# FireSafe™ Solutions

**CASE STUDIES IN STRUCTURAL STEEL**

FIRE SAFE

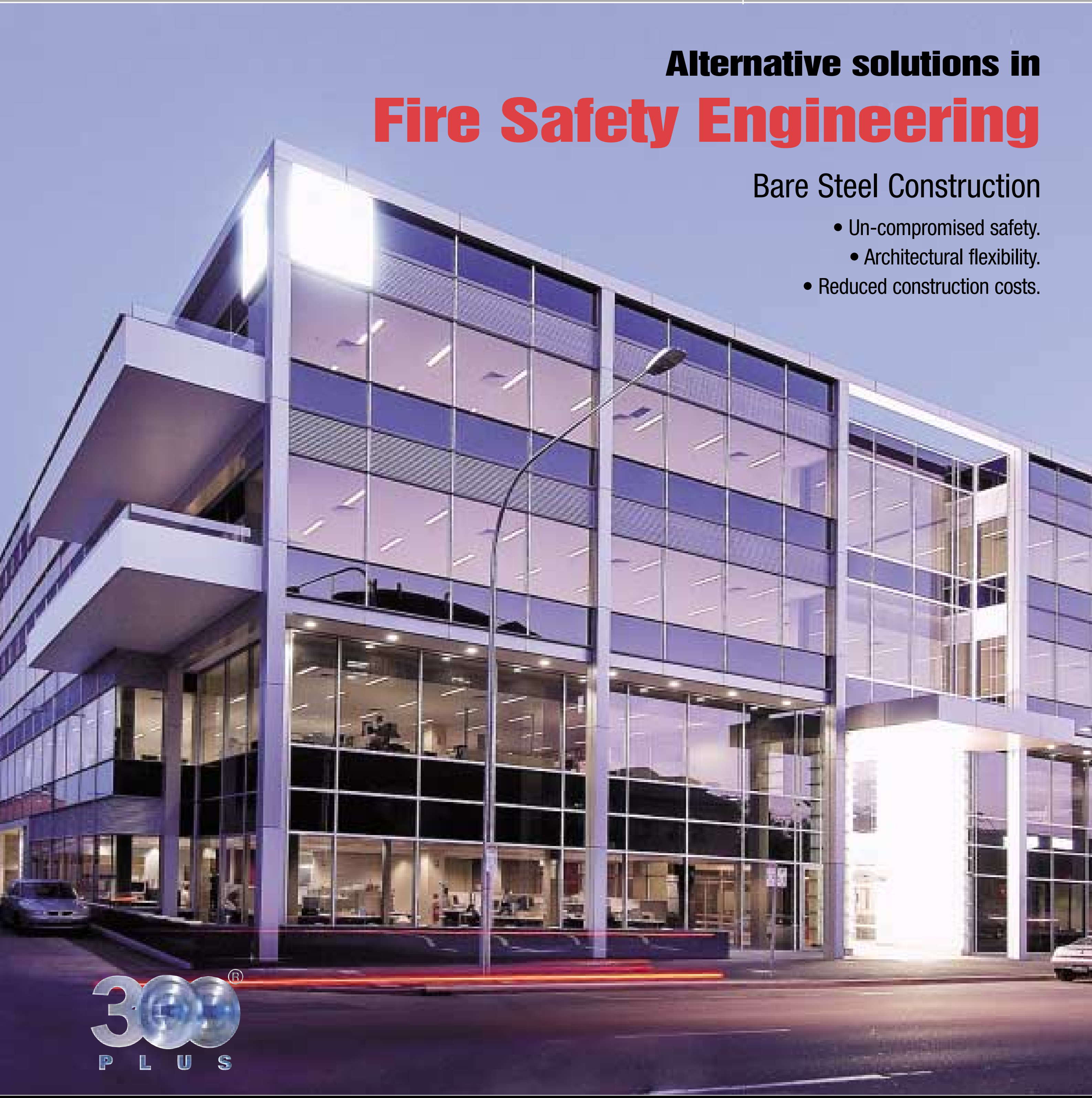
**Fire safety engineering by design**

Issue 2, January 2005

## Alternative solutions in Fire Safety Engineering

Bare Steel Construction

- Un-compromised safety.
- Architectural flexibility.
- Reduced construction costs.




BEDEV Office Development in Adelaide: Structural steel solution delivers significant cost reductions.

