ARCHITECTURAL VISION DELIVERED WITH STEEL

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Puhinui Station has been transformed into a state-of-the-art rapid transport hub linking South Auckland to the airport and central city. The $69m shovel-ready project was delivered by Auckland Transport as part of the wider Southwest Gateway programme.

Guiding the design team was the desire to deliver a smooth passenger journey, enhanced safety, a future-proofed transport hub, and a high-quality, airport-like experience. The result ticks all the boxes.

The combined bus and train interchange provides seamless connectivity between transport modes. It has also been future-proofed to accommodate rail upgrades, including space for further platforms and provision for a raised bus drop-off at concourse level.

And it looks the part. The Station's stunning roof structure has a feather-like appearance, featuring compound geometry and attention to detail. The building's landmark sculptural form was made possible with the use of structural steel.

The Station is built like a bridge with a building on top. A steel structural system was designed to provide a cost-effective skeleton for the upper portion of the building and to support the façade. The high-strength steel design supports a minimalist yet striking structural form.

THE FACTS

- 14 percent of the primary steel members are 2D curves
- 450 tonnes of structural steel
- 32,000 manhours to deliver detailing, fabrication and site installation

ARCHITECT – JASMAX **STRUCTURAL ENGINEER** – AURECON **STEEL CONTRACTOR** – D&H STEEL CONSTRUCTION
BUILDER – MCCONNELL DOWELL **DEVELOPER/OWNER** – AUCKLAND TRANSPORT

THE ARCHITECTURE ENHANCES THE PASSENGER JOURNEY. THE CEILING SERVES AS A WAYFINDING ELEMENT, VISUALLY CONNECTING THE PLATFORM AND CONCOURSE THROUGH ITS FLOWING FORM.

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ARCHITECT

The Station's layout was designed to optimise people's movement through the space and architecture is used to enhance the passenger journey. The ceiling serves as a wayfinding element, visually connecting the platform and concourse through its flowing and inviting sinuous form.

The roof structure lightly touches the concourse level through articulated 'V' columns, creating an open atmosphere; lateral bracing is discreetly concealed within the flanking roof wing walls. This, coupled with the lightness of the expressed steel structure, helps to give this key piece of public infrastructure its distinct identity.

The roof design provides other benefits: protection from wind-driven rain; passive ventilation up through the concourse; natural light without the need for skylights; and an optimised solar load that offers protection from the hot summer sun while letting in the winter sunlight.

Steel enabled the team to build the bespoke form with precision, using a combination of 'off-the-shelf' elements and curved members. When the steel sections arrived on site, the team knew they'd fit together.

A key design consideration was to minimise the number of columns within the building, especially in the common areas that have surges of people walking through the space. Steel's long, clear spans enabled the building's large, uninterrupted spaces. And the material's inherent span-to-depth ratio allowed the roof's slender profile.

"BEING ABLE TO WORK WITH A HIGHLY SKILLED LOCAL STRUCTURAL STEEL FABRICATOR WAS MASSIVE – WE WERE ABLE TO SKETCH TOGETHER IN THE SAME ROOM, DESCRIBE THINGS IN PERSON, AND VISIT THE FACTORY TO SEE THE VISIBLE PRIMARY ELEMENTS."

ROWAN TURKINGTON, SENIOR ASSOCIATE, JASMAX

ENGINEER

To accommodate the intricate geometry of the building envelope, a one-of-a-kind steel structure was designed to support the façade. Several design iterations of the main lateral system were required to optimise the superstructure while also realising the visual ambitions of the architectural design and form. The dramatic roof form is supported by V-shape moment frames with bespoke connections arranged along curved spine beams – 14 percent of the primary steel members are curved.

All exposed steel connections were rigorously reviewed, scrutinised and coordinated by the design team. It was a highly iterative process to optimise the connections from both an aesthetic and a structural perspective, and involved the engineer, architect and structural steel fabricator. This level of coordination was achieved by overlaying the architectural and structural models in BIM, enabling an exact understanding of each connection's location in the structure – to the millimetre.

OPTIMISED HIGH-STRENGTH STEEL WAS USED TO REDUCE THE MASS OF STEEL FRAMING, AND THE STRUCTURE'S DESIGN LIFE WAS EXTENDED TO 100 YEARS. THE EFFECT HAS BEEN TO GREATLY REDUCE THE BUILDING'S CARBON IMPACT.

Two examples of the complex connections involve the curved rectangular hollow section beams that help to form the curving glass-reinforced concrete façade and the balustrades at the central stairs. To create the curving visual impression, all the secondary steel used to form the central stair balustrade and the façade have varying heights and angles.

The true curves at the building tails created many geometrical challenges, requiring curved welded beams, three-dimensional trusses to form the fascia of the tails and several one-of-a-kind connections between steel members. The bold curving roof form also meant that each purlin at the top of the steel structure had a slightly different height and angle from the previous one.

