This case study was written at the time when OneSteel was part of BHP. In that context, in some instances within this case study, reference may be made to BHP.

Lightweight steel helps Grammar bridge the generations

OneSteel Welded Beams support the link between old and new at Brisbane Grammar School. A new steel pedestrian bridge spans 43m over the railway to the site of a new $8.5M Indoor Sports Centre. The lightweight, long-spanning characteristics of OneSteel's Welded Beams were equal to the challenge of an inaccessible site.

A Link With the Past

The school is located at the corner of Gregory Terrace and College Road, Brisbane, with the original school building being designed by James Cowlishaw in 1880.

The English Greater Public School educational model of that time encouraged boys to value scholastic achievement, physical exercise and adherence to Christian principles. This greatly influenced Brisbane Grammar School's early vision of what a public school education should be. This vision extends to the present time, with the new sports centre development emphasising the holistic development of the individual, especially physical development. The centre is located to the western side of the railway, adjacent to the highly trafficked 'Normanby Fiveways' intersection, and is on a site once used as cattle-yards for the nearby Roma Street goods yards.

The indoor sports centre comprises:

- Sports hall and gym facilities
- 25m heated pool
- classrooms
- weights room & indoor cricket nets
- general purpose and associated areas
- 82m long covered bridge to link old with new

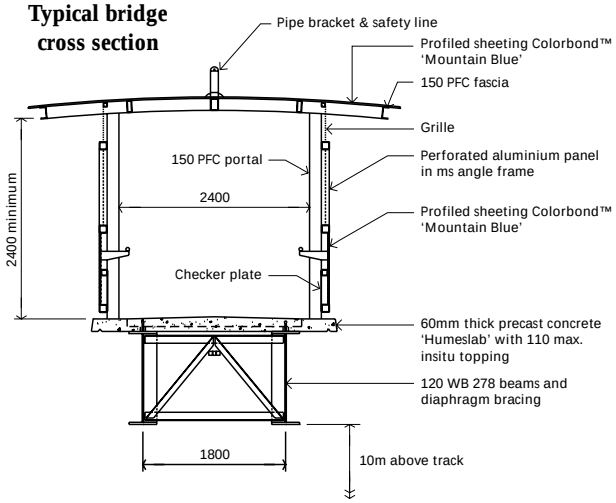
Watpac Australia Pty Ltd is the project builder. A key feature of the development is the bridge access over the railway that provides a dynamic and inviting approach to the new centre and enhances the building's presence.

The high visibility of the bridge led the project architect, Anne Sulinski of Bligh Voller Nield Pty Ltd, to emphasise the elongation of the bridge by using OneSteel's Welded Beams, topped by an enclosed canopy. The canopy has a clear inside width of 2.4m between frames, and a curved roof profile of 4.4m overall width. A steel truss solution was originally considered, but steel girders were thought to provide a

Above: 'Visual imagery' – enclosed walkway or rail cars?

Left: Girders ready for transport to painter.

Typical bridge cross section



Lightweight steel helps Grammar bridge the generations, continued

Design engineer Peter Melloy inspects the bridge girder.

more aesthetic solution and allowed greater freedom of architectural expression for the canopy design. Both the canopy roof and lower walls are clad in Longspan Colorbond 'Mountain Blue' corrugated steel.

The exterior surfaces of the girders are painted in a charcoal colour which contrasts with the 'Mountain Blue' walling and roofing, providing a strong banding effect and symbolising, athough not exactly replicating, the school colours. Because of the site access difficulties, the canopy was prefabricated and erected in 6.1m long units.

Structure

Structural engineer for the indoor sports centre (excluding the swimming pool) and bridge is McWilliam Consulting Engineers Pty Ltd. According to project design leader, Peter Melloy of McWilliams, steel was selected over concrete for the bridge superstructure because:

- Of the inaccessibility of the main span over the railway
- Of difficulties in transporting concrete girders to site by rail because of electrification overhead
- Of the need to minimise girder mass for ease of erection
- A steel solution was acceptable to Queensland Rail

Design Criteria:

- Australian Bridge Design Code – vibration (First Natural Frequency = 1.75; Max Dynamic Deflection due to a single 70kg pedestrian = 0.63mm; ignores damping effect of canopy)
- AS4100 Steel Structures Code
- AS2327 Composite Structures Code
- Design Live Load 5kPa
- Maximum camber 360mm over 43m centre span

Main span being lowered onto support pier.

The bridge superstructure consists of two 1200WB278 Grade 400 steel girders which have a 43m main span over the railway, a further span of 9.2m to the new sports building at the western end, and a 4.5m cantilever span which supports shorter spans at the existing school (eastern) end. The two main span girders are vertically cross-braced in a 'K' configuration at locations over the piers and at 8.6m centres along the centre span. The top flanges are fully braced in the horizontal plane to resist lateral wind load on the 3m high canopy.

The 30m overall length bridge section at the eastern end utilises two 410UB54 OneSteel 300PLUS girders supported at 13.7m maximum centres by a tubular steel column 'tree' arrangement. The bridge girders are supported on Herculon Type D neoprene bearings where it connects tothe new sports centre building, and are bolted in place at the piers and eastern abutment. Longitudinal movement of the bridge superstructure is facilitated through the flexibility of the concrete pier supports in the longitudinal direction. 2400mm wide x 500mm thick x 6000mm high concrete piers are positioned each side of the railway easement, 43m apart.