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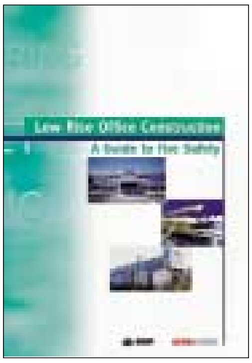
Welcome to **FireSafe**™ Solutions Issue 2, showcasing a diverse range of structural steel projects that benefited from the application of performance based Fire Safety Engineering assessments, to provide alternative solutions using bare steel construction that can offer benefits such as:

- **Increased Safety Levels**
- **Architectural Flexibility**
- **Reduced Building Costs**
- **Faster Construction**

## CASE BOOK PUBLICATION

# Low-Rise Office Construction




The design of low-rise office buildings for fire safety is considered in detail in the OneSteel Market Mills publication "Low-rise Office Construction – A Guide to Fire Safety" (see website www.onesteel.com).

This OneSteel Market Mills publication is applicable to office buildings with a rise in storeys of up to four, summarises the Building Code of Australia (BCA) Deemed-to-Satisfy (DTS) requirements for these buildings but also proposes a number of alternative solutions allowing the use of essentially bare steel construction.

One set of alternative solutions presented in this publication applies to office buildings that incorporate sprinklers where these would not be required by the (DTS) provisions (note that sprinklers are normally only required by the DTS provisions if the building exceeds 25m in effective height, or the building is considered to be a large isolated building or contains an atrium of a certain height).

Sometimes, however, sprinklers are incorporated in a building for the purpose of property protection and safety. Their presence will also have an impact on achieving the BCA objectives and performance requirements. It is argued that bare steel-framed buildings can be constructed. The justification for this approach is given in this publication.

Essentially the argument is that there is a direct correlation between the number of deaths in buildings and the size of the fire and that sprinklers are more effective in preventing large fires than compartmentalised construction. The evidence for this is the case is obtained from real fire statistics.

Two buildings featured in this edition, the BEDEV office development (SA), Type A construction, and the Australian Corporate Headquarters of Toyota (VIC), Type B construction, are examples of buildings where sprinklers have been incorporated into the design. This has allowed significant variation from the DTS requirements – particularly in relation to the use of OneSteel **300PLUS**® and bare steel construction.

Other fire engineered examples featured in this edition are: Toyota Showroom at Nunawading (VIC), a school building, Our Lady of Mercy College (VIC), and the extension to Frankston Hospital (VIC).

## Would you like to find out more?

### Talk in confidence to your OneSteel State Market Engineer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# BEDEV Office Development

## SIMPLIFY THE PROCESS AND REDUCE COSTS USING BARE STEEL CONSTRUCTION

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**THE BUILT ENVIRONS DEVELOPMENT, LOCATED AT THE CORNER OF FROME AND FLINDERS STREETS IN ADELAIDE, SOUTH AUSTRALIA, PROVIDES CAR PARKING IN A BASEMENT, PLUS 4 LEVELS (EACH 1280M²) OF OFFICE CONSTRUCTION WITH A PLANT ROOM ABOVE.**

With the exception of the reinforced concrete basement, the building was constructed using a bare steel frame incorporating OneSteel's range of **300PLUS**® structural steel sections.

A fire safety engineered solution was employed to reduce costs and provide a more flexible solution to accommodate the architects requirements. The methodology adopted, as with most fire safety engineering designs, was to demonstrate that the alternate design has an equivalent or better level of fire safety than required by the appropriate Deemed-to-Satisfy (DTS) provisions of the BCA.

For this development, the DTS required the building frame to have an FRL of 120/-/- and the floor slabs 120/120/120 but did not require the building to be sprinklered. However, the developers required sprinklers for other reasons, namely, to offer the office to A-grade tenants that require sprinklers for property protection.

An alternate fire safety engineering solution was developed consisting of sprinklers in combination with the inherent fire resistance of unprotected 300PLUS® steels (bare steel). This alternate solution provided a higher level of fire safety than the steel frame protected to the FRLs required by the BCA. As a result of the bare steel solution being adopted, significant cost savings were realised and the construction process was greatly assisted.

In addition, the presence of sprinklers allowed some additional architectural flexibility for the arrangement of the exit doors at ground level. Although the number of exits remained the same and are fire isolated from each other and the rest of the floors, the doors from these exits were located next to each other instead of the minimum distance apart as required by the DTS provisions.

