FireSafe™ Solutions

CASE STUDIES IN STRUCTURAL STEEL

FIRE SAFE

Fire safety engineering by design

Issue1, July 2003

Performance Design Benefits

- increased levels of safety
- reduced building costs
- architectural flexibility
- faster construction

Discover how

OneSteel can help you to apply world leading research into fire safety engineering and deliver these benefits on your next multi-level project.

300 PLUS

University Square – New Law Building. The fire-engineering design included a risk assessment to demonstrate an acceptable level of life safety in the event of a range of fire incidents

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Designing in structural steel has many positive benefits when it comes to Fire Safety Engineering

Welcome to the first edition of **FireSafe**™, a new periodical from OneSteel Market Mills showcasing structural steel projects that have benefited from the application of the latest advancements in Fire Safety Engineering. These advances in the science and technology of fire safety engineering design have enabled **performance design solutions** to satisfy the Building Code of Australia as well as significantly reducing the cost of constructing in steel.

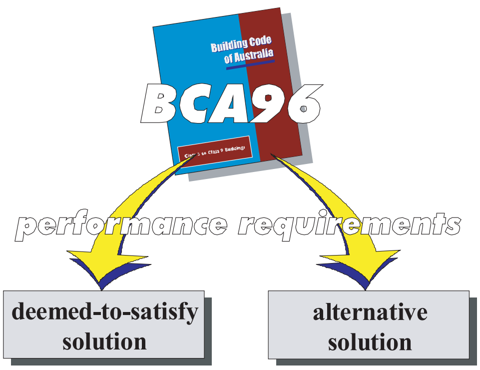
OneSteel Market Mills through its sponsorship of one of the leading authorities on fire engineering in the world, located at the Victoria University of Technology, has built up a reputation for delivering simple and economical fire safety engineering solutions for structural steel construction.

Performance Design Solutions

The Building Code of Australia (BCA) allows for both Deemed-to-Satisfy provisions and for **performance design solutions (called Alternative Solutions)** which need to satisfy relevant performance criteria. BCA '96 gives overall and specific objectives for all parts of the building code and corresponding performance criteria.

Alternative Solutions must necessarily consider the factors that are really likely to be significant in satisfying the relevant performance requirements.

It is normally expected that an **Alternative Solution** will result in similar or better levels of safety than that associated with the minimum building solution that complies with the Deemed-to-Satisfy Provisions.



Performance Design can offer benefits such as:

- **increased levels of safety**
- **reduced building costs**
- **architectural flexibility**
- **faster construction**

Would you like to find out more?

Discover how OneSteel Market Mills can help you to apply this world leading research into fire safety engineering and deliver real benefits on your next multi-level project.

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The University of Melbourne

NEW LAW BUILDING

STRUCTURAL STEEL DELIVERS CONSTRUCTION COST BENEFITS AND ARCHITECTURAL FLEXIBILITY FOR LANDMARK BUILDING

FIRE SAFE

THE FIRE SAFETY ENGINEERING DESIGN INCLUDED A RISK ASSESSMENT TO DEMONSTRATE THAT THE DESIGN OFFERED AN ACCEPTABLE LEVEL OF LIFE SAFETY IN THE EVENT OF A RANGE OF FIRE INCIDENTS.

The twelve-storey Law School building is part of the University of Melbourne's recent development at University Square in South Carlton. The development consists of three academic buildings and an underground carpark with space for 1,100 cars. The Law Building provides 20,000 square metres of academic and educational space for the University's Law Faculty.

The application of fire safety engineering research to the design of this building delivered construction cost benefits as well as allowing architectural flexibility for this, the tallest structure in the University Square complex.

The building was constructed with suspended composite floor slabs supported by steel floor beams, most of which have no fire protection. Columns up to and including first floor level are welded steel sections with pre-cast concrete columns above this level.

Some of the steel columns on the lower level are located outside the line of the facade of the building and are clad with polished granite. Two fire-protected staircases are encased within reinforced concrete shafts.

Two major sets of open stairs connect up to seven levels within the building, representing a major departure from the Building Code of Australia (BCA) deemed-to-satisfy provisions.

