

Karrinyup Shopping Centre Perth

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

Steel provides pleasant promenades in Karrinyup

Karrinyup, 8 kilometres North West of Perth, is generally considered to be one of the city's most desirable suburbs. Karrinyup's shopping centre represented a contradiction to the premium locality. It was old and did not capitalise on its location. Its potential however was recognised by developer Schroders. Costing \$68 million, and estimated to take two-and-a-half years to fully redevelop, the centre is shaping up to be a 'must' for the discerning shopper.

As with most shopping centre redevelopments, it was essential that reconstruction work was carried out while the centre remained functional in order to minimise loss of trade to remaining tenants and minimise inconvenience to shoppers. This requirement called for careful planning by the contractor and the consulting team and was facilitated by dividing the project into three stages:

- Stage One involved demolition of the existing shopping mall between Myer and Aherns department stores and the reconstruction of a two level shopping mall. The number of speciality shops in the mall was expanded from 70 to 150 shops.
- The second stage added a new restaurant court to the North East area of the site and an elevated car park.
- The final stage is currently under construction and includes refurbishment of the old food court as a fresh food centre and an extension of Woolworths.

Superior open space environment

The two level shopping centre is constructed of structural steel columns supporting an in-situ slab. Column grids were constructed on the old 6 x 6 metre grid (approximately), throughout the lower level. However, on the upper level, only one column every second grid was required. Most columns were incorporated in the tenancy walls, a key benefit of utilising

structural steel. This feature maximised both available space and clear space, which in turn contributed to heightened aesthetic appeal of the centre.

To maximise construction speed on site, the lower and upper level columns, 150SHS and 100SHS respectively, were splice welded together with a cap plate and lifted into place as a two storey column. In-situ slabs were supported off the columns at the first level via cast in lugs which were welded under the column splice cap plates.

In keeping with the architect's vision of an open, light and attractive shopping environment, the centre has 'promenades', unlike a traditional mall. The promenades have been created by eliminating the first floor walkway soffit and having a parapet to the shopfronts. The ceiling springs from well behind the parapet, supported by 3-dimensional trusses which taper in both planes towards the centre of the arch. These structural trusses are light and open in nature, a system made possible by external supports.

The architect's vision in using a triangulated truss system to support the roof in the promenade was one of the challenges faced by the engineers. After investigating various steel sections for the chord members, Peter Reynolds of Connell Wagner noticed a Hexagonal bar on the front cover of an old BHP Steel catalogue, which suited the inclined struts coming into a perpendicular face. The 63mm Hexagonal bars separated by struts, (25mm square rods), were used for all the 24 metre long arches. In between these struts were a series of corner and centre rings joined by diagonal rods. Whilst at the ends where the distance between chord members is shallow and where the mall glazing was supported, 4mm steel plates were used. The hoop pine plywood ceiling was



supported on metal framing channels above the trusses.

Part of the COLORBOND® roof profiles were to be sprung curved to a 120 metre radius, however this presented a challenge, as the manufacturer's product information nominated a maximum 60 metre radius. BHP Building Products overcame this restriction by using a lower tensile G300 profile Klip-Lok 406, Colorbond XRW, and demonstrated the required radius on a test rig.

Speedier construction with steel

In the first stage, protection was provided by a 7 metre wide access walkway, comprising steel portals and precast planks. This secured a safe pedestrian walkway from Myer to the central promotional area. This meant that demolition above the walkways could proceed whilst people continued to shop. Mobile cranes, on either side of the walkway, were used to erect the trusses which were then temporarily propped in the middle with scaffold towers which were supported on top of the temporary structure. The trusses were then butt welded together with a 25mm thick plate to form the arch. The ends of the arches were connected to the lower roof and the load was transferred down to the firewall at the corridor. Whilst commencing the next stage, the two level retail centre was in operation.

A similar construction method was used for the second part of phase one, from Aherns to the central promotional area. To save time on

North elevation



site, the trusses were welded together on the ground and lifted with a spreader beam to final position. A Leibherr hammer head electric tower crane on 50m long rails was used for this operation due to a lack of access for mobile cranes on one side of the walkway. This enabled work to proceed on both sides of the enclosed pedestrian walkway at the same time enabling practical completion to be one week early.

John Flecker of Multiplex Constructions commented that he was pleased with the speed of steel fabrication in the project. With the majority of structural steel already fabricated during the first phase of stage one, it was immediately available for erection during the second phase; a time-saving bonus.