**BEDEV OFFICE DEVELOPMENT – FIRE RESISTANCE REQUIREMENTS SUMMARY**

| BUILDING ELEMENT | ELEMENT REQUIREMENT | |
|---|---|---|
| | **DTS#** | **Alternative Solution** |
| **columns** | 120/-/- | ESA/M ≤ 26m²/tonne |
| **beams** | 120/-/- | |
| | ESA/M ≤ 30m²/tonne | |
| **floor slabs** | 120/120/120 | 60/60/60 |
| **sprinklers** | no | yes * |

\# Type of construction: A
\# Classification of building: Class 5
* requested by client for property protection irrespective of form of construction.

**OWNER**
Built Environs Developments Pty Ltd

**ARCHITECTS**
Matthews Architects

**STRUCTURAL ENGINEER**
Meinhardt PT Design

**QUANTITY SURVEYOR**
Rider Hunt Pty Ltd

**BUILDER/PROJECT MANAGER:**
Built Environs

**STEEL DETAILER / FABRICATION / ERECTION**
Samaras Structural Engineers

**BUILDING CERTIFIER**
Katnich Dodd

**FIRE SAFETY ENGINEERING**
Cesare (VUT)

**PHOTOGRAPHY**
Kevin O'Daly

# Toyota Corporate Headquarters

## ARCHITECTURAL FLEXIBILITY, PLUS REDUCED BUILDING COSTS OF OVER $0.5 MILLION


**THE AUSTRALIAN CORPORATE HEADQUARTERS OF TOYOTA, PORT MELBOURNE, VICTORIA. STRUCTURAL STEEL MAKES A STATEMENT IN DESIGN EXCELLENCE TO REFLECT TOYOTA'S LEADERSHIP AND SUCCESS AS A COMPANY.**

**OWNER**
Toyota Motor Corporation of Australia Limited

**ARCHITECT**
Woods Bagot Pty Ltd

**PROJECT MANAGER**
D G Jones Property Advisory

**STRUCTURAL & CIVIL ENGINEER**
Brown Consulting (VIC) Pty Ltd

**BUILDER**
Probuild Constructions Aust Pty Ltd

**SERVICES ENGINEER**
Irwinconsult Pty Ltd

**BUILDING SURVEYOR**
Gardner Group Pty Ltd

**FIRE SAFETY ENGINEERING**
Umow Lai & Associates Pty Ltd

**PHOTOGRAPHY**
David Simmonds

The building provides 12000m$^2$ of floor area over three levels and will house over 340 employees. The building provides office space but also other facilities such as an auditorium, seminar and staff meeting rooms, kitchens, gymnasium and staff retail facilities. Open stairs connect the various levels. At the front of the building is a curved façade that forms a space (or "atrium") between this façade and the façade associated with the three-storey part of the building. However, the "atrium" is not strictly an atrium in terms of the Building Code of Australia.

The construction is entirely framed in structural steel with the floors incorporating composite steel beams with **300PLUS®**, 610UB101 primary and 310UB40 secondary beams. The primary beams have been designed to be continuous. A 120mm composite floor slab on structural steel decking spans between the secondary beams.

Due to the open stairs connecting the levels the Deemed-to-Satisfy (DTS) provisions required the building to be considered as a large isolated building. This required sprinklers and continuous vehicular access around the building. However, the designers wanted to maximise the utilisation of the site resulting in vehicular access on only three sides. Since the rise-in-storeys is three the DTS provisions also required the building to be of Type B construction which required protection of columns and possibly beams.

The fire engineer, in his alternate design, was able to demonstrate that the safety of the occupants would not be compromised by the absence of high levels of fire resistance associated with the columns and beams, and vehicular access on three sides only. Rather, the major threat to the occupants is due to smoke from a serious fire. The most important fire-safety measure is to minimise the likelihood of such a fire and this is achieved through the provision of a reliable sprinkler system.

The resulting building exhibits architectural flexibility, reduced building costs (ie. more than $0.5million from not having to add fire protection products to the beams and columns) and does not compromise the level of fire safety compared with that associated with a conventional building designed to satisfy the minimum DTS provisions of the BCA.