Similarly, the use of bare steel floor beams, reduced level bare steel floor beams, reduced levels of protection for some of the columns, was a departure from the 'deemed-to-satisfy' provisions of the Building Code of Australia (BCA), which require 120 minutes fire resistance.

Fire safety engineering evaluation by Bruce Thomas & Associates, and assisted by the OneSteel sponsored fire research conducted at the Victoria University of Technology, demonstrated that the building met the performance requirements of building regulations without adopting all of the prescriptive rules.

This evaluation demonstrated that most of the steel floor framing of the building could be left unprotected. Steel columns on the lower levels were designed to have sufficient fire resistance to withstand a fully developed fire.

The internal columns were protected to achieve 120 minutes fire resistance and the granite cladding of the lower level external columns was shown to provide sufficient insulation to achieve adequate fire resistance.

Part of the fire safety engineering design included a risk assessment to demonstrate that the design offered an acceptable level of life safety in the event of a range of fire incidents, taking into account the effectiveness of the fire safety systems, which included sprinklers.

The sprinkler system that was incorporated within the building offered a higher level of reliability than required by the provisions of the BCA. Subsidiary valves allow each floor to be isolated independently. A tap is located on each floor to check the presence of water during commissioning and following tenancy upgrades. A sprinkler management protocol is also part of the essential services requirement for the building.

OWNER
University of Melbourne

ARCHITECT
METIER3

DEVELOPER
Equiset

STRUCTURAL ENGINEER
Meinhardt Group

SERVICE ENGINEERS
Simpson Kotzman

BUILDING CONTRACTOR
Grocon

STEEL FABRICATOR
Alfasi Steel Constructions

STEEL DETAILER
BDS Steel Details

FIRE ENGINEERING
Bruce Thomas & Associates

209 Kings Way, South Melbourne

PERFORMANCE DESIGN – REDUCING THE COST OF CONSTRUCTION

IN ACHIEVING THE REQUIRED LEVELS OF FIRE SAFETY MANY OF THE STRUCTURAL STEEL MEMBERS DID NOT REQUIRE THE ADDED COST OF PROTECTIVE COATINGS.

BUILDING CONTRACTOR
Multiplex

STEEL FABRICATOR
Alfasi Steel Constructions

ARCHITECT
METIER3

STRUCTURAL ENGINEER
Bonacci Group

FIRE ENGINEERING
Norman Disney and Young

STEEL DETAILER
Universal Steel Detailers

The fire-engineering for this 11-storey building with a total floor area of 45,000 square metres, incorporating a showroom for BMW vehicles at ground level and offices for the ANZ bank, was undertaken by Norman Disney and Young Pty Ltd with assistance from OneSteel's fire research conducted at the Victoria University of Technology (VUT).

The building is required to have a sprinkler system and was designed to satisfy the performance requirements of the Building Code of Australia (BCA) through the application of a fire-engineering methodology developed for OneSteel's structural products.

Dr Ian Bennetts from the VUT said that the beams within the open-deck carpark levels were specified in accordance with the BCA deemed-to-satisfy provisions which allowed them to be unprotected. The columns are also unprotected in the carpark levels and this was justified on the basis of their low exposed surface area to mass ratio and the results of fire tests in open – deck carparks. These tests showed that the columns would not reach temperatures that would impact on their load carrying capacity required in a fire.

In achieving the required levels of fire safety many of the structural steel members did not require the added cost of protective coatings. **(See table below)**

The fire safety strategy is centred on the incorporation of a commissioned and properly managed sprinkler system. The sprinkler system includes:

- fast response heads
- monitored isolation valves for each level of the building
- end-of-line taps to check the presence of water on a regular basis, or after modification of the sprinkler pipe work on the floors in the event of a tenancy upgrade
- a management protocol detailing specific requirements to be met when sprinklers are altered on a floor.

Norman Disney and Young developed the egress strategies using fire engineering principles ensuring the egress system allowed for swift evacuation in accordance with the performance requirements of the regulations.

