steel structure as permanent formwork. This process is repeated for the remaining Megafloors.

As each Megafloor is completed, the habitat below can begin construction, and the façade be attached to the exoskeleton. This allows construction of the Megaframe and 'habitat' infill to happen in tandem. Timber prefabricated elements are loaded via gantry and can be assembled while sheltered from above.

4 – HABITATS

The Atlassian Central 'habitats' are repeatable discrete structures that infill between Megafloors (Fig. 9). They were designed to be self-similar to simplify coordination, structural engineering, fire engineering, and delivery.

Figure 9. Rendering of Typical habitat without façade.

Each habitat starts at a mega floor and comprises 3 levels of glulam framed structure and CLT slabs. The top level is supported entirely from below which provides a 'column free' environment, creating four storeys in total.

The habitats themselves are a relatively simple mass timber structure, however the interactions and differential movement between timber structure and the surrounding Megaframe are novel at a global scale, requiring bespoke structural and fire engineering solutions to provide fire and acoustic separation.

4.1 CLIMATE CONCEPT

Habitats are divided in plan and section into three 'Office Types' (Fig. 10) transitioning from inside to out. The concept was driven in two parts, to significantly reduce the operational energy demand through leveraging Sydney's temperate climate, and to provide high levels of indoor air quality (IAQ) and indoor environmental quality (IEQ) for occupants.

- Type A: Conditioned zone.
- Type B: Mixed mode.
- Type C: Unconditioned semi-outdoor space.

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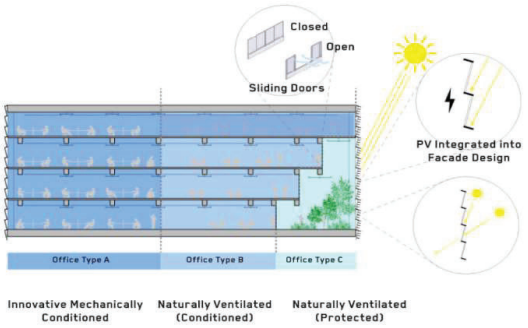

Figure 10. Climate Concept Diagram (SSDA)

Type A uses innovative active systems, including chilled beams, variable primary air supply and ceiling fans, and use thermal comfort principles to allow for elevated temperatures whilst maintaining high levels of thermal comfort for occupants. Type B uses ceiling fans, active heating and operable façade to leverage the temperate Sydney climate to maintain thermal comfort. Type C is entirely naturally ventilated, featuring large planting zones and direct sunlight. In combination, the Office Types provide a range of comfortable environmental conditions, complimented by timbers insulative and biophilic aspects.

4.2 TIMBER STRUCTURAL STRATEGY

Habitats use a column grid of 10m by 5m, offset from the core. The narrower 5m grid spacing is not disruptive, providing a colonnade beside the façade zone. The GLT spans between 8.5-10 m, providing an uninterrupted ring of flexible workspace. The floor's structural depth is 840mm including notched GLT beams to allow CLT slabs lay flush with the beam.

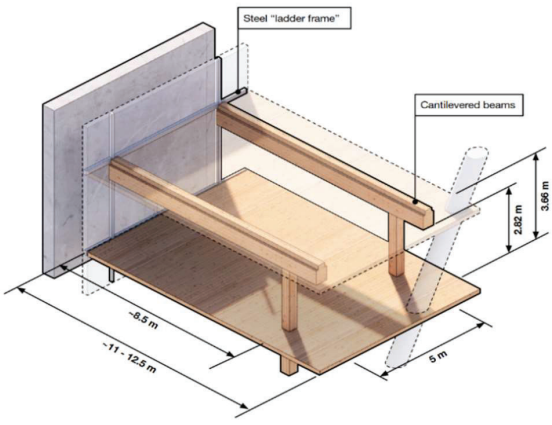

Figure 11. Axonometric of single timber structural bay.

Timber beams and slabs connect to a 'ladder frame' of steel structure (Fig. 11) adjacent to the core. The space within the ladder frame zone contains services risers which are substantial, as is consistent with other commercial buildings of this size. Use of timber risers was deemed infeasible due the greater structural dimensions and fire performance in this application. Instead, the core and risers are separated from the timber, by a fire rated shaft. Inside is the concrete core, steel framing, and steel composite flooring. The GLT beams then span from the ladder frame 8-10m, cantilevering 1m past the end of the column, the remaining distance is cantilevered by the CLT slab.

