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Ecolibrium

Tall timber

Brisbane is home to Australia's tallest CLT building.

AIRAH

King in the north

Built as part of a continuing $2.9 billion regeneration of Brisbane's RNA Showgrounds, 25 King is Australia's largest and tallest engineered timber office building. **Sean McGowan** reports on a project that has pushed boundaries in construction, sustainability and indoor environment quality.

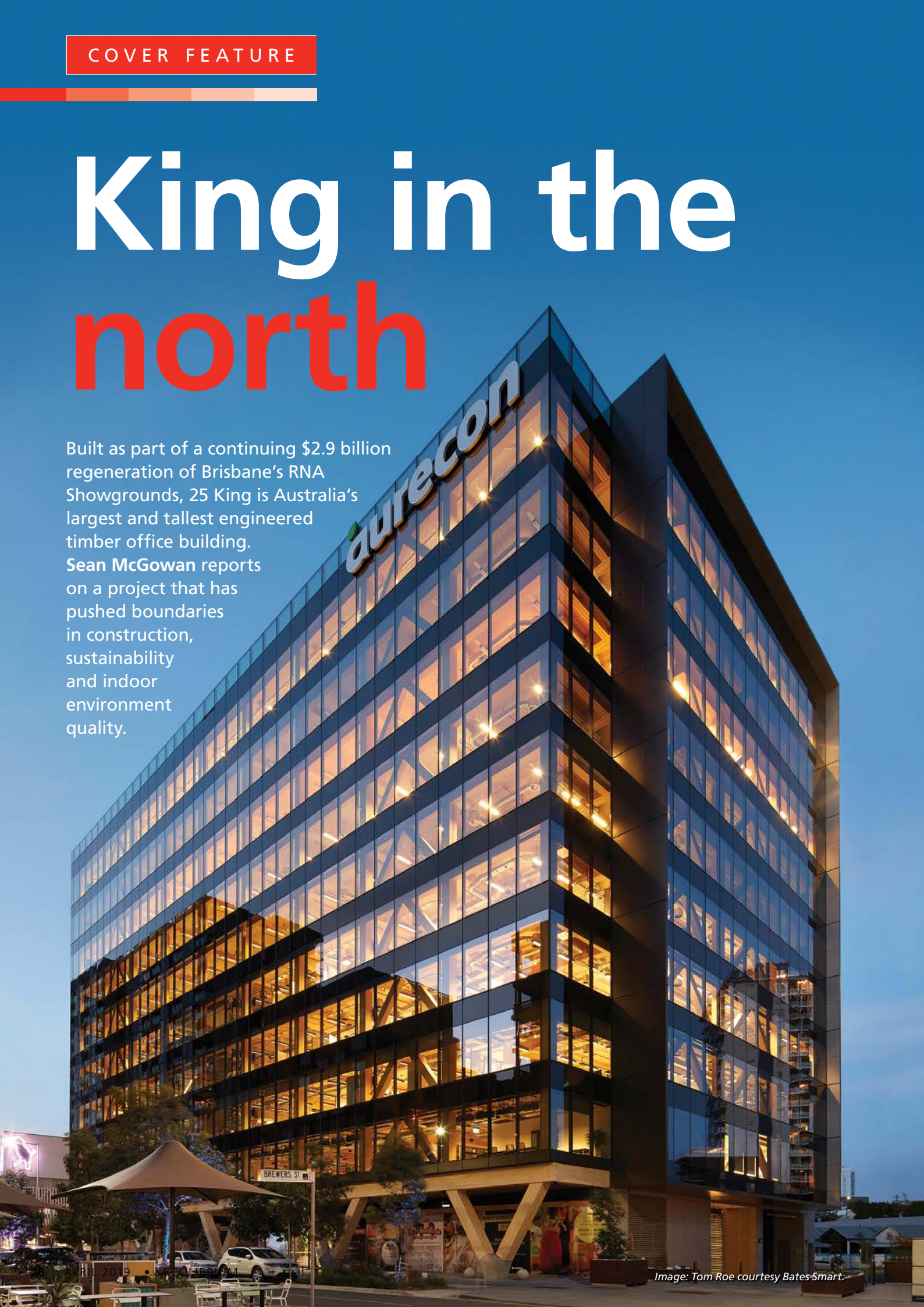


Image: Tom Roe courtesy Bates Smart.

