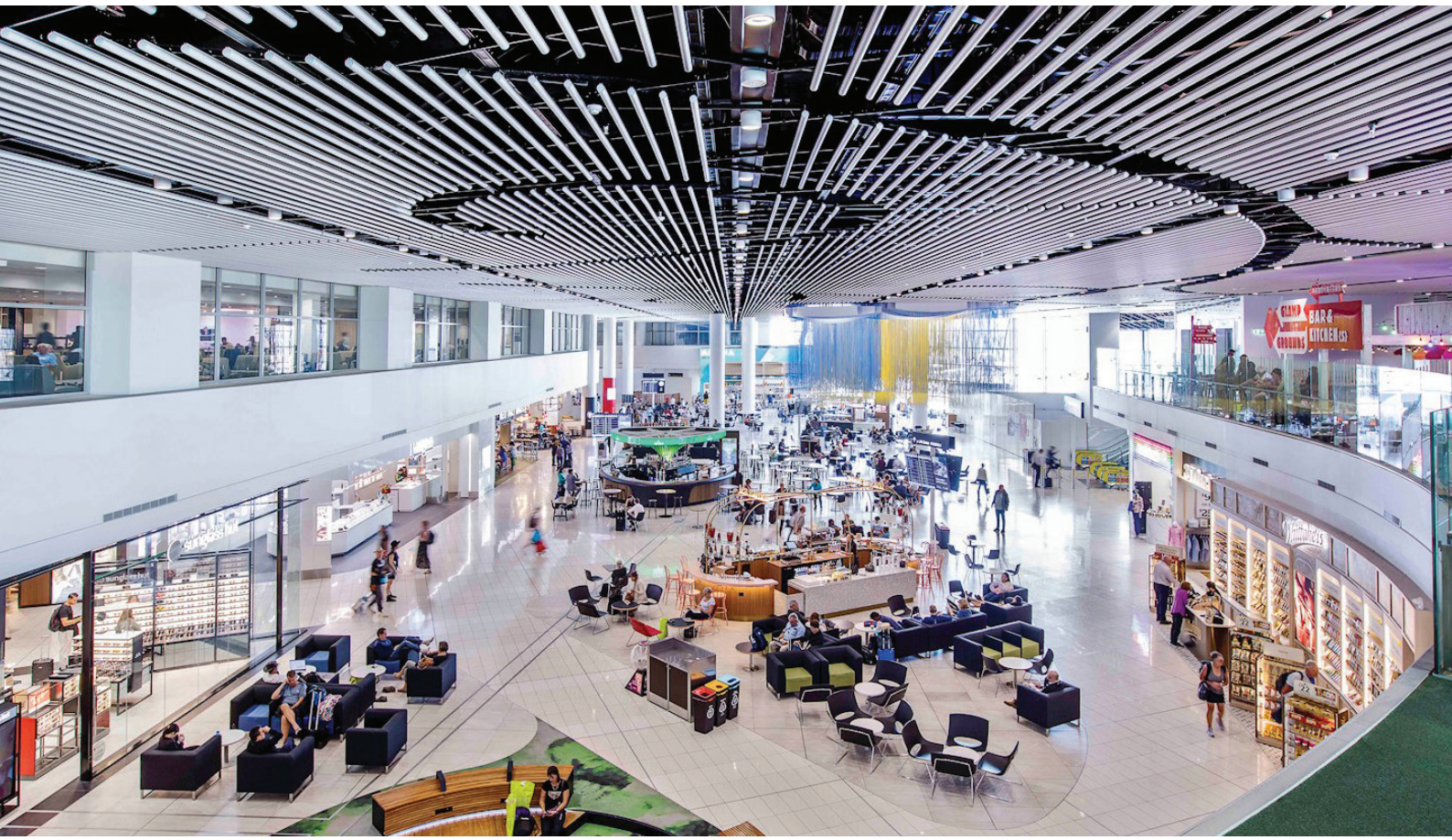
CASE STUDY NO 8

AUCKLAND INTERNATIONAL AIRPORT – DEPARTURE TERMINAL REDEVELOPMENT

STEEL CONSTRUCTION NEW ZEALAND

JUNE 2020



STRUCTURAL STEEL SETS THE FRAMEWORK FOR MASSIVE AIRPORT REDEVELOPMENT

Driven by Auckland Airport's goal to be future-ready, the transformational International Terminal Expansion project is an important milestone in its journey to increase the Airport's annual capacity.

The project has almost doubled the size of the departure processing zone, reconfiguring the landside farewell area; building a new and expanded security screening and processing area; and building a new passenger lounge and duty-free shopping hub.

It also included the removal of significant legacy structures, such as redundant mezzanine plant areas plus a bridge and stairs 'to nowhere'. The reconfiguration improved the flexibility of the terminal for future alterations and enabled higher ceilings and unified public spaces. The project offered a few key challenges, including a tight timeframe and the need to minimise impact on passenger movements and disruption to flight schedules.

