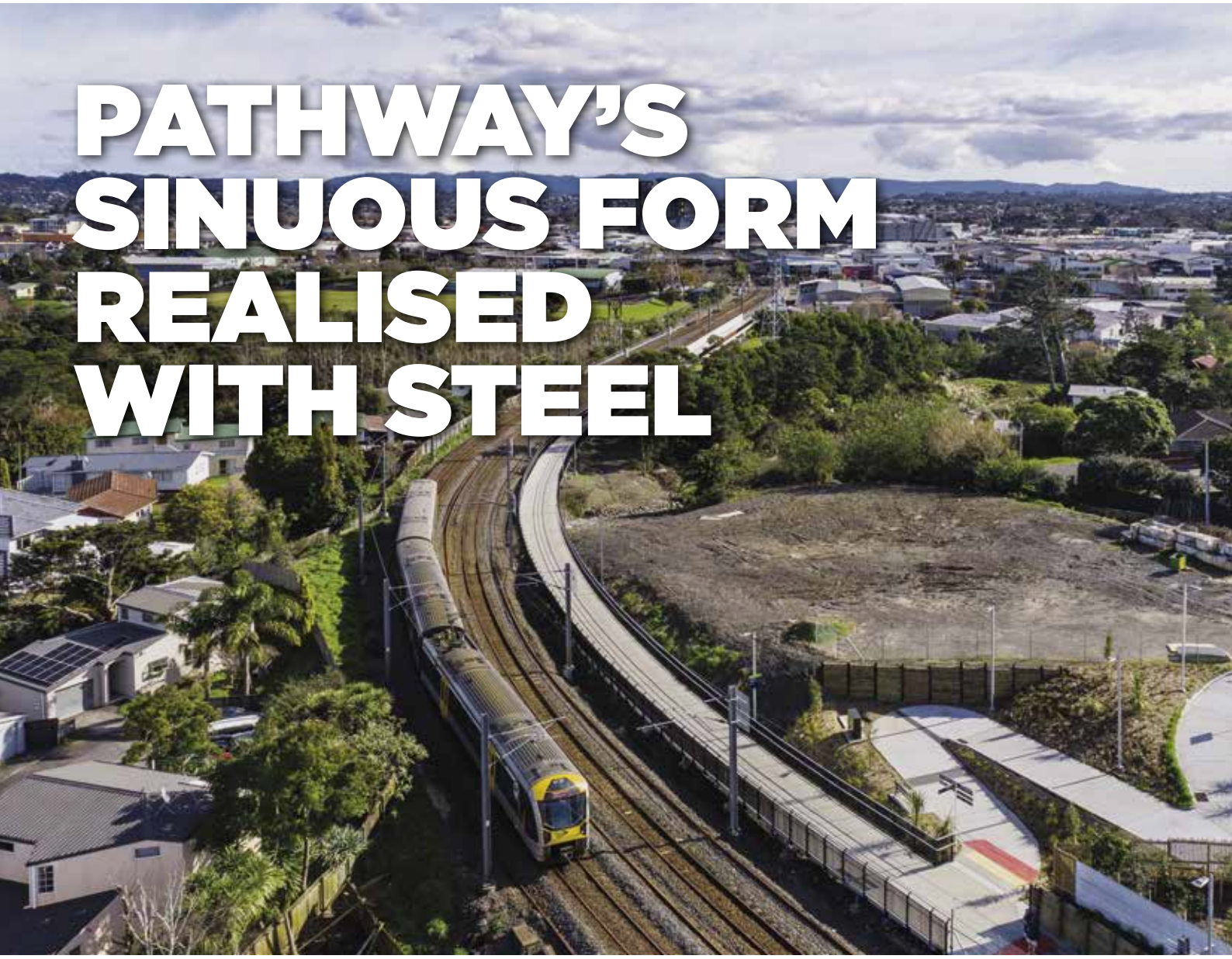
PATHWAY'S SINUOUS FORM REALISED WITH STEEL



West Auckland's award-winning New Lynn to Avondale shared pathway is a walking and cycling route that links the two town centres and their train stations. It follows the gentle gradient of the rail corridor and is part of a wider network of shared paths. It connects to the Waterview and south-eastern routes, enabling people to cycle safely all the way from New Lynn to the city centre.

Steel features heavily in the pathway, which comprises elevated helical boardwalks, balustrades and hand rails, and two new pedestrian bridges. Situated over rough terrain and waterways, the project team collaborated to make the 2.9km pathway buildable and practicable.