The Brisbane Showgrounds, in the inner suburb of Bowen Hills, has long been one of the city's most popular recreation destinations.

Home to the Ekka (the Royal Queensland Show) since 1876, the 22 hectare site is owned and operated by the Royal National Agricultural and Industrial Association of Queensland (RNA) and has played host to thousands of events across its 143-year history.

Now, the Brisbane Showgrounds Regeneration Project is breathing new life into the precinct.

Representing the largest brownfield development of its kind in Australia, the regeneration project is being delivered by RNA's project partner Lendlease. It includes 340,000m² of new residential, commercial and retail buildings, together with new development of 76,000m² of RNA-attained land.

Among the works is the upgrade of the Brisbane Showgrounds, including the already completed, state-of-the-art Royal International Convention Centre, plaza and porte-cochere.

Residential projects have included the addition of The Green and The Yards apartment buildings, while the creation of King Street includes the construction of 25 King, Australia's latest timber office building.

> This is not a boutique, experimental or demonstration project

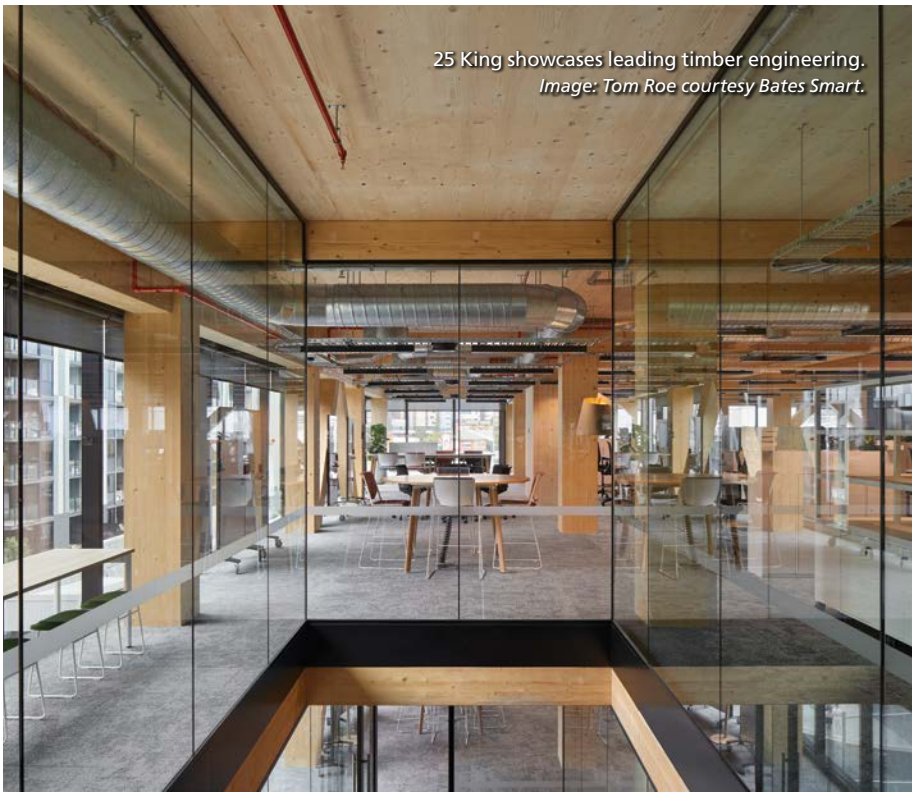
ON SHOW

Developed by Lendlease and owned by leading Australian funds manager Impact Investment Group (IIG), 25 King commands a unique presence on the newly developed King Street.

The building's exterior features a striking combination of engineered timber and clear glazing, while internally each of the nine office levels offer approximately 1,500m² NLA (net lettable area) of A-grade commercial office space.

