Rail bridge builds that don't get 'in the road'

Steel composite railway overbridges, Sydney

Everyone in Sydney knows how sensitive an issue on-time running of the city's rail network is so it's even more crucial that developments within those corridors occur fast and smoothly to avoid undue disruption. Aurecon Transport engineering specialist, PETER SKELLY tells how a steel-intensive approach came to the fore on three recent railway overbridge projects.

Three rail overbridges (road over rail bridges) along NSW RailCorp's main Western line at Station Road and Alice Street, Auburn and another over the Northern line at Copeland Road, Beecroft required integrated design solutions to overcome geometric and site-specific constraints.

The work involved renewing steel trestle or masonry arch structures to improve safety and maintainability of the existing RailCorp network and vehicular traffic flows.

These projects presented additional design and construction challenges to those normally associated with 'greenfield' sites such as new street alignments from adjacent approaches limiting the vertical road alignment, accommodating existing road and rail services, working within short duration track closures and relocating fixed Over Head Wiring (OHW).

The design adopted for all three bridges comprised a superstructure of steel trough girders made composite with a cast in-situ reinforced concrete deck cast onto precast concrete deck slabs spanning between girder flanges.

Apart from facilitating fitting within a narrow vertical envelope to maximise rail clearances and minimise the road re-alignment, steel trough girders improved the speed and ease of erection to fit within 48 hour rail track possessions, provide stable support during placement, and could be fabricated off-site in a controlled environment to reduce construction risk.

All three bridges comprise a single span approximately 30 metres long. The number of steel girders ranges from four to eight with infill precast concrete permanent formwork slabs placed during the same closure period. This provided a safe work area for the construction teams to fix the reinforcement for the next stage.

The trough girders have a horizontal bottom flange and vertical webs. These were each manufactured with a different pre-camber to compensate for the sag from dead loads, to achieve the required road geometry and vertical clearance from the rail track and to accommodate long-term creep and shrinkage effects.

Cross-bracing within each trough girder minimised distortion of the top compression flange during manufacture, handling, lifting and placement of the wet deck concrete. Shear stud connectors are provided in the top flanges to provide the required composite action with the deck. The girders are internally painted and completely sealed with a 6mm thick steel plate and together with the concrete slab this provides the necessary long-term durability protection.

The requirement for a slender superstructure at each site was dictated by limiting the extent of approach roadworks whilst coupled with the need to maintain safe vehicle sighting distances and inclined grades to meet the requirements of AS1428: Design for Access and Mobility. Slender steel girders proved ideal in all three cases as they could be manufactured to meet varying geometric conditions, are relatively light to erect and offer a stable unit at placement.

Risk was reduced as both the steel girders and precast concrete infill panels were pre-fabricated off-site reducing the number of critical possession activities, construction error risks and time overrun. This also enhanced the quality of the final product.

The relative light-weight of the trough girders ensured that they could generally be lifted into position without a dual lift. The light precast concrete infill panels were then quickly lifted into place during the same possession.

Placing the girders on two bearings at either end provides stability, eliminating the need for cross bracing between girders when installing the deck concrete precast infill panels. This arrangement provided greater safety to the contractor during placement of the panels and less risk of failure from unbalanced loading.

By utilising both propped and un-propped construction on the Station Road Bridge project the design team developed a unique way to overcome construction staging issues. The existing bridge supported both the OHW and numerous essential external services. Aurecon's design solution enabled rerouting of services and supporting of the OHW in-between demolition of the existing bridge and erection of the new.

> *"The relative light-weight of the trough girders ensured that they could generally be lifted into position without a dual lift."*

The outside composite bridge girders were designed as propped units and constructed off-site prior to the first possession. During the possession the outside steel girders with the deck slabs already in place were lifted into position outside of the existing operational bridge on newly constructed abutments. The girders were positioned on two elastomeric bearings for stability without any cross-bracing back to the existing bridge.

The second rail possession was then used to demolish the existing bridge and install the remaining six inner girders, designed as un-propped units. Although this required two possessions, it ensured minimal disruption to essential services and train running.

A significant challenge was to accurately determine deflection differentials between the outer and inner girders (propped and un-propped units) as the deflection characteristics of the two are very different. The inner units each deflected approximately 140mm when the concrete top slab was placed while the outer girders remained in the original position. Careful consideration of deflection differentials, including creep of the already placed girders, ensured the adjacent girder deflections matched up exceptionally well.

The outside composite girders were installed using a dual lift with a 300 and 500 tonne crane with a load transfer triangle for the mid-air transfer. By working closely with the construction team these complete units were designed to ensure that the craneage weight limit was not exceeded. The heaviest of the outside units came in at just under 100 tonnes with some minor design adjustments which ensured the lift was achieved safely.

The steel girders were externally painted with either a polyurethane or polysiloxane system complying with RTA B220. A single inorganic zinc primer coat was also applied to the internal surfaces. This external paint system is anticipated to provide the minimum 15-year maintenance-free life in the local environment with ongoing inspection and maintenance prolonging the life of the paintwork beyond this nominal design life.

The anti-throw screens, electrical safety screen, posts, handrails and OHW attachments are all hot dipped galvanised to provide acceptable long-term durability.

About Aurecon

Aurecon provides engineering, management, and specialist technical services for public and private sector clients globally. Aurecon was formed in March 2009 through the merger of three heritage engineering consultancies, Africon, Connell Wagner and Ninham Shand and has a presence in Australia, New Zealand, Africa, Southeast Asia, China and the Middle East.

Project Teams

South Parade and Rawson Street Intersection Upgrade and Rail Bridge Renewal, Auburn

Client: Auburn City Council
Structural Engineer: Aurecon Australia
Head Building Contractor: The Reed Group
Steel Fabricators: Adua Engineering
Steel Detailer: Ahaust Steel Detailers
Coatings Supplier: R.E.D Abrasive Blasting & Protective Coatings
ASI Distributor: OneSteel Steel and Tube
ASI Manufacturer: BlueScope Steel

Copeland Road Overbridge, Beecroft

Client: RailCorp
Structural Engineer: Aurecon Australia
Head Building Contractor: RailCorp
Steel Fabricators: I.M. Engineering
Steel Detailer: Industrious Design
Coatings Supplier: Jotun
ASI Distributor: BlueScope Distribution
ASI Manufacturer: BlueScope Steel

Station Road Overbridge, Auburn

Clients: RailCorp and Auburn City Council
Structural Engineer: Novo Rail
Head Building Contractor: Novo Rail
Steel Fabricators: Adua Engineering (girders), Metwest (miscellaneous steelwork)
Steel Detailer: 3D AccuDraft
Coatings Supplier: R.E.D Abrasive Blasting & Protective Coatings
ASI Distributor: OneSteel Steel and Tube
ASI Manufacturer: BlueScope Steel

**Novo Rail is an alliance of RailCorp in partnership with Aurecon, Laing O'Rourke and O'Donnell Griffin, to deliver a substantial portfolio of infrastructure work across Sydney's rail network.*