Success for a big steel project

The Rhodes Waterside Shopping Centre

Rhodes Waterside is an ambitious project on the Parramatta River with facilities to accommodate a new community, provide work space and meet the needs of the people for shopping and entertainment. In developing Rhodes Waterside Walker Corporation worked on the principle that all great communities have an active town centre, a sophisticated business quarter and a fabulous shopping centre.

The new shopping centre was built at a cost of $150 million and covers an area of 50,000 square metres rising over four to ten storeys. The shopping centre is part of an overall complex which interacts with the residential buildings around it, providing not just shopping but medical services, business offices, restaurants and an eight screen cinema complex. The centre relies on the residents to provide retail custom and business to the commercial centre but also has a major drawcard in the international furniture retailer, IKEA, to attract custom from the surrounding suburbs.

Built on a former industrial site, Rhodes Waterside is strategically located on the Parramatta River, just off the road and transport hubs leading to Sydney Olympic Park and takes advantage of the infrastructure developed for the Sydney Olympics.

The master plan for the centre was created by The Buchan Group, selected by Walker Corporation for their expertise in town planning. Paul Malone, the principal architect who executed the master plan, said that it was driven by the need to create an Ikea Superstore as a draw card to the Centre.

Malone said he liked to design in steel and that the material had become fairly voguish. "You can get interesting shapes in steel and it's attractive as people are looking for lighter, slender looks. The principles for a good retail environment are: it should be friendly, well anchored, have good lines of sight, be well lit by natural light, have excitement and achieved a measure of scale. All of these principles can be realised in steel."

"The IKEA store is a giant industrial box – very IKEA very minimalist. IKEA was persuaded to integrate the entry and exit to their store, which is the largest IKEA in the southern hemisphere, within the shopping centre," Malone said.

Just over 8,000 tonnes of structural steel went into the project which was constructed over 15 months from September 2003 to the opening date on 2 December, 2004. By anyone's standards this makes it, while not quite *the Colossus*, a big steel story. The shopping centre joins the Myer Centre in Adelaide, completed in 1991, and the original Tuggeranong Centre in the ACT built in the mid 80s, as one of a group of centres in Australia to be built entirely of steel.

Key drivers to build in steel

The tight construction timeframe was imposed by the commercial requirements of the retail and business tenants who wanted to open at the new location for pre-Christmas trading.

The initial Buchan Group master plan was accepted by Walker Corporation, who then appointed an architectural drafting team. While adhering largely to the Buchan master plan, the in-house team made the necessary variations and supervised the work. The team leader, Paolo Razza, was a key link interpreting what the project manager wanted from structural steel into architectural concepts.

Photography: Michael Nicholson

Time and cost were the key drivers to build in steel but central also was the experience Walker Corporation has gained on other steel projects. Walker Corporation knew they could call on known multiple steelwork contractors who could deliver and erect structural steel within the tight building schedule. The steel solution also eliminated a number of other risk factors.

David Gallant, Walker Corporation's Project Director on the job said that: "The original reason we went with steel was the speed with which we could deliver the building. We didn't feel we could get a formwork company to supply the amount of flat plate formwork we needed in the timeframe. With steel there was a dramatic increase in the speed of construction. With the steel solution we had tenfold less men on site during the initial construction. On a traditional concrete structure, 600 to 700 men are on site which creates many issues, not least housing and coordinating them and the potential for safety risk and industrial disputes. Doing the job in structural steel meant that it was a lot more manageable."

Delivering a major $150 million shopping centre in 15 months is a big achievement.

"We could never have done it using other materials. It would have added another six months," Gallant said.

Walker Corporation worked with the structural engineers, Van der Meer Bonser, and together they fine tuned the design to get more accurate steel pricing. OneSteel and National Engineering were able to provide early steel prices that were relatively accurate, rather then an arbitrary rate per tonne. Gallant said that: "In the original costings [for the composite steel solution] we estimated it was around $40 dollars a square metre cheaper for the decks or between $8 and $10 million cheaper just on the actual structural cost. That didn't take into account any time or labour savings within our preliminaries.

The participation of OneSteel Steel & Tube and National Engineering from the start meant that the beams were cut to length and connections and penetrations were detailed to suit the fabricators. This achieved economies in both the steel supply and fabrication.

Key benefits of steel

- greater architectural freedom
- lighter weight structural frame
- lower comparative cost
- faster construction
- longer spans created column free spaces
- flexibility to alter design to accommodate tenancies
- simultaneous fabrication by multiple workshops using 3D project model
- off-site steelwork fabrication
- smaller on-site workforce meant less site congestion reduced OH&S costs and greater site manageability
- ease of future proofing

Steel industry delivers

Rhodes Shopping Centre was a job that needed an industry with sufficient men, equipment and expertise to have a large amount of steelwork completed very quickly. The job needed fabricators with sophisticated systems and processes to get the steelwork through.OneSteel Steel & Tube supplied the majority of the structural steel into the project. Paul McNicholl,

Photography: Michael Nicholson

Top: High windows and skylights in the mall let in natural light.