The building's ground floor accommodates end-of-trip facilities for the building's tenants, as well as three retail tenancies facing the vibrant King Street, adding to its mix of food and beverage venues and outdoor seating areas.

Four of the nine office levels have been tenanted by engineering consultants Aurecon – the company that also delivered the structural engineering design, building services and ESD on the project.



25 King showcases leading timber engineering.
Image: Tom Roe courtesy Bates Smart.

"Aurecon sought to create a world-class working environment when searching for a new office space to relocate its 700-plus Brisbane team," says Aurecon senior mechanical engineer, Danni Roberts.

"We were really excited about the innovation of the timber building Lendlease had planned for the site. It was a great opportunity to work together for an innovative and sustainable solution."

Architecturally designed by award-winning firm Bates Smart, 25 King showcases leading timber engineering and environmental approaches that differentiate it from typical office developments.

"This is not a boutique, experimental or demonstration project but rather a commercially viable alternative to steel and concrete construction in mid-scale office buildings," says Bates Smart director, Philip Vivian.

The building's superstructure utilises a combination of engineered cross-laminated timber (CLT) for the floors, lift shafts and escape stairs, and glulum (glue laminated timber) for the structural beams and columns.

As well as demonstrating the potential future of medium to high-density construction, 25 King was designed with a wellness objective. The plan was to create a workplace that is both sustainable and healthy.

SYNERGETIC OBJECTIVES

According to Danni Roberts, the project's WELL and Green Star rating design objectives were synergetic, with several of the design requirements and intents overlapping.

"WELL-specific design requirements included increased outside air rates, HEPA-level filtration of air within the lobby and end-of-trip spaces, and future spatial provision for activated carbon filters on all air conditioning equipment," she says.

The prefabricated nature of engineered timber construction presented a host of design and construction challenges. *Image courtesy of A.G. Coombs.*

"Architecturally, the use of natural materials – as opposed to concrete and plasterboard – creates a happier and healthier workplace," says Vivian.

"With the timber structure and floor soffit exposed, as has been achieved at 25 King, the office environment glows with the material's warmth and better connects building occupants with nature."

The project set out to achieve a number of ambitious rating targets, including a WELL Platinum Core and Shell rating, and 6 star Design and As Built V1.1 Green Star ratings. The Aurecon tenancy has also targeted a WELL Interiors silver rating.

Additionally, a 5-star commitment agreement to NABERS Office Energy for the base building was targeted.

> The office environment glows with the material's warmth and better connects building occupants with nature

WOOD WORKS

According to Vivian, the choice of engineered timber construction offered a number of sustainability advantages for the 25 King project that have ultimately enabled it to meet its ambitious targets.

"Regarding sustainability, timber's major advantage is its ability to sequester carbon and reduce a building's carbon footprint," he says.

"Timber building reduces embodied carbon by 74 per cent when compared to an equivalent steel and concrete building. In fact, timber continues to sequester carbon from its environment well after it is installed, prolonging these benefits."

The timber used on the project was responsibly sourced from forests in Austria with full "chain of custody" certification. Its use alone achieved all points in the Green Star sustainable products credit and greatly assisted the whole-of-life-cycle assessment, allowing the project to achieve full points in this credit also.

"Timber also has low thermal conductivity," adds Roberts. "This allowed the roof and slabs to achieve over R2.0 from the material alone, whereas a typical concrete slab would only achieve R0.15."

EARLY CO-ORDINATION

Naturally, the prefabricated nature of engineered timber construction presented a host of design challenges – not least of which was the necessity for early coordination of timber penetrations.

This required close collaboration between the design teams of Bates Smart, Aurecon and Lendlease's manufacturing business DesignMake.

In fact, DesignMake was able to draw on its experience of developing other engineered timber buildings such as Barangaroo's International House Sydney.

"Due to the relatively long lead time for the preformed CLT and glulum panels and beams, all beam and wall penetrations had to be coordinated during the design phase," says Aurecon mechanical engineer Joel Fernandes.

