CASE STUDY

Building Sydney's Skyline

118 Mount Street, North Sydney

THE BRIEF

Delivering high-rise commercial buildings is no mean feat. With city space at a premium and a highly competitive market, building designs are expected to deliver on the *golden trifecta:* optimise valuable real estate, respond to changing user needs and be environmentally sustainable.

To be truly successful on these types of projects, engineers must have a combination of technical and technology skills, an innovative design approach, and a strong understanding of commercial tenant requirements.

118 Mount Street is a building that showcases Northrop's commercial engineering approach in spades. Instantly recognisable in its prominent position on the edge of the North Sydney CBD, this 29-storey, PCA A-grade building is the flagship Australian headquarters for one of the world's most experienced insurers - Zurich Financial Services.

AT A GLANCE

Project Contact

Isabel Duffy - Associate | Structural Engineer

Some project facts

- Project value: $150M
- 29 stories high
- PCA A-Grade
- Iconic location
- Complex high-risk engineering

Collaborators

- Client: Zurich
- Northrop services: structural engineering
- Architect: fjmt
- Builder: Roberts Co.

Our team of determined structural engineers, working in close collaboration with the project architects (fjmt) and builders (Roberts Co), enthusiastically rolled up their sleeves to tackle some unique and complex engineering problems offered up by both the site conditions and the building design, to unlock the value of this site and create a world-class asset for Zurich.

Here is how we did it.

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REALISING POTENTIAL THROUGH CLEVER DESIGN

Core placement and floor plate arrangement

We understood very early on in the project that maximising the floor plates was key to the building's design, which featured a side core to the north, and a flexible, open-plan work space.

Developing on a site bounded by three streets with a building to the north and sweeping harbour and CBD views to the south and east, meant there was really only one place for the core – off-set to the north, as close to the boundary as possible.

Although this core location unlocked the floor plate arrangement and ensured maximised views, floor space utilisation and circulation of movement of the occupants, this in turn produced a new set of engineering conundrums to solve.

ONTO THE NEXT CHALLENGE: CAN IT BE BUILT?

Safeguarding success – using collective ingenuity and technology to predict building movement

Predicting exactly how much the building was going to move under lateral and gravity forces so that it stayed within our site boundaries, particularly adjacent our northern neighbours, was crucial to maintaining the optimised floor plate arrangement.

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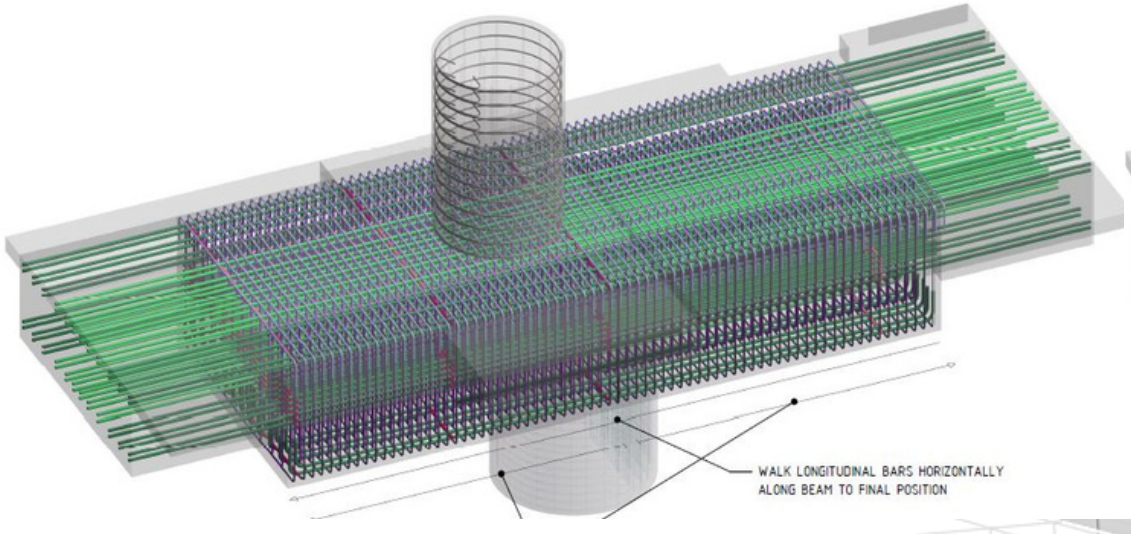

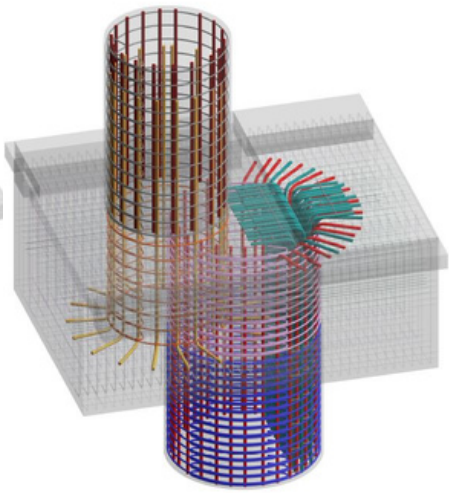

Wind tunnel tests, common practice for a building of this height and exposure to the harbour, were carried out with the data then imported into a Finite Element Analysis modelling program, Etabs, to help optimise our designs.

We then assessed the building's predicted **'tilt'** caused by the structural imbalance posed by the difference in size and stiffness of the off-set core compared to the comparably smaller and less stiff columns. This phenomenon called 'axial shortening' occurs over the life of a building as concrete creep, shrinkage and loading leads to heavily compressed elements wanting to 'squash' - which can become problematic if the building structure has an asymmetry in stiffness as it will tend to 'tilt', in our case with the columns shortening 50-70mm more than the core.

