Quiet crossing over busy bypass

- Craigieburn Bypass

A striking steel bridge over the 23-kilometre Craigieburn Bypass in Victoria skillfully combines a curtain wall and pedestrian bridge.

The bypass links the Hume Highway with the Melbourne Ring Road, north of the city.

The curtain wall height, set by noise control parameters, comprises a ribbon of fabricated sheets of weathering steel. The pedestrian bridge is the climax of the curtain wall and the whole gateway experience, carefully sited to frame the view toward Melbourne.

The structural design by Meinhardt is principally a box truss formed from circular hollow sections. The 'box' shape is actually trapezoidal in section and varies along the length of the bridge. The only constant is the spacing of the bottom chords. The side trusses are inclined at varying angles, from three to 30 degrees with truss depth from 4.17 to 5.77 metres. Tubular bracing between both bottom and both top chords of the side trusses completes the box truss.

The chords are 406 diameter steel pipes varying from 6.4 to 31 mm thickness. The braces, pipes 219 to 324 diameter.

"Making the trusses meet seamlessly with the concrete was a challenge. We kinked the bottom chords in to attain the required look," Design Director for Meinhardt, **Peter Placzek** said.

"Initial calculations showed that the structure would deflect too much so a series of tieback cables were used to maintain correct positioning."

The bridge shape is maintained by stiff-end portals constructed from 500WC sections. The portals were split vertically down the middle where stresses are minimal to ease transporting and enable galvanising. The tension cables were anchored to the top of the portal and stressed from the abutment ends. There are four cables (two each end) each comprising twenty two 15.2 diameter strands with a 5500 kN breaking load. The design allowed for final adjustment of the cable stress.

The bridge end portal is supported vertically and horizontally by bearing plates. The tension in the cables at the top of the portal is more than adequate to hold the bridge in place so there is no positive fixing other than tongue and groove arranged plates to maintain lateral alignment of the bridge with the abutment.

The uninterrupted continuity of the weathering steel cladding confined the width of the bridge abutments. The cable stressing and bridge bearing all had to fit inside the cladding line and required careful detailing.

Weathering steel plate cladding of about six millimetres thick give the sound wall and bridge a distinctive appearance, each plate panel having a diagonal fold to enable 2.5 degree incremental angle changes at each support.

Inclined T-shaped mullions, fixed at the base to a concrete wall, support the cladding on the sound wall. Through the transition zone approaching the bridge, the mullions are fixed to the side of the concrete bridge abutment.

The bridge is, in effect, an innovative combination of truss, cable stayed and cantilever bridge, a new type of structure. The weathering steel panels were folded to create the visual effect of a moving form at speed.

The panels were used on both the bridge and wall to visually integrate the two elements. The weathering steel cladding has the unique characteristic that, under proper conditions, it corrodes by forming a dense and tightly adherent oxide barrier sealing out the atmosphere and retarding further corrosion. The weathering steel is isolated from the galvanised steel with neoprene washers. The weathering steel is durable, maintenance-free and has a low life-cycle energy cost.

The weight of the structure is concentrated in the ends, particularly the end portals, minimising the dead weight of the structure. The truss tube sizes were optimised using computer modelling, pipes being the most

efficient shape. The steel structure weighs 70 tonnes supporting over 250 tonnes of bridge deck, superimposed dead and live loads.

The detail design was carried out through extensive consultation with the steel fabricator, especially to simplify the typical truss connection.

The initial design required connection gussets to be slotted into the truss top and bottom chords. It was found that in many cases the slotting was not required. An economical design was achieved by isolating the bridge slab deck from the truss. This was achieved by providing movement joints in the deck at every truss panel point. Arrangement of slotted holes and oversize holes in the deck support steel allows the deck to work independently.

All connections were bolted or fastened with pins for fast assembly on site. The top chord connections, viewable by pedestrians, have neat clevis and pin connections.

The bridge was trial assembled in the workshop to ensure correct fit up, while maintaining the designed camber and curve, then disassembled and sent for galvanising.

The bridge was assembled in three sections on the ground and then lifted into final position. The two end segments were lifted and seated on the abutments and temporary trestles first, then the middle segment. The minimum final pre-stress was then applied to the stressing cables, causing the truss to lift off the trestles, which were then removed.

Finally, the stress in the cables was increased to compensate for variations in and take-up of clearances in the connections. All structural steel, apart from the weathering plate, was galvanised by Industrial Galvanizers. They were involved in detailing of the required holes to allow good inflow and drainage of the zinc metal. The dimensions of all the truss fabricated elements were limited to fit in the galvanising bath.

Project Team

Client: VicRoads
Architects: Taylor Cullity Lethlean & Tonkin Zulaikha Greer
Structural Engineering: Meinhardt
Contractors: Abigroup
Fabricator: GFC Industries
Shop Detailing: Di Paul Construction Services