Air conditioning plant is located within the Level 10 rooftop plant room. *Image courtesy of A.G. Coombs.*

> Mechanical plant was placed on pre-fabricated skids to reduce mechanical installation time

Not surprisingly, the use of BIM (building information modelling) became critically important. Regular design coordination sessions were therefore held between the structural, architectural and services design teams.

Appointed by Lendlease as mechanical services contractor on the project, A.G. Coombs led the coordination of services. A. G. Coombs also arranged regular coordination and clash detection meetings with all trades to establish the necessary accuracy of the model.

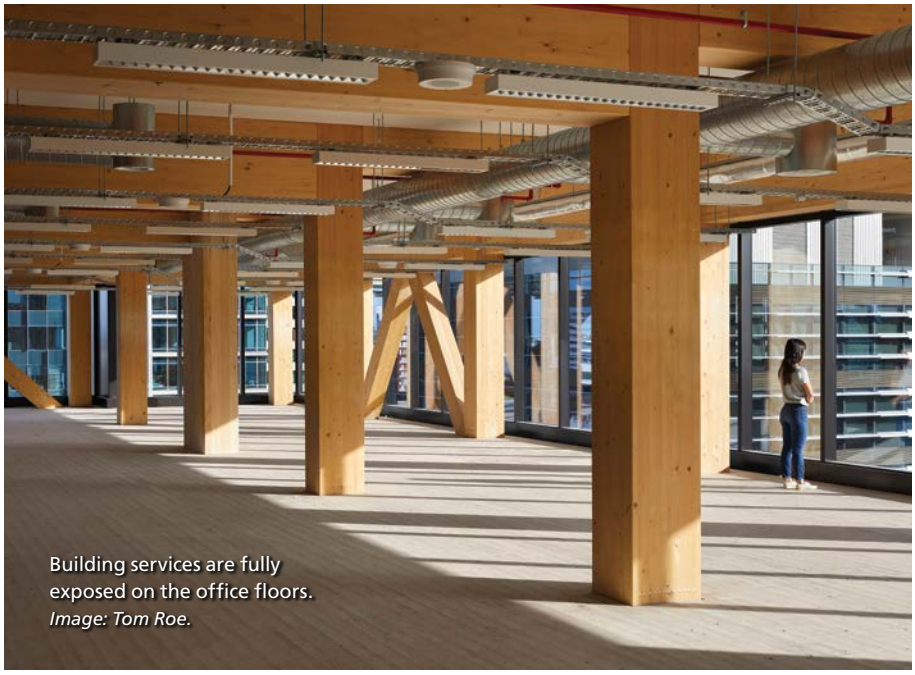
This approach allowed all elements of the design to be fully coordinated before installation, reducing time spent on site coordinating during the construction phase.

According to Fernandes, project-specific Revit families were also developed to assist in penetration sizing and location. Complicated and congested areas such as the Level 10 plant room, the basement carpark and areas outside tenant floor risers could be workshopped and resolved during the design phase.

These areas were affectionately labelled as "super highways" by the project team.

Several mechanical elements of the design also made use of parametric modelling to verify duct sizes, size equipment and automatically generate equipment schedules. The use of these techniques reduced rework during the design stage and allowed for design iterations to be quickly reviewed and updated to meet Lendlease requirements.

As well as presenting challenges in the coordination of services penetrations, the engineered timber construction presented structural challenges for A.G. Coombs in the set-out and installation of mechanical and HVAC systems.



Building services are fully exposed on the office floors. *Image: Tom Roe.*

For example, secondary steel framing was required for all mechanical plant located in the rooftop plantrooms to protect the timber slab. Air-handling units (AHUs) were also installed on steel frames raised above the plantroom floor to distribute the load to steel supports. This reduced the stress placed on the CLT construction.

Elevated steel platforms, step-overs and walkways were also required for low-level services. Mechanical plant was placed on pre-fabricated skids to reduce mechanical installation time.

According to A.G. Coombs project manager Bryce Dunbar, all ductwork and pipework hanger fixings also demanded an unusual level of detail.

"Hanger fixings were required to be long enough to penetrate 30mm into the second lamella of the cross-laminated timber," Dunbar says.