**TOYOTA CORPORATE HEADQUARTERS – FIRE RESISTANCE REQUIREMENTS SUMMARY**

| BUILDING ELEMENT | ELEMENT REQUIREMENT | |
|---|---|---|
| | **DTS#** | **Alternative Solution** |
| **columns** | 120/-/- | ESA/M ≤ 26m$^2$/tonne |
| **beams** | 120/-/- (possibly) | ESA/M ≤ 30m$^2$/tonne |
| **floor slabs** | - | 60/60/60 |
| **sprinklers** | yes | yes |

# Type of construction: B    # Classification of building: 5

# Toyota Showroom, Nunawading

## A SAFE AND ECONOMICAL SOLUTION DRIVES BARE STEEL CONSTRUCTION WITH 300PLUS®

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**THE TOYOTA SHOWROOM IS AN ATTRACTIVE STRUCTURAL STEEL-FRAMED BUILDING THAT CONSISTS OF A LOWER GROUND, GROUND FLOOR AND A FIRST FLOOR MEZZANINE.**

The building incorporates bare steel beams and columns throughout utilising OneSteel's **300PLUS®** range of structural sections.

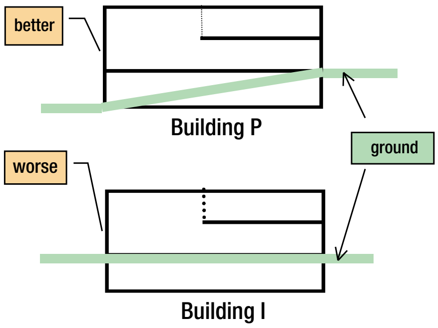
According to the Building Code of Australia (BCA), the mezzanine must be treated as a storey due to its area. This means that the building is classified as having to be Type B construction due to its rise in storeys.

According to a strict interpretation of the Deemed-To-Satisfy (DTS) provisions of the BCA, columns and beams (since these give lateral support to the columns) would be required to have a fire-resistance level of 180 minutes. There is no requirement for the floors to have a fire-resistance level, which would have required protection of the structural steel members adding significantly to the cost of the structural steelwork.

A fire-engineering assessment was undertaken for this building to investigate whether protection of the structural steelwork was necessary. This assessment recognised first of all that evacuation would be relatively rapid from all levels (less than 5 minutes) given that direct egress is available at lower ground and ground levels. This building is relatively open so occupants would quickly become aware of a fire due to the smell and sight of smoke and this would reduce the time to evacuate the building. It was found that the building structure would not experience significant deformations until well after evacuation had taken place. Fire brigade access is good since a major fire can be fought from outside the building. It was concluded that the use of **bare steel construction** throughout was acceptable and would not have any detrimental effect on occupant safety.

The assessment also compared DTS differences for the Toyota showroom building (Building P) with an almost identical building (Building I). The difference was that in Building I the lower ground level has become a basement such that direct egress to outside is no longer possible – so that egress must be via stairs that allow evacuation at ground level. Building I can be constructed as Type C construction and beams, columns and floors have no fire-resistance requirements. Unlike Building P where the columns would require 180 minutes of passive fire protection.

In comparing these two buildings, it is concluded that with respect to evacuation of occupants on the mezzanine level or (upper) ground level and their potential exposure to a fire, the two buildings are equivalent. In the case of occupants within the lowest level, it is argued that Building P is better than Building I, since direct egress to outside is available. It follows that Building P is at least as safe as Building I and therefore it is difficult to see why the requirements applicable to Building I should not apply to this building.




**OWNER**
Toyota Motor Corporation of Australia Limited

**ARCHITECTS IN ASSOCIATION**
Michael Z Avramidis in association with Gray Puksand

**BUILDER**
APM Group (AUST) Pty Ltd

**STRUCTURAL & CIVIL ENGINEER**
Burns Hamilton and Partners Pty Ltd

**BUILDING SURVEYOR**
Stokes Building Surveying Pty Ltd

**FIRE SAFETY ENGINEERING**
Cesare (VUT)

**PHOTOGRAPHY**
Ian McKenzie

**TOYOTA SHOWROOM – FIRE RESISTANCE REQUIREMENTS SUMMARY**

| BUILDING ELEMENT | ELEMENT REQUIREMENT | |
|---|---|---|
| | **DTS#** | **Alternative Solution** |
| **columns** | 180/-/- | ESA/M ≤ 26m²/tonne |
| **beams** | - | ESA/M ≤ 30m²/tonne |
| **floor slabs** | - | 60/60/60 |