Given these constraints, the project team broke the work into three major parts: a new immigration processing area to create a low-vibration environment, maximising open space in a much larger dwell area, and installing an extra centralised plant floor, and myriad lifts and stairs. To achieve these outcomes, a steel solution was adopted, offering a lightweight yet flexible structural system, which proved to be a crucial factor in the project's success.

THE FACTS

- Mostly built on an existing steel structure from the 1970s & 1990s
- Spans eight existing terminal structures and comprises nearly 100 different interfaces
- Massive dwell roof structure represented 40 percent of the overall project with 3,000 components
- 550-tonne crawler crane positioned airside to assemble roof structure
- Structural steel contractor expended 90,000 site hours and 40,000 factory hours over an 18-month period
- More than $15 million of structural steel used
- 1,550 tonne structural steel

ENGINEER BECA **ARCHITECT** JASMAX & GENSLER **STEEL CONSTRUCTOR** D&H STEEL CONSTRUCTION **BUILDER** FLETCHER CONSTRUCTION

"WORKING WITH STRUCTURAL STEEL IS A HUGE ADVANTAGE IN CONSTRUCTION. NOT ONLY DOES ITS FLEXIBILITY ALLOW US TO COME UP WITH COMPLEX FORMS, BUT ITS LIGHTNESS MEANT THE EXISTING STRUCTURE COULD BE STRENGTHENED WITHOUT ADDITIONAL STRAIN. THIS IS A MASSIVE SUSTAINABILITY WIN AS WE WERE ABLE TO BUILD ON THE ORIGINAL DESIGN INSTEAD OF KNOCKING IT DOWN."

- AARON BEER, TECHNICAL DIRECTOR STRUCTURAL ENGINEERING, BECA

The roof structure represented 40 per cent of the overall project, consisting of 3,000 components fabricated into 15 large trusses.

• • •

ENGINEERING

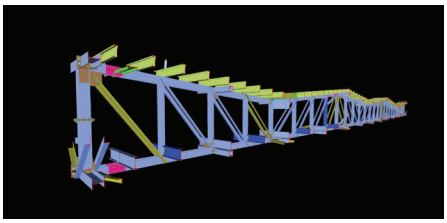
At the concept design phase there were two possibilities: demolish parts of the existing structure and build entirely new; or re-use and adapt the existing buildings. Structural engineer Beca completed a rigorous analysis of the existing structures and determined that it was possible to maintain a seismic performance of 100% NBS (new building standard) by careful adaption while reducing the number of seismic separations, which are problematic operationally.

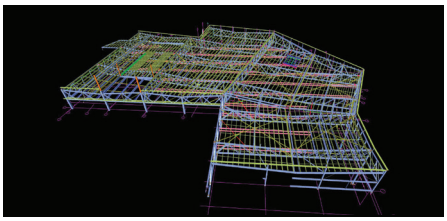
The designers of the original 1970's terminal showed considerable forethought by future-proofing the structure with the use of robustly detailed structural steel. The original structure's use of the lightweight, adaptable material meant that large areas of the terminal could be re-purposed rather than demolished, and allowed it to be integrated and significantly expanded to double the dwelling space for passengers without increasing the overall footprint.

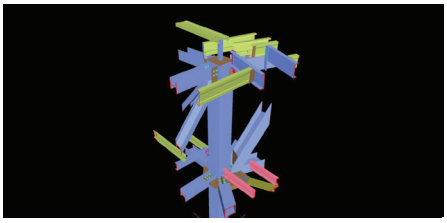
The existing steel building was made up of disparate structures with various ages and design standards, a unique situation that challenged Beca to develop a large Revit model of the terminal, partially stitched together from original shop drawings produced in the 1990s for the last major airport expansion. The model was supplemented with digital cloud scanning to establish an accurate exterior envelope. The Revit representation was used throughout the design and construction process from the base model for the new shop drawings, aiding mechanical and electrical design, to construction planning.

The first part of the project was to redesign and expand the immigration processing facilities. The design of this area needed to support the functional brief of a low-vibration environment for the sensitive scanner operation above the truck dock. The innovative use of Resotec, a constrained damping layer installed under the ComFlor decking, absorbed vibrations and improved the dynamic performance of the floor. It also enabled lighter steelwork to be used.

The design for the new level-three plant floor had to consider the extra load on the existing foundations. The original terminal design proved to be exceptionally flexible and analysis found it could cope with an additional level. In terms of the piles, these are extremely difficult to strengthen in an operational building, and the geotechnical engineers managed to demonstrate sufficient redundant capacity. This was a tricky exercise as there were no piling records. However, by collecting enough anecdotal evidence, such as interviewing the now senior citizens who installed the piles, it was possible to determine that no







The original 1970's terminal was future-proofed with structural steel, allowing the structure to be re-purposed and expanded. The new terminal has double the dwelling space without increasing the overall footprint.