The ladder frame and timber are strapped back to the core for seismic performance, as the exoskeleton and façade move independently; The timber structure needs to be pulled back to the core in instances of sway. Services penetrate through the ladder frame and fire rated plasterboard into the main floor. The ladder frame in combination with the mass timber structure simplified the structural, services and fire strategy.

4.3 PENETRATIONS

As the timber is entirely prefabricated, all penetrations for services must be planned and coordinated. In terms of complexity there are two main types of timber penetrations:

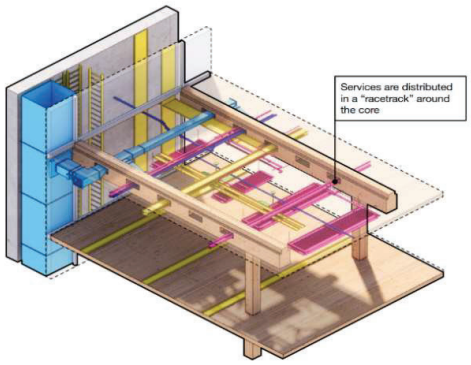

Figure 12. Axonometric of penetrations and indicative services.

First, Atlassian Central employs a 'racetrack' (Fig. 12) of services reticulation circulating the core. A grid of penetrations was added to the GLT beams to provide for the 'racetrack' servicing strategy and allow future adaptation pending changes in organisation, use or technology. There remains a hard limit for penetration size and number, each requiring structural reinforcement.

Second, are 'one off' penetrations which require every affected party contribute to the detailing. For example, penetrations between habitat zones have implications for the architect, structural engineer, plumbing sub-

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contractors, fire engineering, and HVAC consultants; Each must provide drawings for review.

4.4 FIRE ENGINEERING

As a timber and Exoskeleton structure was unprecedented at this scale, a performance solution was required to ensure structural stability:

Firstly, the imposed fuel load of the timber structure must be analysed and managed. A 2-hour fire rating was targeted across the Megaframe structure, and equivalent char ratings for all timber. Through the performance solution, GLT could remain exposed within offices Type A and B. All timber structure could be exposed in Type C due to the additional ventilation, and absence of introduced fuel such as furniture.

Second, the 'one off' penetrations of the Exoskeleton through the CLT slabs must stop smoke and heat transfer, while not structurally attached. A connection that allowed movement had to be developed and subject to a Standard Fire Test, to then be generalised for such intersection. No such detail had been developed of this kind and required collaboration between all parties to create an innovative solution fit for Atlassian Central.

4.5 PROCUREMENT

For timber used in the project, performance specification was employed rather than selection of specific products. As each timber supplier has different appearance grade and allowable parameters, the specification was developed to outline both structural and visual performance. The aim was to remain agnostic, leveraging the standardisation made available with Eurocodes such as EN14080, allowing an open procurement pathway to foster competitiveness within the timber market.

5 – RESULTS

Built, contractors in a joint venture with Obayashi Corporation, were engaged as part of an early contractor involvement agreement in 2020 to work closely with Atlassian and Dexus along with architects BVN and SHoP and other consultants to unlock the design, construction program and methodology.

As of July 2024, the project's concrete core structure has been constructed to Level 1 (RL 40.650m). Jump formwork will continue to progress the concrete core, with Megafloors and steel Exoskeleton constructed in parallel. Prefabricated mass timber elements composing the 'habitats' will be progressively manoeuvred into location for assembly. When complete (estimated end-2026) the project should achieve a 50% reduction in upfront embodied carbon compared to conventional premium commercial buildings, while operating on 100% renewable energy.

6 – CONCLUSION

The Atlassian Central project showcases the effectiveness of hybrid timber construction in high-rise commercial buildings. The design of Atlassian Central employs innovative solutions to meet the design and performance briefs. Enabled by a closely aligned client and project team, Atlassian Central will, on completion, achieve class-leading reductions in embodied carbon and operational energy consumption.

In doing so, the project will demonstrate the feasibility of hybrid timber construction for high rise commercial projects, providing construction strategies and tested solutions that will assist the growth of this construction type. The integration of timber, steel, concrete, and innovative climatic engineering in Atlassian Central establishes a global benchmark for sustainable commercial developments.

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