THE FACTS

- 165 tonnes of structural steel
- 18 tonne, 26m-long St Jude bridge
- 450 tonne Mega-Wing crane used to lift bridge
- 22 minutes to lift and position the bridge
- 2.9km-long shared pathway

LEAD STRUCTURAL ENGINEER (DESIGN) – AURECON **STRUCTURAL ENGINEER (CONTRACTOR'S DESIGNER)** – ROADLAB
STRUCTURAL ENGINEER (CONSTRUCTION OBSERVATION) – HOLMES **STEEL CONTRACTOR** – D&H STEEL CONSTRUCTION
MAIN CONTRACTOR – DEMPSEY WOOD **DEVELOPER/OWNER** – AUCKLAND TRANSPORT

STRUCTURAL STEEL IS WELL-SUITED TO MODULAR CONSTRUCTION AND IT WAS A RELATIVELY SIMPLE EXERCISE FOR THE TEAM TO ADAPT THE DESIGN FOR THE HIGH PIERS.

ENGINEER

The success of the shared pathway's design lies in its simplicity, making it easier to build and easier to install.

Boardwalks were chosen over at-grade paths because they could achieve the required vertical gradients without the need for retaining walls and earthworks. The boardwalks presented a simpler and cheaper solution.

Lead engineer Aurecon chose to establish a steel structure because it offered a higher design life and larger spans than a timber alternative. The lightweight solution also meant the section sizes were smaller compared with other options, which reduced the loads.

The structure's weight was reduced further with the use of a lightweight fiberglass-reinforced plastic (FRP) decking. The FRP provides a permeable surface for rainwater and avoids additional load to the existing stormwater system.

Auckland Transport specified the boardwalks be at least three-metres wide and able to accommodate lightweight maintenance vehicles. There are two key boardwalk sections of the pathway: one is 218m long and 4.5m above ground at its highest point; the second is 163m long and it reaches almost 2.4m high.

The shear scale of the boardwalks drove the modular design, which could be easily replicated. Structural steel is well-suited to modular construction and it was a relatively simple exercise for the team to adapt the design for the high piers. Extra bracing was added to achieve the required deflection limit and the same lightweight materials were able to be adopted.

The vertical and horizontal geometry of the boardwalks varies considerably along its length. Steel offered a flexible solution to achieve the gentle gradients required for walking and cycling. The lightweight spans easily accommodate changes in the vertical and horizontal alignment, even with the modular system.

The position of the boardwalks in relation to the operational railway was important. The design aimed to keep the boardwalks as far away as possible from the tracks to maximise work that could be undertaken while the railway was operational.

The railway corridor is also the backbone for KiwiRail's critical underground services. Minimising the number of piles required directly reduced the risk of hitting the services – this was a core focus for the project team.

Steel was the ideal material for this purpose thanks to its high strength-to-weight ratio and ability to deliver long spans. Timber, on the other hand, would have required an estimated 80 percent increase in the number of piles.

Another advantage of structural steel was its ability to support the welcoming 'splay span' at the entrance to the boardwalk on Blockhouse Bay Road. It was designed to be wider, allowing a better transition from footpath to shared path and, as a result, access to the boardwalk is more seamless for users.

"THERE ARE MASSIVE BENEFITS TO HAVING A NEW ZEALAND-BASED FABRICATOR. IT MEANT WE COULD TALK THROUGH THE DETAILS TOGETHER AND MAKE ADJUSTMENTS WHERE NEEDED TO ASSIST WITH FABRICATION AND ERECTION."

DAVE MOCKETT, TECHNICAL DIRECTOR, AURECON

"THE STEELWORK WAS PREFABRICATED IN MODULAR SECTIONS IN A WORKSHOP ENVIRONMENT AND ESSENTIALLY JUST BOLTED TOGETHER ON SITE. IT IMPROVED PRODUCTIVITY ON SITE AND REDUCED TIME ON SITE."

ANTHONY MANUELA, CONTRACT MANAGER, DEMPSEY WOOD

THE 18T SINGLE-SPAN BRIDGE WAS SEAMLESSLY LIFTED OVER A MAIN ROAD, AND ELECTRIFIED RAIL AND POWERLINES, AND LOWERED INTO PLACE.

BUILDER

Buildability was a strong focus for the team and steel's light weight allowed an efficient substructure. The lightweight modular construction maximised the spans and reduced the number of piles. The effect was to limit the number of railway closures required to install the boardwalks and minimise disruption to passenger rail services.

The first option considered to support the boardwalks was screw piles. However, the high volume of underground services meant this approach, which takes time and precision, would have made it difficult to install these piles within the tolerances required for the structural steel connections.

Instead, the team proposed a shallow concrete foundation using short-bored micropiles – small-diameter steel rods installed in concrete-filled drill holes. This meant the superstructure units could be positioned with minimal adjustment. Installation work followed an 'as built' survey integrated into D&H Steel's three-dimensional (3D) BIM model, ensuring accurate placement of the posts and hold-down bolts.