• • •

ONE OF THE KEY OPPORTUNITIES IN THIS DESIGN WAS TO RESHAPE THE PASSENGER DEPARTURE JOURNEY, ELEVATING SOMETHING THAT CAN BE STRESSFUL OR SIMPLY PERFUNCTORY TO AN EXEMPLAR PASSENGER EXPERIENCE, NOT JUST AT A NEW ZEALAND LEVEL, BUT ON THE WORLD STAGE. THE FINISHED TERMINAL IS A TRUE TESTAMENT TO EVERYONE'S INPUT."

- NICK MOYES, PRINCIPAL ARCHITECT, JASMAX

strengthening was required if the weight of the new structure was minimised. This was achieved with the extensive use of optimised, lightweight custom-welded beams and columns.

ARCHITECTURE

Jasmax, Gensler and artist Dr Johnston Witehira worked closely with mana whenua to weave the overarching narrative, 'A New Zealand journey from the Sea to the Sky', into the architecture. The redesigned international departure experience aims to deliver a world-class architectural solution, one which enhances the passenger journey, represents our cultural identity and creates a unique space where Aotearoa touches the world.

The double height 'Dwell' lounge created with a 50m long-span roof unites four separate existing structures and serves as a transition from land to sky. The ceiling treatment expresses the swirling clouds of New Zealand combined with a large sun shower and a flock of migrating godwits – although passengers are departing, they will hopefully return just as the godwits do every year.

The key architectural features of the project were enlarging internal spaces of the departure experience – from the farewell and retail area to the atrium and boarding the plane. There was a desire to give a unique New Zealand feel and experience of the outdoors, particularly the sense of sun, light and fresh air, mimicked through the design. In the large retail area, the overriding objective of the structural roof design was maximising open space.

Architecturally, this project was a little unusual in that the concept was constrained to the confines of the existing buildings. A certain amount of creative flexibility was required to adapt the architectural design to match the structure as it was revealed in the renovation process. Therefore, it was sensible to extend in the same medium of structural steel, which has many benefits – light, easy to work with and flexible, to name but a few.

While on site, one of the biggest challenges was working within a live operating international airport terminal, juggling site access with a busy retail terminal, security and timings. Jasmax credits working with structural steel as key to overcoming this challenge, with all steel fabricated off site, allowing parts of the building to be erected swiftly with minimal disruptions.

FABRICATION & ERECTION

D&H Steel Construction has been involved with Auckland Airport's development

"THE COMPLEXITY OF THIS PROJECT WAS THE ON-SITE FABRICATION, DUE TO THE HUGE AMOUNT OF BUILDING WITHIN AND ON TOP OF AN EXISTING STRUCTURE. STRUCTURAL STEEL WAS THE ONLY LOGICAL MATERIAL FOR THE JOB, AND THIS PROJECT REALLY ALLOWS THE BENEFITS TO SHINE."

- RICHARD HINE, CONTRACTS MANAGER, D&H STEEL CONSTRUCTION

A 550-tonne crawler crane was positioned airside to preassemble the trusses and lift them into final position, while maintaining normal airport operations. D&H Steel developed unique material handling systems to manoeuvre the trusses around the workshop and for trial fit-up, avoiding the need for substantial shore-loading towers.

• • •

for almost 40 years and understands the requirements of working in this challenging, unrelenting, operationally live environment. At the peak of the contract, D&H Steel had 36 staff on site booking some 90,000 hours over the 18-month duration of the project.

With the eight existing terminal structures and nearly 100 different interfaces, it was vital to have structural elements and connections that could both be detailed with dimensional tolerances and fabricated to match site measurements. Structural steel offered a lightweight but flexible structural system, which was a crucial success factor.

The multiple interfaces to the existing structure involved 20,000 hours of site welding to form the connections. The specification required ultrasonic testing of the site butt welds and magnetic particle testing of structural purpose category site welds. Third-party weld inspectors visited the site almost daily to carry out the necessary analysis.

In the large retail area, the overriding objective of the structural design was maximising open space. The new atrium roof structure represented 40 percent of the overall project and consisted of 3,000 components fabricated into 15 large trusses, 4.5m deep, between 26m and 52m in length and weighing 12-32 tonnes, delivered to site in transportable-sized sections and stored landside. Having inhouse welded beam manufacturing enabled D&H Steel to fabricate custom-welded beams to suit specific geometrical and strength requirements.

The fabrication of the large trusses was critical to the overall programme. Because of the size, weight and number of trusses, D&H Steel developed unique material handling systems to manoeuvre the trusses around the workshop and for trial fit-up, avoiding the need for substantial shore-loading towers. This meticulous planning resulted in the overall success of the fabrication.

On site, a 550-tonne crawler crane was positioned airside and mobilised to preassemble the trusses on the apron and lift them into final position between 1am and 4am. Every aspect of the fabrication process was carefully considered, from resource scheduling to logistics management. Despite some nights of poor weather, the fabrication and installation of the trusses went incredibly smoothly while maintaining normal airport operations.