Bottom: Only a month prior to opening an escalator penetration was relocated without delaying the project, enabling Walker Corporation to add an additional two tenancies.

General Manager - OneSteel Steel & Tube said "The size of the project required a dedicated project team to manage the logistics associated with the supply of 8,000 tonnes of structural steel to the many fabricators working on the project. As well as ensuring that the steel was supplied and delivered to the fabricators in line with the project schedule, the team optimised the structural steel for the project, ensuring the most efficient lengths of steel were provided to the project with minimal waste.

Ken Wilson, a Director of National Engineering, said that a large number of detailers worked on the documentation using electronic format. Cad Tech SA prepared a 3D model of the project and in most cases drawings were transferred electronically and steelwork produced offsite from 3D drawings on computer numeric controlled (CNC) beamlines.

The three major steel fabrication companies were National Engineering, steelwork contractors on the IKEA and southern retail section, Torresan Engineering, who did the bulk of the structural steel in the mall and the carpark, and Profab who fabricated and erected the steelwork in the cinemas and offices.

Greg Connica, who directed the steelwork operations for ProFab in the cinemas, commented that it is very unusual to have several fabricators working concurrently on a project. "Steel meant that once construction began the steelwork crews could work in various zones simultaneously and in each zone you could have several workfaces at once."

"With only one road in and out, a large amount of cooperation and coordination was needed between the fabricators in each precinct to facilitate progress. They needed to work as a team so one crew didn't disadvantage the others," Connica concluded.

The methodology of working on a number of fronts and working in towards a section allowed construction using only mobile cranes. With the separate work faces established the steelwork went up rapidly. The simultaneous erection meant that steelwork from different workfaces was moving inexorably forward towards the same building interface.

National Engineering, who worked on the carpark, the retail section, the roof and the façade supplied and erected 4,800 tonnes of steelwork in 24 weeks averaging 200 tonnes a week.

The structural story

The integrated steel structure divides into separate areas – the carpark, the IKEA section,

the retail mall, cinemas and business and professional office area.

There were a number of fabricators constructing steelwork off site simultaneously. Bill Gunther, as Van der Meer Bonser's structural engineer, was on site for the whole of the construction period working closely with Walker Corporation's in-house architects and project management team. This allowed a continuous consultative process and final details to be checked and approved as the project proceeded.

Designed as a braced frame with composite floor slabs, the structure has vertical bracing for stability, wind and earthquake loads. "The bracing is in the form of inverted V braces from OneSteel 300PLUS® universal column sections which range from 150UC to 310UC," Gunther said. "The building is quite variable with significant areas of irregular spans, transfer beams and trusses, and different loading conditions. The typical floor-to floor-height in the carpark is 2.85 metres, the retail area 5.7 metres, while in the warehouse they reach 11 metres." Some of the more typical areas are summarised in table 1.

The composite floor slabs were formed with Fielders Kingflor decking. Trapezoidal decking, 1.00mm KF70, was used extensively in the carpark and retail areas which allowed secondary beams to be spaced up to 3.4 metres apart. In areas of high shear load, such as the warehouse, loading docks and roadways the decking was 1.00mm KF57. Slabs were typically 130mm thick, with 150mm thick slabs in the heavier loaded areas. Concrete strengths varied from 25 to 32 MPa.

The secondary beams incorporated single 19mm shear stud connections at 300mm centres. Similar studs were used on primary beams at centres ranging from 120mm to 300mm. Double studs were adopted in some of the more heavily loaded areas in conjunction with KF57 decking.

Because of the size of the building expansion joints were provided through all the levels to control shrinkage and thermal movements. These joints divided the building into 9 main sections, each up to 90 metres long. The preferred method of forming the expansion joints was the use of double columns. In some areas this was not possible because of architectural requirements, so steel haunches with bearing pads were used to support the adjacent beams.

The mall has been designed with a lot of natural light from high windows.

Some of the more typical area have column grids of 8.4 x 8.4 metres, 8.4 x 10.0 metres and 16.8 x 16.8 metres.

Table 1: Typical member sizes and spans

Location	Column grid	Slab thickness	Kingflor decking	Secondary beams			Primary beams		
				Span	Spacing	Size	Span	Spacing	Size
Undercover carpark	8.4m x 8.4m	130mm	1mm KF70	8.4m	3.36m	310UB40	8.4m	8.4m	460UB67
Retail	8.4m x 8.4m	130mm	1mm KF70	8.4m	3.36m	410UB54	8.4m	8.4m	530UB92
Retail	8.4m x 10.9m	130mm	1mm KF70	10.9m	3.36m	530UB82	8.4m	10.9m	530UB92 2 span continuous
Warehouse	8.4m x 8.4m	150mm	1mm KF57	8.4m	2.4m	530UB82	8.4m	8.4m	530UB92 250x32 btm flange plate 2 span continuous
Roof carpark & warehouse	16.8m x 16.8m	150mm minimum	1mm KF70	16.8m	2.8m	610UB101	16.8m	16.8m	1000WB296 continuous

In the cinema areas sizable transfer beams and trusses have been used to span over large distances. On the southern end of the cinemas there is a span of approximately 35 metres which was achieved by trussing two floor plates together with diagonal members.