# Type of construction: B    # Classification of building: 6

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# Our Lady of Mercy College

## SAFETY-FIRST APPROACH SEES STRUCTURAL STEEL CHOSEN FOR THE LATEST ADDITION TO THIS GROWING COLLEGE

**ONESTEEL'S 300PLUS® RANGE OF HOT ROLLED STRUCTURAL SECTIONS WERE USED IN THIS TWO-STOREY ADDITION TO OUR LADY OF MERCY COLLEGE.**

The ground level of the extension consists of a 200 seat auditorium with a stage, a band room adjacent to the stage, a foyer and kitchen servery, toilets and a small storage room.

The upper level consists of general classrooms and a common area, overall accommodating up to 108 students and staff.

Egress from the upper floor is via one set of stairs from the common area and a bridge across a void to the existing three-storey part of the building and then to stairs. The void effectively separates this part of the building from the remainder of the building. A smoke detection system is incorporated within the lower level of the building and will result in shut down of air supply to the auditorium.

In the event of activation of the detection system, an alarm will be sounded at both levels.

Since the two-storey extension is connected to a three-storey existing building, the Deemed-to-Satisfy (DTS) provisions of the BCA would require the two-storey extension to be treated as Type A construction. Structural steel beams and columns require a Fire-Resistance Level (FRL) of 120 minutes with the floor between the levels having an FRL of 120/120/120.

The **300PLUS®** structural steel columns and beams are unprotected and the slab between the levels has been designed to have an FRL of 30/30/30.

A composite slab can achieve the latter performance without taking into account the influence of reinforcement other than the steel decking.

The fire-engineering solution demonstrated that the risk associated with the proposed extension incorporating bare steel beams and columns and a floor having a reduced FRL was not less than that associated with the building should it have been designed to the DTS provisions. This was able to be demonstrated on the basis of the following arguments:

(a) evacuation time for the upper floor is short and occupants will become aware of the fire due to detection at the lowest level and from the other cues associated with a fire at ground level. The DTS provisions do not require the detection and alarm system.

(b) it is not possible for a significant fire to take hold in the auditorium due to the lack of air supply. A door would have to be left open to get sustained burning but even then the resulting fire would not be of sufficient intensity to seriously affect the columns and beams within the auditorium. Other parts of the ground floor also have insufficient fire load or ventilation to result in a fire capable of significantly affecting the structural steel members.

**OUR LADY OF MERCY COLLEGE – FIRE RESISTANCE REQUIREMENTS SUMMARY**

| BUILDING ELEMENT | ELEMENT REQUIREMENT | |
|---|---|---|
| | **DTS#** | **Alternative Solution** |
| **columns** | 120/-/- | ESA/M ≤ 26m²/tonne |
| **beams** | 120/-/- | ESA/M ≤ 30m²/tonne |
| **floor slabs** | 120/120/120 | 30/30/30 |
| **local detection** | no | yes |

# Type of Construction: A # Classification of building: 9b

**OWNER**
Our Lady of Mercy College, Melbourne. The college is incorporated as the Mercy Secondary Education Inc.

**ARCHITECT**
Williams Ross Architects

**CONSTRUCTION MANAGER**
Burns Bridge Australia Pty Ltd

**STRUCTURAL & CIVIL ENGINEER**
Burns Hamilton & Partners Pty Ltd

**SERVICES ENGINEER**
Sanderson Consultants Pty Ltd

**BUILDING SURVEYOR**
PLP Building Surveyors & Consultants Pty Ltd

**FIRE SAFETY ENGINEERING**
Cesare (VUT)

**PHOTOGRAPHY**
Peter Hyatt

# Frankston Hospital Extension

## 300PLUS® STRUCTURAL STEEL – THE IDEAL CHOICE FOR EXTENDING EXISTING BUILDINGS IN ANY DIRECTION

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**FRANKSTON HOSPITAL IS A FIVE-STOREY BUILDING THAT HAS BEEN EXTENDED WITH BARE STEEL CONSTRUCTION. THE UPPER FLOORS HAVE BEEN COMPLETED WITH THE LOWER TWO FLOORS LEFT INCOMPLETE. IN THE FUTURE THESE LOWER FLOORS CAN BE CONVENIENTLY IN-FILLED IN THE SAME MANNER AS THE TOP FLOORS.**

OneSteel's **300PLUS®** hot-rolled structural steel sections were the material of choice for this project due to the ease with which steel frame construction can be used to extend an existing building.