Optimised high-strength steel was used to reduce the mass of the steel framing, and the design life of the structure was extended to 100 years. The effect has been to greatly reduce the carbon impact of the building.

"STEEL IS FLEXIBLE; IT CAN BE MODIFIED TO MEET THE MOST COMPLEX ARCHITECTURAL FORMS. AND THE LOCAL STEEL INDUSTRY IS WELL DEVELOPED SO WE CAN ACTUALLY BUILD COMPLEX PROJECTS LIKE THESE."

NIK PREZAS, ASSOCIATE, STRUCTURAL, AURECON

FABRICATOR

The highly architectural shape had very few vertical supporting elements. It posed a big challenge for the structural steel contractor – how best to connect the long-span structures with their complex geometries to the columns in order to transfer loads down into the main foundation structure?

The slanting, curving roof meant that no one member was the same as the adjacent member; each one was bespoke, as was each connection. The exceptional versatility of steel's different connections allowed the seamless integration of intersecting long-span structures. These connections effectively joined columns at various angles and ensured the safe transfer of loads throughout the structure.

The roof presented a number of challenges, not least the fascia trusses forming the edge of the cut-outs. The trusses are effectively a compound ellipse, curving at different rates along its length. There are also sections where the truss transitions from curved to straight.

In total, there are 14 different three-dimensional fascia trusses and large curved Custom Welded Beams. They have no symmetry, so to set them out in a traditional manner would have been extremely difficult. Instead, the team created a bespoke jig for each truss to control the geometry and fixing points, and ensure that minimal set-out was required. The trusses could be tacked and welded directly in the jig, maintaining accuracy throughout the process.

Each purlin had a slightly different height, angle and rotation from the previous one to form the curve. For the steel detailers to model this, crucial set-out lines were provided by the architect around the roof's perimeter, which informed the purlins' positions and that of the structure below. Once the purlin modelling was completed and verified by the architect, the steel model was provided to the roofing contractor to set-out, draw and manufacture the curving roof envelope.

"THE WAY IT HAS BEEN BUILT ON SITE HAD TO BE RESOLVED UPFRONT. SO A LOT OF TEAMWORK AND COLLABORATION WAS REQUIRED TO MAKE SURE THE DESIGN AND THE FABRICATION WERE SUITABLE FOR THE COMPLEX BUILD AND FOR THE ERECTION. THAT'S WHAT MADE IT A SUCCESS."

RICHARD HINE, GENERAL MANAGER,
D&H STEEL CONSTRUCTION

BUILDER

It was a complex build. McConnell Dowell was engaged in an early contractor involvement capacity to provide constructability advice. For the first five months it worked closely with KiwiRail, the designers and Auckland Transport to review the design. The team considered the design's buildability alongside the non-negotiable deadline – first, could it be built, second, could it be built within the timeframe? Once the design was agreed, a construction methodology was developed.

PUHINUI STATION WAS BUILT OVER TWO LIVE RAIL LINES – TRAINS RAN THROUGH THE SITE EVERY 15 MINUTES DURING PEAK HOURS. PLANNING WAS PIVOTAL TO SUCCESS.

The Station was constructed over two live rail lines – during peak hours there were trains running through the site every 15 minutes. Disruption to the rail operations had to be kept to a minimum; passenger and freight volumes needed to continue as usual. That, combined with the presence of overhead electrification and the site's location on Auckland Airport's flight path, meant appropriate construction methods were critical to the health and safety of workers on site.

Steel construction reduced the risk. Structural steel not only ensured that a significant amount of the works could be done off site as part of the fabrication process, it also allowed for the structure to be safely preassembled on site prior to lifting into position.

The lifts were planned several months ahead of time. To complete the work, a block of line – when the rail line is temporarily shut down – was necessary. The date had to be scheduled months in advance, and it was fixed. To meet this commitment, fabricated steel elements were delivered to site well in advance.

The steel was preassembled into nine modules using temporary jigs at ground level away from the dangerous rail corridor.

To facilitate the lifting and placement of preassembled modules, detailed lifting plans were devised. These plans incorporated temporary lifting beams and specified lift paths, which considered both minimal disruption to rail lines and compliance with the height requirements set by the Airport Authority. Large sections of the structure were erected quickly and safely with the majority of connections – and, with that, plant and workers – kept outside of the live rail corridor. The modules were hoisted into place in a single lift.

"IT COMES BACK TO PLANNING; IF YOU DO THE BACKGROUND WORK EARLY ON, IF YOU TICK ALL THOSE BOXES DURING THE SHOP DRAWING PROCESS, STEEL GOES UP VERY QUICKLY."

TANUJ JUNEJA, PROJECT MANAGER,
MCCONNELL DOWELL