The upper mall features 8.6m wide voids with 4.5m suspended walkways on either side. The bridges between the voids connecting the suspended paths are supported by a 3-dimensional truss similar to those of the ceiling.

The central promotional area is essentially a dome structure, supported on similar triangulated trusses emanating from the four corners. A feature above this area is the flagpole support structure made of 323.9 x 6.4CHS Grade 350 and braced with 24mm round bars connected to the lower roof structure.

North-East Carpark:

Engineers Connell Wagner investigated several options for the carpark design, and realised a 10% deck saving by incorporating a 17 metre clear span structure, avoiding any loss of space due to internal column widths. Overall dimensions of the elevated carpark are 104 metres long and 51 metres wide.

The carpark structure is made up of steel columns and beams supporting Double-T precast concrete beams. East-West frame action is provided with two internal rows of 610UB125

beams and 530UB82 edge beams in 300PLUS®, supported over 355.6x12.7CHS Grade 350 single level columns spaced every three car bays, 7.5 metres apart. The 15 metre long steel beams were erected continuously over two columns and connected to adjoining members with simple pin web splices near the point of contraflexure.

Full height stiffeners were used in steel beams over columns to transfer floor load and provide beam stability during erection. Steel beams were then fixed with four M24 bolts on capped columns.

In the North-South direction, lateral resistance was provided with shear walls and the ramp structure. The Double-T beams span 17m between steel beams and are 2.6m wide and 500mm deep with 80mm thick slab. The precast beams were notched to 180mm thick and placed on 75mm x 10mm thick Granor Bearing Strips which were glued on top of the steel flanges.

Camber tolerances varied with the precast units and they were clamped back together at the top to even out the floor level. Drainage required a 1 in 100 fall to the north and south of the centre of the deck and this was achieved by setting down the end steel beams by 100mm.

The precast units were then sealed and the electrical services and F81 fabric were placed on deck and covered with the required topping. Precast planters were used at deck perimeter.

The ramp however comprised of 460UB67.1 end beams supporting 200mm thick precast panels and 50mm thick topping.

The steel frame was erected very quickly with a 20 tonne capacity mobile crane, whilst the precast units were erected over a two month period as production allowed. Each plank was bolted in place on 125 x 125 x 8mm EA erection angles welded to edge of beam flanges.

Peter Reynolds of Connell Wagner said that, "Overall efficiency of structure was achieved, minimum mass solution was not necessary and the beam arrangement had simple connections".

Design Software

All steelwork was designed to AS4100. SpaceGass was used to do analysis and Limsteel for design. Drafting was done on Autocad. This enabled the information to flow from architect to engineer to fabricator shop detailer. Project architect Duncan Jordan of Cameron Chisholm & Nicol said that the ability to fine tune drawing details via computer and then to look at buildability and adjust aspects of the design, for example the rings in the trusses, made the project considerably easier.

Fabrication

Terry Condipodero of Allcon Steel Construction said that the fabrication of the trusses required a suitable jig to cater for the varied radii along the truss. One truck could accommodate three trusses on jigs, firstly to the paint shop and then to site.

A total of 650 tonnes of steel was fabricated for the project by Allcon with 107 tonnes required for hexagonal bar chords of the trusses.

Surface treatment

The carpark steelwork was abrasive blast cleaned to Class 2 finish and painted with 75µm of Inorganic Zinc Silicate. The exposed steel trusses inside the shopping centre had the same base treatment but were finished with Taubman's Interprime and sun proof acrylic low sheen in pendulum dark green.

Conclusion

Project Manager Doug Hellens of PenLas said the lightweight steel roof trusses were innovative and aesthetically pleasing, offering the solution to the open promenades. The small steel columns provided added flexibility, meeting the leasing agent's need of some column-free shops.

Developer:	Schroders, on behalf of Perpetual Trustees Co. Ltd. as trustee for KSC Trust
Project Manager:	PenLas
Architect:	Cameron Chisholm & Nicol
Engineer:	Connell Wagner
Contractor:	Multiplex Constructions
Fabricator & shop detailing:	Allcon Steel Construction
Erector:	Perth Rigging
Distributors:	Steelmark Eagle & Globe Tubemakers Steel

Upper level view of mall, towards central promotions area