Upon completion of the construction, new space will have been provided for wards, birth suites and other procedural rooms, dining areas, day surgery areas and minor plant.

A fire-safety engineering assessment was undertaken for this building with part of the assessment focussing on the extent of fire protection required for the steel columns and beams associated with the extended parts of the building.

In Victoria, all hospitals are required to be sprinklered. This is not the case in other parts of Australia and is not required by the Building Code of Australia (BCA) - unless the building exceeds 25m in effective height or is a large isolated building. This is not the case with this building

It is reasonable to suggest that it will be almost impossible to deal successfully with a fully developed fire in a hospital given the potential condition of the occupants and the difficulty in evacuating them. Evacuation times are likely to be long.

The best way of managing the risk in these buildings is to minimise the likelihood of a fire. This can be done in various ways. One of the best ways is to incorporate sprinklers and manage them so as to achieve the high levels of effectiveness that are possible.

The statistical record shows that sprinklers are more effective than compartmentation in limiting the spread of fire. It also shows that fatalities are correlated with the size of the fire. It follows that the extended building is safer with sprinklers than if it had been designed to the BCA - Deemed to Satisfy provisions.

In hospitals, it is critical to avoid a severe fire because the smoke and heat would result in major loss of life.

The optimal risk management strategy is to take particular steps to minimise the fire size. It is really too late once the fire reaches major proportions. Management strategy should include staff training on fire awareness and response and the management of the sprinkler system.

Bare steel construction utilising OneSteel's **300PLUS®** range of hot-rolled sections were used throughout the hospital extension with the exception of columns within the health-care parts, which were fire protected with plasterboard.

**FRANKSTON HOSPITAL EXTENSION – FIRE RESISTANCE REQUIREMENTS SUMMARY**

| BUILDING ELEMENT | ELEMENT REQUIREMENT | |
|---|---|---|
| | **DTS#** | **Alternative Solution** |
| **columns** | 120/-/- | 60/60/60 |
| **beams** | 120/-/- | ESA/M ≤ 30m²/tonne |
| **floor slabs** | 120/120/120 | 120/120/120 |
| **Sprinklers** | no | yes* |

# Type of construction: A
# Classification of building: 9a
* required by local Victorian regulations only

**CLIENT**
Peninsula Health

**PROJECT MANAGERS**
John Wertheimer Consultants Pty Ltd

**ARCHITECT**
Silver Thomas Hanley Pty Ltd

**BUILDER**
Hooker Cockram Projects Limited

**STRUCTURAL & CIVIL ENGINEER**
Meinhardt Consulting Engineers Pty Ltd

**BUILDING SURVEYOR**
Stokes Building Surveying Pty Ltd

**FIRE SAFETY ENGINEERING**
Meinhardt Consulting Engineers Pty Ltd & Cesare (VUT)

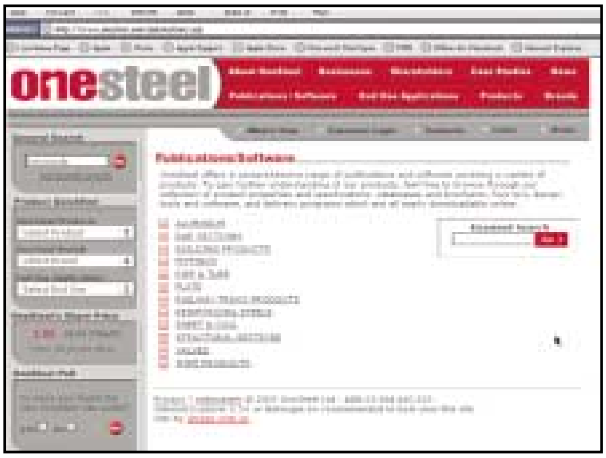
**PHOTOGRAPHY**
Martin Saunders

# OneSteel FireSafe™ Guides

FIRE SAFE

## ONESTEEL'S FIRESAFE™ DESIGN GUIDES ARE AVAILABLE TO VIEW OR DOWNLOAD FROM THE ONESTEEL WEBSITE

## www.onesteel.com/publications.asp



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