The design and construction of high-rise commercial buildings must take this into consideration in adjusting the building levels to adjust for predicted shortening effects, as well as ensuring elements such as the façade and lift mechanisms are designed to allow for future movement. Again turning to complex FEA modelling and computational programming, we were able to accurately predict how the building would 'tilt' over time and fine-tune our designs to improve the building's behaviour under these different movement effects and inform the site team.

The result of our analysis led to the following engineering interventions:

1. *The floor plates were formed up and poured on an angle, with the columns built several mm higher than the design floor level, and the slab built on a slope to allow for future shortening of the columns.*
2. *The core was also built on a slight angle, allowing for the column shortening to occur which would see the core 'pulled' back into a vertical position.*

Our team received **live data** from a significant level of surveying which was carried out during construction to ensure the accuracy of our designs. We worked closely with Roberts Co. to incorporate their construction tolerances and make adjustments to respond to the data we received from site surveys. Our site measurements demonstrated our predictions were within 15% accuracy!

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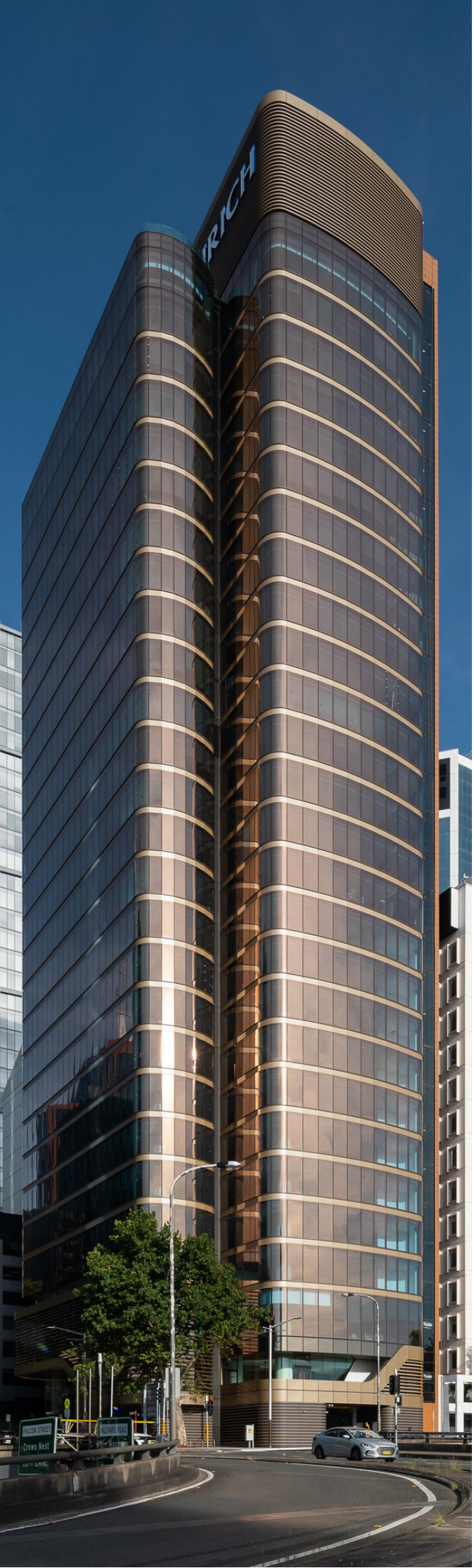

Complex, high risk engineering

High-rise office buildings have heavy loading and require a high degree of quality. The design of key building elements such as transfer beams/walls and the base of the lift core required working collaboratively with the architects, fjmt, as well as weeks of detailed engineering modelling, calculation and checks. To provide an additional QA measure for these elements, we engaged with technical experts from across Northrop's national offices to ensure a thorough and independent verification was carried out on these elements. We also worked with a specialist concrete technologist for a review of large pour elements to mitigate the risk of thermal cracking.

INSPIRING A NEW GENERATION OF FEMALE CONSTRUCTION PROFESSIONALS

As site works were established and the building started to come out of the ground, the project team spotted an opportunity to inspire a new generation of female construction professionals by organising a site tour for Sydney Girls High and Willoughby Girls High. Led by Isabel and the CEO of Roberts Co, Alison Mirams, the site team including female engineers, architects and builders discussed their roles on the project with the students and painted a picture of how rewarding and collaborative working in construction can be.

ENDURING PARTNERSHIPS – HOW THE EARLY BIRD CATCHES THE WORM

One of the key drivers of success on this project was that our structural team immersed themselves in this project from as early as fee proposal stage. We were able to carry our unwavering enthusiasm and passion for this project through to completion. Our early involvement enabled us to bring a deep knowledge of the site, building and the client's vision as well as provide consistency to project collaborators.

With a shared ambition to deliver a high value commercial building for Zurich, and by responsively and proactively working through the intricacies of this project with architects and builders, we strengthened our existing relationship with fjmt and forged a brand new one with Roberts Co, who we have now partnered with on two further projects.

118 Mount Street is a landmark project for Northrop and showcases our ability to help shape modern cities through creating iconic commercial buildings and realising our clients' goals.

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"High-rise commercial buildings involve a whole suite of technical challenges which are completely unique to their sector. Working through structural engineering issues around building movement, huge transfers and the offset core, our team feels proud to have delivered a beautiful addition to Sydney's skyline."

Isabel Duffy - Sydney Business Development Manager | Associate | Structural Engineer

Northrop Consulting Engineers