Somerville House Brisbane

December 2002

This case study was written at the time when InfraBuild (formerly Liberty OneSteel) was part of OneSteel. In that context, in some instances within this case study reference may be made to OneSteel.

Somerville House, Brisbane

Visual and Performing Arts Complex at

Somerville House

The new Visual and Performing Arts Complex at Somerville House in Brisbane was a worthy celebration of the school's centenary year.

The new Centenary Building, which was 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. At ground level, car parking and storage facilities are provided. The Level 4 Music School features two double height orchestral rehearsal rooms that are designed to give high quality acoustics and allow for the permanent set up of instruments.

On the upper level, connected to the major east/west pedestrian spine through the school, is the Performing Arts facility, a multi modal assembly area capable of seating up to 1050 people. The hall subdivides into two 250-seat lecture theatres of tiered configuration, leaving a flat floor area capable of being used for theatre in the round, examinations, and school dances. There is also an extensive stage area for large-scale productions.

The variety of spaces and the proximity of the project to the heritage listed South Brisbane Town Hall provided an initial challenge for the design team. The end result is a handsomely scaled building that tucks neatly into the steep landform of the school and makes a high level connection to the existing pedestrian spine. From the upper north terrace areas 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 as been created.

STRUCTURE

The lower 3 levels of the building have a conventional concrete frame. The structure at the upper auditorium level changes to steel framed, with graduated steel trusses spanning across the auditorium to support the roof, architectural acoustic ceiling and operable walls which can divide the auditorium. Steel UB columns support the trusses.

With the assistance of OneSteel and Victoria University of Technology, approval was obtained to omit the requirement for fire rating of the structural steel. In accordance with the deemed-to-satisfy provisions of the BCA, the roof and columns require a fire resistance rating of 120 minutes. A performance based assessment was undertaken which demonstrated that the fire safety of the building satisfied the fire-safety objectives of the BCA.

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.

FIRE ENGINEERING

The auditorium seats 1050 people and 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 and the portable seating is stored below the inclined seating. Exits comply with BCA requirements.

"...the opportunity to use an unprotected steel structure simplified the construction and provided a significant cost saving."

CLIENT

Somerville House

BUILDER

Barclay Mowlem Construction Ltd

CONSULTING ARCHITECT

Devine Erby Mazlin (Qld) Pty Ltd

DESIGN ENGINEER

McWilliam Consulting Engineers

SPECIALIST FIRE ENGINEERING:

OneSteel

Victoria University of Technology

(Dr Ian Bennetts)

STEEL FABRICATION & ERECTION:

MILFAB Pty Ltd

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.

According to the deemed-to-satisfy provisions of the BCA, the building must be of Type A construction. The provisions require that the upper storey of the building must have a fire-resistant roof or a ceiling that is resistant to the incipient spread of fire. In addition, the columns associated with the upper storey, both internal and external, are required to have an FRL of 120/-/-. The external walls, because they are not load bearing and due to the distances to relevant fire-source features, are not required to have an FRL.

The site boundaries are distant and the closest building on the site is 11.8 metres in plan from the outer wall of the auditorium.

DEEMED-TO-SATISFY PROVISIONS NOT COMPLIED WITH

The auditorium construction utilised means that the following deemed-to-satisfy provisions are not complied with:

- Internal and external columns and rafters will not achieve 120/-/-.
- Roof will not achieve 120/120/120.
- Acoustic ceiling below roof will not provide resistance to the incipient spread of fire.

“There will be sufficient threatening cues for the occupants to begin evacuation once they are aware of the presence of a fire.”

PERFORMANCE REQUIREMENTS TO BE MET

The overall objectives of the performance requirements, in the event of a fire, can be summarised as follows:

(a) The building shall be designed to allow safe evacuation of the occupants

(b) The building shall be designed so as not to put the fire brigade at risk in the exercise of their duty

(c) The building shall be designed to avoid the spread of fire to other buildings

(d) The building shall be designed to avoid damage to other buildings

The relevant performance requirements relating to this evaluation are CP1 and CP2. Each of these requirements needs to be considered in order to demonstrate that an alternative solution satisfies the fire-safety objectives of the BCA.

The performance requirements make mention of maintaining structural stability or preventing flame spread, taking into account any active systems installed in the building, the function of the building, the evacuation time, and various other factors. The fact that these factors are mentioned means that the BCA recognises that the structural adequacy of various elements of construction cannot be seen in isolation, and that the fire safety of a building is a function of factors other than the structural adequacy of the building.