"Therefore the screws used must penetrate the timber of an embedment of at least 70mm to ensure the supports would be capable of withstanding the expected 40mm of the CLT sacrificial loss in the event of a fire."

> Exposed services require a higher standard of workmanship

Also, no hot works were permitted on the site during the construction phase. This created challenges for the A.G. Coombs team when cutting the ductwork for spigots and the like.

This was further complicated by the fact that all mechanical services are fully exposed on the office floors, attached to the exposed CLT soffits.

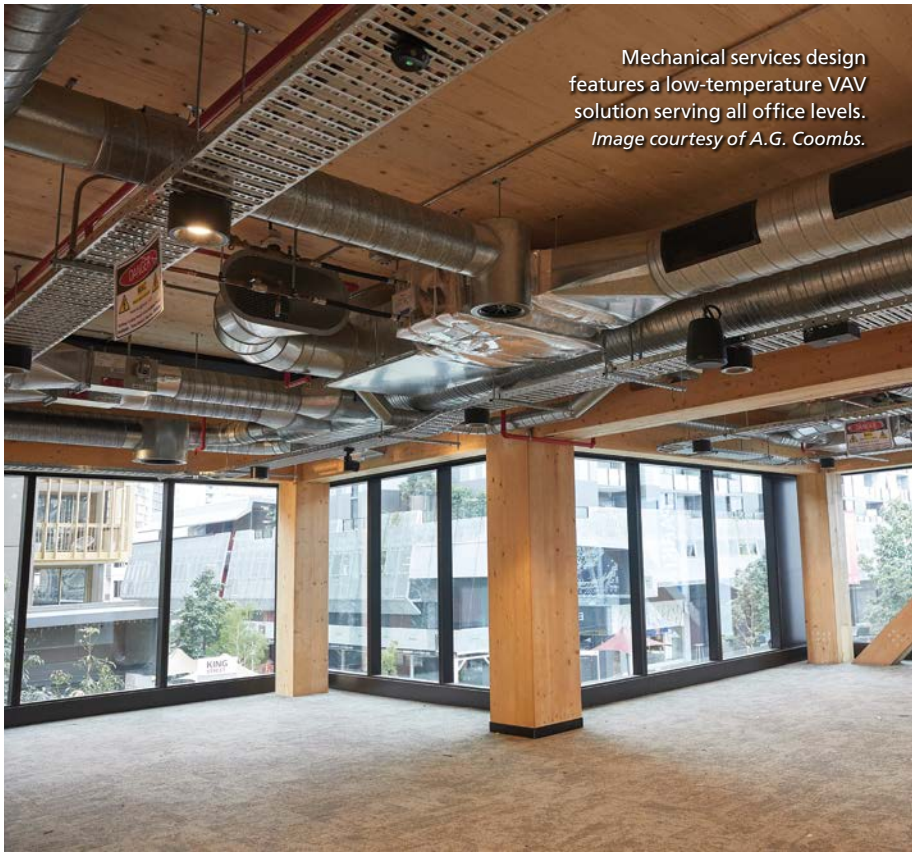
FIRE DAMPERS

25 King features a standard smoke-control system and automatic stair-pressurisation systems to serve the fire-isolated exits.

But since cross-laminated timber is an unusual building material, a limited range of fire dampers that have been tested for the application exist in the marketplace.

This led to a fully designed and coordinated solution, with the project's structural team being sought at the earliest stages of the project.

"The use of fire dampers within timber walls is not a standard detail, and therefore only specific fire damper products and arrangements had been type-tested and deemed to comply," explains Joel Fernandes.



Mechanical services design features a low-temperature VAV solution serving all office levels. *Image courtesy of A.G. Coombs.*

"Exposed services require a higher standard of workmanship, and Lendlease placed a strong emphasis on installing all ductwork, pipework, electrical services, supports and brackets in a very neat manner," Dunbar says.

Prototype examples of all duct and pipe jointing methods were set up to the agreed installation methodology, and compared to the BIM model to confirm accuracy.

Rather than the standard-practice use of grinders, the A.G. Coombs team cut all ductwork manually using nibblers and electric shears. This proved particularly time-consuming where insulated oval duct was being installed. Despite this, the overall speed of the construction process was deemed to be significantly quicker than that of wet concrete.

