(putting aside any associated site allowances should these come into play) would still appear to be more cost competitive than thin-film intumescent coatings. There is a role for both types of material. The cost of off- or on-site application of intumescent materials will reduce if the market size increases, but some effort needs to be made to improve the cost effectiveness and the marketing of these materials.

Similarly, an increased effort is required to advance Strategy 3 in achieving builder acceptance of sprayed fire protection.

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4.5.5 FIRE ENGINEERING

By Ben Ferguson

For The Warren Centre

Summary

Generic building codes may not provide the most suitable solution for today's steel buildings. Fire engineering can be used to ensure the structural solution is developed with respect to each particular building's characteristics, resulting in efficiencies of design, cost, aesthetics and program.

Through the use of fire-engineering technology, 'Alternative Solutions' can be developed to reflect specific developments where generic codes cannot be applied or are inappropriate. The Building Code of Australia (BCA) has been a performance-based document since 1996, which supports such Alternative Solutions as a means of designing buildings that are fit for purpose, efficient and robust.

Some examples of how fire engineering, undertaken by a qualified fire engineer with specialist structural fire engineering knowledge and experience, can benefit steel buildings are:

- reduction or deletion of fire-rating requirements to specific structural elements, including beams, columns, walls etc. For example, modern open-plan offices with full height, glazed curtain walls are often suitable without full protection to steel beams. The use of bare steel secondary beams is becoming common in many such buildings and there are recent examples of buildings with all steel beams unprotected
- use of unprotected structure supporting external elements of a building, such as a balcony/walkway.
- use of external stairways, constructed of unprotected steel and glazing
- use of alternative fire protection methods
- use of steel cores in some circumstances (i.e. low-rise buildings)
- use of lightweight construction.

This paper provides a summary of fire engineering to assist developers, designers and authorities to understand the methodologies used to assess steel buildings and the benefits of fire engineering.

What is fire engineering?

Fire engineering is based on knowledge of fire science and chemistry, physics, mathematics, building services engineering, structural engineering, materials science,

architecture and psychology. These elements are used to assess and determine fire-safety solutions for new developments and redevelopments of existing buildings.

The primary aims of fire safety in the built environment are:

- ensuring the safety and safe escape of building occupants in the event of fire
- protection of adjoining buildings
- protection of fire fighters
- minimising property damage or loss due to fire.

These are the key objectives of the BCA. Figure 1 shows the structure of the BCA.

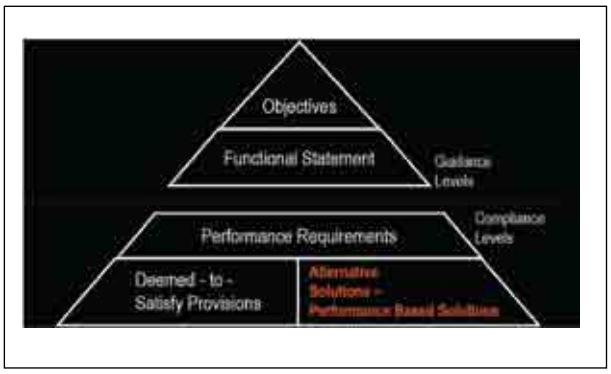

Figure 1: Structure of the BCA

At the compliance level of the diagram, the Performance Requirements are the absolute requirements that must be satisfied to ensure the design of a building complies with the BCA. There are two ways of meeting the Performance Requirements, namely: Deemed-to-satisfy (DTS) provisions (i.e. follow the 'cookbook' type approach); or develop an Alternative Solution.

Fire engineering is concerned with the second of the two, 'Alternative Solutions – Performance-Based Solutions', which are developed as part of the overall fire-safety design when the DTS provisions cannot be applied or are inappropriate. This may be due to the generic DTS provisions being:

- excessively conservative for a specific building
- inflexible and restrictive
- inappropriate for complex architecture, structure or services design
- unsuitable for heritage/refurbishment projects.

Fire-engineering techniques are used to measure the level of fire safety and risk in a building and establish an acceptable fire-safety design. Some of the areas fire engineering can be applied in buildings are:

- alternative smoke hazard management strategies
- rationalisation of materials for construction
- assessment of fire and smoke spread
- rationalised structural fire protection
- increased fire and smoke compartment areas
- computer modelling of fire and smoke development
- assessment of fire authority requirements
- access and egress of emergency personnel
- fire fighting facilities.

Fire engineering and steel structures

There are a small number of qualified fire engineers in Australia who have a detailed understanding of a sub-category of fire engineering, known in the UK as 'structural fire engineering'. Fire engineers with this specialist knowledge offer significant advantages on a steel-framed building project, including time savings, cost reduction and design flexibility/freedom.

Traditionally, the design of steel structures to withstand fire has been based on a series of tests conducted for isolated steel members. The load characteristics of each section type and size are well known, as is the effect of high temperatures on steel.

To enable a reasonably simple set of reference tables, the tests were limited by the following parameters:

- A 'standard' heating regime was used (i.e. AS1530.4 in Australia). The structural member was placed in a furnace that has a temperature controlled in accordance with a specific rate over time.
- The heating regime used in the tests does not represent all types of fire scenario, however is designed to be applicable to all types of fire to ensure the structure retains its integrity during a total burnout of a particular compartment. It is therefore logical to suggest that such a generic application may create cases where the structure and/or its protection is over-designed.

From these tests, the behaviour of the steel when heated was determined and the amount of protection required to maintain the structural integrity of the steel element was derived.

A single member of each section type and size was tested.

Research undertaken in recent years (British Steel 1999, Thomas 1992a 1992b) has demonstrated that a structural system will behave more favourably in a fire than a single element, due to the transfer of load from a weakened element to other structural members

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The University of Sydney

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It has three principal objectives:

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- to provide independent comment and advice to government and industry on these and related issues.

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