Vibrations

During the design stage vibrations were assessed using the methods proposed by Murray, Allen & Ungar in *Floor Vibrations Due to Human Activity, Design Guide 11*, a 1997 design guide published jointly by the American Institute of Steel Construction (AISC) and the Canadian Institute of Steel Construction (CISC). Typically composite beams, sized for strength and deflection were found to comply with the recommended vibration criteria.

Fire Resistance

Testing and fire engineering studies have demonstrated the adequacy of steel framing, with little or no applied passive fire protection in many building applications. This is largely based on cases where the steel beams are in contact with closed-rib type steel decking profiles. As Fielders KF70 has a trapezoidal profile and therefore leads to greater exposure of the beam top flange to high temperature gases in the event of a fire, OneSteel Market Mills commissioned fire researchers at the Victoria University of Technology to conduct tests on its steel beams with a KF70 slab.

This testing demonstrated that, while the trapezoidal deck offered less shielding to the beam than a conventional deck, this had very little impact on the inherent fire resistance of 300PLUS beams.

A fire engineered solution adopted for the building using these test results permitted the use of unprotected steelwork throughout, except

Right Top: Typical suspended floor framing

Right Bottom: Typical suspended floor framing in the carpark. Note service pipe running through the beam penetrations.

for some critical areas. Columns and beams were limited to specified surface to mass ratios and the fire engineers identified some elements which had to be sprayed after construction. As a result very little steel had to be sprayed.

Protective coating

The external awnings are protected with a system of Interzinc 42 epoxy zinc, Intercure 420 high build epoxy and Interfine 629 catalysed acrylic from International Protective Coatings. This higher exterior specification reflects the Rhodes Shopping Centre`s proximity to the Parramatta River.

Perceptions of safety and security are important in modern carparks so to address these, Walker Corporation invested $1.5 million in painting the carpark. The system adopted was alkyd zinc phosphate primers and/or enamel finish coats, where an aesthetic finish was required. Paint was provided by a number of paint suppliers. These are economical systems for use in dry, benign environments.

Steel facilitated flexibility

Steel's ability to accommodate on site changes such as penetrations through beam webs and relatively thin slabs, the insertion of steel trimmer beams, strengthening beams and columns with steel plates and the removable or relocation of columns, was a huge advantage on this project.

A number of late design changes were made to the supermarket areas, the office floors and the retail mall as the final tenancy layouts were developed. In the retail area, as tenancies were leased designs would be provided well after the structure was complete. In some areas these changes necessitated the relocation of columns, beam penetrations floor set downs, compactus and safe loadings, trimmer beams and the need to strengthen beams and columns.

Steel's flexibility made it possible to accommodate these changes late into the project's construction phase without significant cost or time penalties. One substantial change was made only a month prior to opening when the position of an escalator penetration was relocated without delaying the project, enabling Walker Corporation to add an additional two tenancies.

The achievement of Rhodes was that steel delivered a cost competitive solution while allowing the Walker Corporation to manage project risk and safety and accommodate the varying needs of a diverse group of tenants.

Estimates of the time saved using steel to other materials vary. However, most agree that to have constructed Rhodes with more conventional materials would have added another six months to the construction timeframe and around 20 percent to the cost. The project was opened on time on 3 December 2004, in time for the peak Christmas trading.

Project team
Developer: Walker Corporation
Architect: The Buchan Group
Structural Engineer: Van der Meer Bonser
Building Contractor: Walker Group Constructions
Main Steel Detailer: Cad Tech SA
Main Steelwork Contractors:
National Engineering
ProFab Industries
Torresan Engineering
Steel Manufacturer: OneSteel Market Mills
Steel Suppliers:
OneSteel Distribution
Southern Steel Supplies
Coating Supplier: International Protective Coatings

Rhodes carpark

Accommodation for 2,000 cars has been provided in the purpose built carpark which interacts with the shopping and commercial and business centres. Built in steel, the 135,000 square metre carpark was economical and fast to construct on grids designed to match the retail needs of the centre. The grids were typically 8.4 x 8.4 metres and 10.8 x 8.4 metres. The elimination of back propping and small columns provided construction economies and the fire engineered solution allowed the steel to be unprotected. A sprinkler system was installed to meet the Building Code of Australia regulations.

In the carpark, the services generally pass through web penetrations in the primary and secondary beams. This includes fire sprinklers, hydraulics and electrical conduits. In the retail areas, the majority of services were run beneath the steel beams.

The web penetrations are generally circular. Plate reinforcement was avoided as much as possible by optimising the location and diameter of the penetrations. In some cases it was more economical to increase the beam size rather than reinforce the penetrations.

Expansion joints. Steel haunches with bearing pads were used to support the adjacent beams.

Multi level structural steel framing.