"With no back propping required," Dunbar says, "the floor was available to following trades as soon as the façade was installed."

LOW-TEMP VAV

The mechanical services design of 25 King features a low-temperature variable-air-volume (VAV) solution serving all office levels. This allows for a reduction in the total air volume required.

According to Roberts this provided several tangible benefits including a reduction in riser, plant and duct dimensions, and reduced fan power consumption.

The low-temperature VAV system is served by a chilled water plant comprising two water-cooled, high-efficiency screw chillers. Three cooling towers, seven AHUs and two outside air preconditioning units (PCUs) complete the system. All components were procured on the basis of being the most energy-efficient available. Pumps, fans and heat exchangers were supplied on prefabricated plant skids, as was the chiller enclosure's pumps and tanks in order to optimise installation time.

"Concurrent construction of mechanical services to maintain project timelines against a non-conventional timber construction meant that prefabricated sections of ductwork and pipework distribution were also necessary," says A.G. Coombs project engineer, Dan Ford, M.AIRAH.

Retail and tenancy cooling is provided by a condenser water system that has been decoupled from the main system by a plate heat exchanger. The building's ground-floor retail tenancies are served by dedicated package condenser water-cooled units.

All air conditioning plant is located within the Level 10 rooftop plant room. The rooftop air-side plant room was redesigned by A.G. Coombs in order to incorporate prefabrication methodologies and optimise access and maintainability.

Ford says this involved the use of a common return-air ductwork (essentially extensions of the east and west return air shafts) in lieu of separate return air ducting to each unit.

"Two AHUs on each side of the plant room have been double-stacked as well, to create more plantroom space," he says.

> Make sure you enjoy the success of a project after completion

LESSONS FROM THE CONSULTANT

Aurecon mechanical engineer Joel Fernandes shares some of the key lessons from the company's involvement in the design of 25 King as both lead consultant and major tenant.

Acoustic requirements for achieving a WELL rating can be tough to achieve, so start the design with this in mind.

Coordination with other services and structures is key – particularly when the services are exposed.

Duct heat gain and loss in exposed insulated mechanical ductwork can be significant, and needs to be considered for peak load and occupant thermal comfort calculations.

Make sure you enjoy the success of a project after completion. We often don't take the time to stop and reflect on the journey and the overall outcomes and learnings.

A holistic approach to acoustics and vibration was also required due to the vibration response of the timber building.

Ford says this required all mechanical plant on Level 10 to be supported on spring vibration mounts, as well as secondary structural steel for chillers to achieve the required vibration isolation.

"All technical submissions for plant and equipment were required to include vibration data," Ford says. "This enables vibration isolation to be confirmed by the consultant."

FOUR OF NINE

Following practical completion of 25 King in early November 2018, Aurecon moved into the building just a few days later. The Aurecon tenancy encompasses Levels 1 to 4 of the building, and includes a dedicated entry on the ground floor.

According to Roberts, the open-plan fitout of the tenancy features a

A holistic approach to acoustics and vibration was required. *Image courtesy of A.G. Coombs.*