The deck slab construction utilises 60mm thick, CSR 'Humeslab' precast concrete decking units spanning 1800mm between girders and cantilevering a further 600mm beyond. The decking is topped with 110mm thick Grade N32 insitu concrete topping. All girders act compositely with the concrete deck through single 19mm diameter x 125mm high shear studs at 300mm centres. 100mm diameter holes in the decking allow the decking units to be placed over the shear studs.

Fabrication and Erection

Steel fabricators, Noosa Engineering and Crane Hire, fabricated the 51m long 1200WB girders in three 15m lengths, with the remaining length at each end comprising a fabricated section of varying depth. The girders were then transported to site and spliced by complete penetration welds using manual metal arc techniques, in a location adjacent to and parallel to the railway easement. Welds were ultrasonically tested. The two girders were then braced together and an RHS conduit fixed longitudinally within the girder set to protect service cables linking the existing school campus with the new sports centre.

Lee Robinson from Noosa Engineering commented on the benefits of OneSteel Welded Beam sections for this application – "Welded beam sections have certainly made fabrication easier. Drafting, fabrication and set-up time are halved compared with the traditional welded plate girders. Assembling & fabricating sub-assemblies is cheaper, quicker and safer. On this project, with the drafting being spot on, the operation went very smoothly".

The centre span design camber of 360mm was achieved through the cumulative effect of three 15m long segments, each supplied by OneSteel Welded Products with 40mm camber.

Stud Welding International installed all shear studs in the fabrication shop prior to dispatch to site. Steel workshop drawings were prepared by Paul Anderson Drafting Service.

Brambles Crane Hire undertook erection of the bridge in the early hours of Good Friday, during a rail closure and electrification shutdown. Cranage utilised included a 330 tonne and 70 tonne mobile crane on the western side of the railway and a 130 tonne mobile on the eastern (existing school) side of the railway. The erection sequence comprised:

1.30am–3.30am

- Lift 30 tonne braced twin girder assembly from position on ground parallel to railway (at west side of railway easement) using 330 tonne crane.

Costs:

Bridge details: 3m decking slab width, 2.4m canopy width (clear inside), 82m overall length, 43m main span.

Element	Mass (t)	Cost[2] ($)
Steel girders, bracing, struts, RHS conduit, studs, canopy structure[1]	61t structural steel[3]	240,000
Supply – 'Humeslab' concrete deck units		21,800
Erection – Steel girders etc, canopy, precast concrete decking		33,600
Metalwork incl canopy cladding and safety line		112,500
Insitu concrete incl topping, piers, footings, formwork, reo		19,000
Qld Rail shutdown fees		15,000
Total superstructure, piers, canopy, QR fees		**$441,900 ($1796/sqm)**
Total girders, deck, piers (excl canopy, QR fees)	36t structural steel	**$186,000 ($756/sqm)**

Notes: (1) includes – supply, shop drgs, fabricate, transport, paint. (2) costs exclude builder's margin. (3) excludes mass of roofing, walling & handrails to canopy.

- Rotate through 90 degrees and extend over railway. Attach 70 tonne crane to western end of bridge assembly and 130 tonne crane to eastern end.
- Release the 330 tonne crane.
- Extend further across railway and position over support piers and bolt in place.

3.30am–8.00am

- Erect and install 60mm thick CSR 'Humeslab' precast concrete decking units (2.7 tonne maximum lift).

8.00am–2.00pm

- Place steel reinforcement and cast 110mm thick insitu concrete topping slab.

The installation program for the bridge canopy consisted of painting of member components; pre-assembly of each 6.1m long unit by Noosa Engineering at the paint facility; transport of each unit to site; erection of each unit. The structural frame of a typical 6.1m long canopy unit weighs 2.5 tonnes.

Protective Coating:

Abrasive blast clean: Class 2 1/2
Inside surface of girders: 75 microns Inorganic Silicate – Dulux Zincanode 402
Outside surfaces and top and bottom of girders: 50 microns Dulux Luxathane R, Charcoal over 75 microns Zincanode 402.

Conclusion:

The aesthetic treatment, structural design, and architectural detailing of the bridge have created a striking structure that complements the difficult micro-environment. The visual metaphor of a series of rail cars transporting students to the train(ing) station at the new indoor sports centre is masterful.

The use of lightweight OneSteel Welded Beams ensured fast erection of the 30 tonne main span superstructure over the railway. The use of precast concrete decking enabled a safe and quick floor construction.

The end result is an economical and attractive structure that will provide an all-weather link from the existing school campus to the new indoor sports centre for many years to come.

Client:	Brisbane Grammar School
Architect:	Bligh Voller Nield Pty Ltd
Structural Engineer:	McWilliam Consulting Engineers
Builder:	Watpac Australia Pty Ltd
Steel Fabricator:	Noosa Engineering & Crane Hire
Steel Erector:	Brambles Crane Hire
Stud Welding:	Stud Welding International
Shop Drawings:	Paul Anderson Drafting Service