Potential smoke hazard is managed by an exhaust system. The ability of the building to provide resistance to a rare, severe fire is due to a number of factors:

- only parts of a floor will be affected by a fire at a given time
- vertical support will be maintained by the many protected columns
- the floor slab and the beams will exhibit an enhanced ability to resist load under fire conditions through the development of membrane action.

There is more than sufficient time for evacuation of the occupants in the event of such a fire.

209 KINGS WAY, SOUTH MELBOURNE – FIRE RESISTANCE REQUIREMENTS SUMMARY

AREA	BUILDING ELEMENT	FIRE RESISTANCE – MINUTES (*ESA/M less than - m^2/tonne)
Open Deck Carpark	Beams Columns	0/-/- or (30*) 0/-/- or (26*)
Office	Beams (generally) Beams – Critical Columns	0/-/- 120/-/- Protected by Fire Spray 120/-/- Protected by Fire Spray
Vehicle Service Area	Beams – Critical Columns	120/-/- Protected by Fire Spray 120/-/- Protected by Fire Spray
Composite Lift & Services Shaft	Beams Columns	0/-/- or (30*) 0/-/- or (26*)

ESA/M = Exposed Surface Area to Mass Ratio

151 Clarence Street – Sydney CBD

AN ENGINEERED SAFETY SYSTEM SAVED ITS OWNERS IN THE ORDER OF $1.6 MILLION

FIRE SAFE

THE NRMA'S HEAD OFFICE UNTIL 1999, 151 CLARENCE STREET, IN SYDNEY'S CBD IS A 12 LEVEL OFFICE BUILDING BUILT IN THE 1960'S AND 1970'S. WHEN THE NRMA RELOCATED, THE OWNER, AMP, UNDERTOOK A MAJOR REFURBISHMENT OF THE INTERIOR TO TAKE THE BUILDING INTO THE NEXT CENTURY.

Constructed partly in structural steel, the floor beams had been protected by an asbestos passive fire protection material to achieve the then current fire rating. The steel columns were encased in concrete to increase their load bearing capacity and provide a fire rating. The original building had no active sprinkler or smoke control system.

Refurbishment involved the removal of the asbestos, removal and replacement of all internal partitions, ceilings, and a major upgrade of the fire and smoke safety systems. AMP set a refurbished life on 151 Clarence Street of ten years, so all costs had to reap a rental return over these ten years.

Fire Safety Considerations

Resolve Engineering, as AMP's representative, determined that a full upgrade of 151 Clarence Street to meet the current BCA deemed-to-satisfy provisions would require:

- Installation of a sprinkler system
- Application of 120 minute passive fire protection to floor beams
- Installation of a zoned smoke control system
- A smoke detection system linked to above
- Upgrade of the existing Emergency Warning Information System
- Remodelling and pressurization of the fire stairs.

It was estimated that the sprinkler system alone would cost $600,000, the passive fire protection $800,000 and the smoke handling system in the order of $700,000. With a total refurbishment budget in the vicinity of $13 million, it was found that an upgrade that met all BCA deemed-to-satisfy requirements would make the refurbishment unfeasible over the proposed ten year return life.

Consultant Fire Engineers, Holmes Fire & Safety, discussed the fire safety options with OneSteel (then BHP Steel). They determined the structure would meet the performance requirements of the BCA for a design fire scenario, without re-installation of any passive fire protection to the steel floor beams, saving an estimated $800,000.

The concrete encased steel columns are effectively insulated from the effects of fire and able to resist vertical loads during a fully developed fire on a single floor. Any deformation of the unprotected steel floor beams during a fully developed fire was demonstrated to be resisted by the columns and/or the surrounding structure unaffected by the fire.

A sprinkler isolation valve was provided at each floor to temporarily isolate the system, leaving the remainder of the floors with full sprinkler protection. By analysing the egress paths and determining the escape times for the occupants in a variety of situations, it was also possible to prove that there was no requirement for a zoned smoke control system, which would of cost $700,000.