ANALYSIS OF FIRE SCENARIOS

The analysis of the fire hazards and their likely effect on the occupants are based

on findings from experimental studies and engineering judgement. The acceptance criterion appropriate to this evaluation is that the building structure allows sufficient time for evacuation of the occupants. There will be sufficient threatening cues for the occupants to begin evacuation once they are aware of the presence of a fire. The calculated evacuation time, assuming that all exits are effective is about 3 minutes.
If only one-half of the exits are available, the evacuation time will be around 5 minutes.

A fire test conducted at BHP Research laboratories involved a 5 MW fire with adjacent bare steel construction. Measured temperatures indicate, that should a 100 SHS column section proposed for the seating support be exposed to this fire, it would reach a limiting temperature after about 12 minutes. At that point, the supported beam would simply bow. However, this would not result in a loss of stability of the building or catastrophic failure of the upper seating tier. The smoke at this stage would be under 2m from the floor and almost the entire upper seating tier will be obscured by dense smoke. Survival of the occupants requires the occupants of this tier to have evacuated well before this time

Should a fire develop adjacent to the external columns associated with the steel frame, then it will take even longer for these members, if subject to this fire, to reach a limiting temperature. Furthermore, should the member become locally hot, this will not cause overall failure of the building but deformation of the roof at that point. This cannot pose a threat to the occupants, who at this stage, will need to have well and truly evacuated to escape the effects of the smoke.

It follows from the above paragraphs that protection of the internal or external columns or roof has no impact on the fire safety of the occupants. The situation is identical to that likely to be experienced should a fire occur in an identical auditorium located at ground level (i.e. Situation B).

The greatest threat to the occupants is smoke. A steady state localised 5MW fire (all fires are localised to begin with) will generate sufficient smoke to reach the top of the upper seating tier after 2 minutes, the middle of the seating tier after 8 minutes, and be 2m from the floor after 10 minutes. It follows that if the occupants have not evacuated the building relatively quickly, they will be at risk. If the fire brigade has not arrived before the fire grows into a major fire (>5MW) then it is very unlikely that they will be effective in search and rescue due to the density and quantity of smoke. It is certain that human survival will not be possible within the building. A major fire such as this may threaten the structure, but the frames and roof will simply deform downwards and inwards as described in ref [1, 2]. This deformation cannot pose a threat to the rest of the building or the adjacent buildings.

Fire spread to other buildings is not an issue due to the spatial separation of buildings. This is already recognised by the BCA as the external walls are not required to have an FRL. Radiation from the roof will be less of an issue for this building than for a hypothetical Auditorium comprising one storey of construction at ground level, due to its height above surrounding construction, and therefore the fact that any radiation from the roof will be felt less by surrounding construction than if the roof was associated with a single storey building.

CONCLUSIONS

Within the auditorium, the absence of structural members and ceilings having the levels of fire resistance required by the deemed-to-satisfy provisions of the BCA will have a negligible effect on the level of fire safety offered to the building occupants or the fire brigade.

A comparative evaluation of the completed building (4 storey building with Auditorium at top level) and a hypothetical single storey Auditorium, has found that there is no significant difference in risk between the two buildings. It follows that the relevant deemed-to-satisfy provisions should be the same for both buildings. Since there is no evidence to justify an increase in the levels of fire resistance for single-storey auditoriums, it follows that the requirements for beams, columns, roof and ceiling (ie not required to have an FRL or a fire-resistant roof or ceiling), which are applicable for single storey buildings, should also apply to the auditorium in the proposed construction.

The proposed auditorium construction (see FIRE ENGINEERING section, paragraph 2) clearly complies with the BCA performance requirements.

REFERENCES

1. O'MEAGHER, A. J., BENNETTS, I. D., DAYAWANSA, P. H. AND THOMAS, I. R. (1992), "Design of Single Storey Industrial Buildings for Fire Resistance", Steel Construction, Vol. 26, No. 2.

2. O'MEAGHER, A. J., BENNETTS, I. D., DAYAWANSA, P. H. and THOMAS, I. R. (1991), "Fire Protection of Steel Framing", BHP Research - Melbourne Laboratories Report No BHPRML/CM7/90/001