LESSONS FROM THE CONTRACTOR

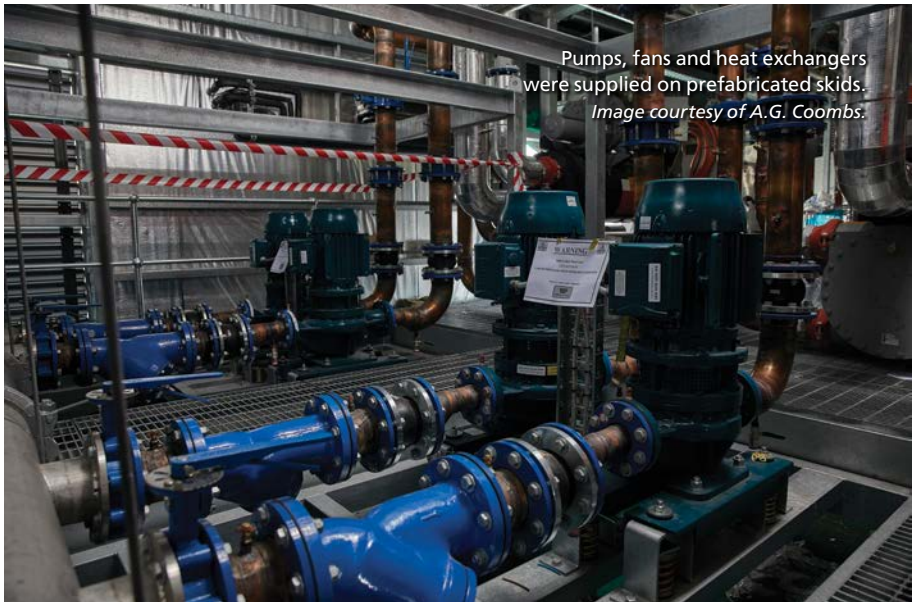
A.G. Coombs project manager Bryce Dunbar offers an insight into the services coordination and installation of the 25 King project.

Exposed services require a greater detail of services coordination. Time spent upfront coordinating between services in the model is time well spent. This philosophy needs to be carried through to the installation stage and be carefully managed to reflect the coordination model. Input from all trades is required early and this needs to be led, or championed, by the lead coordinator.

Timber frame construction uses a prefabricated modularised approach. Taking the same approach where possible to services installation will benefit project installation quality, and is required to keep pace with the faster project timelines.

There is very little mass in the timber construction compared to a concrete slab. This becomes an issue in plantrooms where large deflection springs are required to overcome noise transmission. A hybrid solution of locating plantrooms or large rotating plant components on concrete (inertia) slabs may be a consideration for future CLT developments.

Hot works in all but most extenuating circumstances are prohibited for CLT projects. The use of cold joining techniques and prefabricating pipe sections for risers with minimised cold jointing onsite is preferable.



Pumps, fans and heat exchangers were supplied on prefabricated skids. *Image courtesy of A.G. Coombs.*

collaborative seating arrangement, with workstations offered in a range of styles from sit to stand, high and low seating positions and quiet spaces.

Level 1 is the client space and features mostly larger, enclosed meeting areas and an open area for informal meeting and working arrangements.

"The space has a very comfortable feel, with many options available for individual and team requirements," Roberts says.

At the time of publication, building tuning remained ongoing, with every percentage point of efficiency being chased to ensure the project's sustainability and WELL targets were achieved.

"The building has performed admirably so far, and the high-quality installation has really highlighted the effort put in by both the design and construction teams to make this such a special building – timber or not," Aurecon's Fernandes says.

"The team has created a unique space that wows clients, guests and Aurecon staff alike, and I know the whole design team is looking forward to seeing what the energy and health outcomes are in nine months' time."

The team has created a unique space that wows clients, guests and Aurecon staff alike

PROJECT AT A GLANCE

The personnel

- Architectural design (base building): **Bates Smart**
- Aurecon fit-out design: **Woods Bagot**
- Building services consultant: **Aurecon**
- Developer and builder: **Lendlease**
- ESD consultant: **Aurecon**
- Mechanical services contractor: **A.G. Coombs**
- Owner: **Impact Investment Group (IGG)**
- Structural engineering design (structure): **Aurecon**
- Structural engineering design (timber): **Lendlease DesignMake** in collaboration with **Aurecon**

HVAC Equipment

- AHUs: **Carrier**
- BMS: **Siemens**
- Chillers: **Carrier**
- Cooling towers: **Evapco**
- Dampers: **Celmec** and **Blendair**
- Diffusers: **Holyoake**
- Duct: **Premier Ducts**, **Roladuct** and **Trans Vent**
- Fans: **Pacific HVAC**
- FCUs: **Temperzone**
- Grilles: **Holyoake**
- Heat exchangers: **Alfa Laval**
- Pumps: **MASTERFLOW SOLUTIONS**
- Sensors: **Siemens BMS**
- VAV boxes: **Celmec**

Source: A.G. Coombs