Holmes Fire & Safety also proved that, due to the influence of the sprinkler system, smoke detectors were only required in the return air ducts and outside the fire stairs, which saved around $130,000 on the total cost of the smoke detection system.

Significant Savings

Overall, the fire engineering saved in the order of $1.6 million, with the installation of a sprinkler system, no passive fire protection on the steel floor beams, no zoned smoke control system and a reduced smoke detection system. AMP and the design team agreed to adopt the engineered fire safety system described in the Fire Engineering Design Report prepared by Holmes Fire & Safety. This proposal was presented to Sydney City Council and the NSW Fire Brigade who after discussions with both Holmes Fire & Safety and OneSteel (then BHP Steel), approved the fire safety design.

OWNER/CLIENT
AMP

ARCHITECT
Cox Richardson

PROJECT MANAGER
Incoll Management

STRUCTURAL ENGINEER
Connell Wagner

FIRE ENGINEER
Holmes Fire & Safety

GROUP SERVICES ENGINEER
Grocon

This case study, although about the refurbishment of an existing building, has some important implications for the use of structural steel in new high-rise construction. With appropriate fire-engineering input, bare steel construction is likely to be able to be used for many new multi-storey buildings reducing the cost of construction and providing a more cost-effective building.

Chapel Street, South Yarra

BRIDGING THE TRACKS IN STEEL – TURNING EMPTY AIR SPACE INTO VALUABLE COMMERCIAL PROPERTY

BUILDING CONTRACTOR
Probuild Constructions

STEEL FABRICATOR
GFC Industries

ARCHITECT
SJB Architects

STRUCTURAL ENGINEER
Bonacci Group

FIRE ENGINEERING
Philip Chun and Associates

THE BUILDING DEVELOPMENT LOCATED ABOVE THE RAIL LINE ON THE SOUTH EAST SIDE OF CHAPEL STREET AND THE CORNER OF PALERMO STREETS, SOUTH YARRA IS JUST ONE OF SEVERAL LOCATIONS IN MELBOURNE TAKING ADVANTAGE OF EMPTY AIR SPACE OVER ESTABLISHED RAIL LINES TO CREATE A DECK AND ACCOMMODATE NEW COMMERCIAL USES (THE HIGH PROFILE FEDERATION SQUARE IS ANOTHER) MAXIMISING LAND USE AND MEETING DEMAND FOR SPACE IN THE INNER CITY.

Located at the corner of Palermo Street, the Chapel Street project is typical of many suburban shopping centres. Part of the single storey building incorporates a number of major retail outlets positioned on the composite steel deck bridging the busy railway tracks on the south east side of Chapel Street.

Steel beams were the natural choice for this deck as they offer high strength-to-weight ratio and fast erection. Grade 400 OneSteel welded beams at close centres span a distance of some 26 metres. These beams support a 150mm lightweight concrete slab poured on 1.0mm permanent metal deck formwork and act compositely with the concrete deck.

Dr Ian Bennetts from OneSteel's fire research group at the Victoria University of Technology carried out a fire engineering and risk assessment of the deck structure and the superstructure. The roof level plate girder at the Chapel Street frontage and its stabilising elements were fire-rated by spray application. This element had to be relied on to support the deck structure, in the event of a fire without any risk to the trains operating below.

The beams are painted but have no fire protective coating as the bare steel construction has sufficient fire resistance. Also it has been estimated that the probability of a major fire within a train at this location is less than one in a million per year.

Traditionally, construction over railway tracks has been required to have high levels of fire resistance, sometimes up to four hours. However it is now recognised that each project needs its own individual fire-engineering assessment. In this particular case, the risk-to-life due to a fire in the building above the deck is considerably greater than that associated with the activity of trains below. Similarly, it was demonstrated that for the train occupants, the greatest threat to life, should there be a fire below the deck, is from the smoke and flames within the train, as opposed to the deformation of the deck structure above the train.

