

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.



The findings of a decade of fire engineering research by BHP

proved decisive in the selection of composite steel construction for the 26,000 square metre deck of Melbourne's landmark Federation Square project.



# Fire Engineering wins landmark project



Welded beams being placed during night occupation.

The high profile project, which creates almost three hectares of new 'land' in the heart of Melbourne, is being built by Multiplex Constructions for Victoria's Office of Major Projects. The primary challenge was to build a deck over the railway yards extending from Flinders Street station without compromising the rail services coming and going through Melbourne's busiest rail hub. As erection of structural members was limited to as little as four hours a night, the use of fabricated structural steel beams and permanent steel formwork offered an attractive solution, but cost was always the overriding factor.

Multiplex director Brian Cargill said it was the application of findings from BHP's fire engineering research which made structural steel economically viable when compared with alternative construction options. "What made this design a winner was that BHP had done the

fire engineering research, and that allowed it to be a cost-effective solution," he said. "There are plenty of reasons why structural steel is an attractive option for this project, but it could only ever have won if the cost was right."

The costs of the steel deck option for the project were reviewed by the project's building surveyor, Bruce Thomas, of Bruce Thomas & Associates in his paper presented at Victoria's Millennium International Convention (April 1999).

These costs were compared to the alternatives available for consideration at the time:

- i) Reinforced concrete beams (pre-cast)
- ii) Steel beams with passive fire spray application
- iii) Installation of sprinklers beneath the primary deck.

The steel deck option was undertaken on a performance fire engineering basis (quantitative

*Left: Erecting steel beams by mobile crane.*

risk analysis) which negated the need for passive fire protection (i.e. FRL's as per the deemed to satisfy requirements of the Building Code of Australia) and the installation of a sprinkler system below the primary deck.

The review suggests that the combined capital savings, indirect savings and recurrent savings (maintenance) which were individually assessed, aggregated approximately \$8.83 million for the fire spray application and sprinkler installation. A significantly greater amount was saved when compared to the structural pre-cast concrete option.

The fundamental structure of the deck is a composite slab poured on Stramit Condeck HP permanent steel formwork, supported above the railway tracks by more than 800 fabricated welded steel beams. Individual beams weigh between four and 14 tonnes, and typically span approximately 15 metres. The beams rest on 10 reinforced crash walls which run between the railway tracks. Standing nine metres high, the walls stagger and break in plan as the rail lines fan out from Flinders Street station.

In all, the deck uses approximately 26,000 square metres of Condeck 1.0 mm decking with Z350 coating. Slab thickness varies from 150 mm to a maximum of 400 mm. This combination offered a lightweight alternative to the original design proposal featuring Super T beams.

Brian Cargill's enthusiasm for the Federation Square structural solution is a reflection of his enthusiasm for the project overall. Although Multiplex has many Australian buildings to its credit – including some 90 per cent of the major buildings in the Perth CBD – it is the truly landmark projects which fire Brian Cargill's imagination. He sees them not only as important achievements in their own right, but also as the projects which break the mould of traditional thinking and thereby add new techniques and concepts to the industry's repertoire.

"Multiplex loves doing these important public buildings, these one-off designs," he said. "You'll only do a couple of these jobs in your lifetime, and there's a real buzz about them. They are a challenge to architects, engineers and builders; so you tend to be dealing with the highest calibre of people in each of these disciplines – very intelligent, creative people who love the project and don't want to leave it. The skills and abilities displayed are fantastic."

At every stage of this project, Multiplex has focussed strongly on risk reduction. This is where Federation Square brings together elegant design solutions and pragmatic cost containment in a project which pushes the boundaries of established construction practices.

The structural steel solution chosen for

Federation Square, as Brian Cargill sees it, combines elegance, cost effectiveness and, above all, flexibility. He said the need for flexibility arose in several aspects of the job, ranging from the constraints of building over railway lines to the challenges of building the deck to support an incomplete superstructure design.

"The great advantage has been the flexibility for moving things in the superstructure," he said. "This is a project where the design of the superstructure was by no means finalised when we started on the deck. With changes in the superstructure, it's easy to weld a couple of plates or stiffeners for changes to the deck just before installing a steel beam. Typically we just had to reposition a few cleats or add strengthening plates to control the revised loads through different zones."

Limitations on site occupations caused by time-constrained construction access, was another area where Multiplex appreciated the flexibility of steel. If for some reason occupation was not given, the steel beams were easily stored on site, whereas Super T beams would have had size and weight problems.

Brian Cargill expects the project to set the direction for other similar projects, as the

enormous cost of urban land makes over-railway construction increasingly attractive. "There will be more and more building over railways, and this concept will be used again," he said. "Fairly lightweight long spans are the key. It's an economical construction method over long spans when the primary use above it are buildings."

As the Managing Contractor, Multiplex has drawn on diverse engineering and construction expertise to implement the design created by architects Lab + Bates Smart. Structural engineering drew on the expertise of two firms, Hyder and Bonacci Winward, both of whom Brian Cargill credits with making crucial contributions to the success of the design.

"Bonacci Winward came up with the concept for our accepted alternative tender and worked with us closely during the tender period to develop a number of structural steel solutions," he said. "We needed their buildability attitude to design. They understood how it comes together and that reflects in the price and the deliverability of it."

"Hyder then developed that original concept with their knowledge of the load requirements for the project. Hyder also designed the



*Above: Beams stacked on concrete deck for next erection session.*



*Left: Final placement of Condeck.*

superstructure, so it made sense to have them working on the deck too.”

One of the biggest tasks in the entire project has been the creation of more than 500 shop drawings required to translate the complex design into a fabricated structure. Production of so many drawings became a significant cost factor for the overall project.

Chapple Brothers had the task of fabricating the structural steel for the Federation Square deck. An important factor, according to Brian Cargill, was early involvement of BHP Steel’s sales staff with the project. Steel was ordered before the fabrication contract was signed and when required, BHP were willing to do special rollings for the project.

At the end of the day, Brian Cargill considers that Federation Square has helped to significantly advance the state of the art in construction, especially where site occupations are limited. “But the key consideration in any project – even one as special as Federation Square – will always be cost,” he said. “There’s no question in my mind that BHP’s work on fire engineering over the years was the most important single factor in ensuring that Federation Square became a steel structure.”

*View from under deck showing isolating bearings.*



Client:	Victorian Office of Major Projects
Managing Contractor:	Multiplex Constructions
Architect:	Lab+ Bates Smart
Structural Engineers:	Hyder; Bonacci Winward
Structural Steel Fabricators:	Chapple Bros (deck)
Consulting Fire Safety Engineers and Building Surveyor:	Bruce Thomas & Associates
Cost Consultant:	WT Partnership