Dempsey Wood engaged RoadLab to develop the substructure design; it was more accurate, sped up construction and led to cost savings. The flat, capped-off piles provided a level reference point to build off and enabled the team to work to practicable tolerances.

One of the construction challenges of the rail corridor was access; much of it was limited. The team was faced with working in tight and difficult spaces, and alongside the rail track contours with its electrified overhead lines. Fortunately, the lightweight steel solution meant the machinery was smaller, including cranes and trucks. It offered more flexibility to access constricted areas.

Arguably, the St Jude Street rail crossing was the most constrained part of the shared path. The remote site, which was extremely close to the rail power lines and had very little space to manoeuvre, was the location for a new steel footbridge.

Installation of the 26m-long, fully welded bridge section started with a 'block of line', where the rail corridor was only closed for the duration of Labour Weekend. If the team hadn't made this deadline, the programme would have been delayed for more than three months until the next rail closure.

Sandwiched between an apartment block on one side and housing on the other, the 18t single-span bridge was flawlessly lifted over a main road, and electrified rail and power lines, and lowered into place. After three weeks of meticulous planning, a 450t Mega-Wing crane, operating at its full 70m reach and with 160t of kentledge weights, took just 22 minutes to 'land' the bridge from the truck to its final position.

Works were carried out in close proximity to the electrified rail tracks and the overhead power lines. The challenge was to maintain a constant 'earthing and bonding' link to provide safe isolation between the live lines and the new structural steelwork as the project progressed.

The team was careful to prevent arcing between the overhead line electrification and the new steel structure. It meant working within strict clearance requirements and ensuring none of the equipment was capable of stretching farther than the envelope that KiwiRail had defined.

ALL OF THE STEEL FABRICATION WAS COMPLETED OFF SITE IN A CONTROLLED WORKSHOP ENVIRONMENT

FABRICATOR

D&H Steel spent time upfront, refining the details during the shop drawing stage to optimise steel usage and ensure faster, smoother construction on site.

From a fabrication perspective, the project presented many challenges. One was the difficult geometry and the variable gradients of the terrain that had to be negotiated to develop the helical curvature of the boardwalks.

Another was the complex helical trigonometry necessary to transpose the coordinates into a 3D BIM model to produce the shop drawings and integrate them with the 3D survey data for the hold-down bolt assemblies.

Multiple short spans were used to minimise the superstructure steel sizes and allow the curved alignment to be followed. The design called for 5,400mm spans between the piles but the nearest standard size steel beam is 6,000mm. D&H Steel salvaged the 600mm 'offcuts' and advised a change to the boardwalk design so the material could be used for the bracing. It meant no steel was wasted. The consistency applied to the section sizes and spans allowed the details to be repeated across the boardwalks.

D&H Steel's value engineering eliminated labour-intensive welding of the boardwalks by replacing all of the proposed connections with bolted assemblies. It meant that all of the steel fabrication was completed off site in a controlled workshop environment.

The bolted assemblies allowed for smaller components to be fabricated and enabled the vast majority of them to be galvanised locally in Avondale, reducing transport costs. D&H Steel then preassembled them in its yard, stacked them on a truck and delivered them to site. The subassembly modules were put together at ground level, adjacent to their final position. It reduced the work required at height and greatly decreased the construction time within the rail corridor.

"AN ALL-ROUND TEAM EFFORT PROVED TO BE THE KEY COMPONENT TO THE SUCCESS OF THIS PROJECT. ALL CHALLENGES WERE CONFRONTED 'HEAD-ON' AND RESOLVED 'ON THE FLY'. THIS COULD ONLY BE ACHIEVED WITH TOTAL COMMITMENT FROM EVERYONE INVOLVED."

COLIN ROSS, PROJECT MANAGER, D&H STEEL CONSTRUCTION

ARTWORK: MIGRATION OF THE KUAKA

The significance of the area to Māori is reflected in the imagery along the shared pathway. Māori once used the local Whau River as a waka portage route between the Manukau and Waitematā harbours; the route also symbolises the migration of the kuaka (godwit) between Canada and the Whau River.

Beautiful kuaka motifs with a zig-zag pattern representing the waves on the ocean adorn steel panels erected on the new footbridge that spans the River. Elsewhere, the artwork has been etched into concrete façades using a laser-cut steel template and a water blaster.

ARTWORK TEAM: CHARLOTTE GRAHAM (ARTIST); D&H STEEL CONSTRUCTION; AQUAMAX; PRECISION LASER; JUSTIN CROOK DESIGN