Somerville House, Brisbane

VISUAL AND PERFORMING ARTS COMPLEX

PERFORMANCE BASED FIRE ASSESSMENT SIMPLIFIED CONSTRUCTION AND PROVIDED SIGNIFICANT COST SAVINGS

FIRE SAFE

CLIENT
Somerville House

ARCHITECT
Devine Erby Mazlin (Qld) Pty Ltd

DESIGN ENGINEER
McWilliam Consulting Engineers

BUILDER
Barclay Mowlem Construction Ltd

STEEL FABRICATION
MILFAB Pty Ltd

THE NEW VISUAL AND PERFORMING ARTS COMPLEX AT SOMERVILLE HOUSE IN BRISBANE WAS AN EXCITING PROJECT TO CELEBRATE THE SCHOOL'S CENTENARY YEAR.

The new Centenary Building, designed by architects DEM (Qld) Pty Ltd and constructed by Barclay Mowlem Construction Ltd, is a hybrid structure. It contains different levels for performing arts and music rehearsal, as well as classroom facilities establishing a new Middle School.

Car parking and storage facilities are provided on the ground level. The hall subdivides into two 250 seat lecture theatres of tiered configuration, leaving a flat floor area for theatre in the round performances, examinations and school dances. An extensive stage area makes large-scale productions possible.

The variety of spaces and the proximity of the project to the heritage listed South Brisbane Town Hall was an initial challenge for the design team. The end result is a handsomely scaled building that tucks neatly into the steep contours of the school site and makes a high level connection to the existing pedestrian spine. From the upper north terrace of the building there are extensive views of the city and Brisbane River, while on the ground floor, a strong new identity and formal entrance has been created.

With the assistance of OneSteel's fire research conducted at the Victoria University of Technology, a performance based assessment was undertaken which demonstrated that the building satisfied the fire safety objectives of the Building Code of Australia (BCA).

The lower three levels of the building are a conventional concrete frame changing to a steel framed structure at the upper auditorium level. Graduated steel trusses span the auditorium to support the roof, architectural acoustic ceiling and operable walls which can divide the auditorium. Steel UB columns support the trusses.

The auditorium seating for 1,050 includes inclined seating at the rear, and portable seating that can be placed in the middle section of the room. The inclined seating is plywood based and the portable seating is stored below the inclined seating. Exits comply with BCA requirements.

The auditorium is constructed using structural steelwork. The outer cladding of the building is steel sheeting and at some locations the inside of the walls are lined with plasterboard. The roof consists of steel supporting members and roof sheeting.

If the building structure had been designed in accordance with the deemed-to-satisfy provisions of the BCA, the roof and columns would have required a fire-resistance of 120 minutes. A performance-based assessment was undertaken which demonstrated that the use of an unprotected roof and steel columns would still allow the fire safety objectives of the BCA and the associated performance requirements to be achieved.

According to design engineer Brian Wooldridge of McWilliam Consulting Engineers, "the opportunity to use an unprotected steel structure simplified the construction and provided a significant cost saving".

PERFORMANCE REQUIREMENTS MET

The overall objectives of the performance requirements, can be summarised as follows:

- The building shall be designed to allow safe evacuation of the occupants
- The building shall be designed so as not to put the fire brigade at risk in the exercise of their duty
- The building shall be designed to avoid the spread of fire to other buildings
- The building shall be designed to avoid damage to other buildings

Each of these requirements needs to be considered in order to demonstrate that an alternative solution satisfies the fire-safety objectives of the BCA.

OneSteel FireSafe™ Guides

FIRE SAFE

ONESTEEL'S FIRESAFE DESIGN GUIDES ARE AVAILABLE IN ADOBE® ACROBAT® FORMAT TO VIEW OR DOWNLOAD FROM THE ONESTEEL WEBSITE, GO TO STRUCTURAL SECTIONS/DESIGN TOOLS AND SOFTWARE AT OUR WEBSITE WWW.ONESTEEL.COM/PUBLICATIONS.ASP

ONESTEEL'S FIRESAFE™ DESIGN GUIDES ARE ALSO AVAILABLE ON CD AS PART OF THE ONESTEEL DESIGN COMPENDIUM. TO ORDER SIMPLY PHOTOCOPY THIS PAGE AND FAX OR MAIL THE COMPLETED COUPON:

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