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.

Unprotected Steel Beams

A rational fire engineering approach can offer significant cost savings by eliminating the need for passive fire protection of steel beams in high-rise building construction.

Council House, 27 St. George's Terrace, Perth was officially opened by Her Majesty Queen Elizabeth, in March 1963. The design for Council House was chosen in 1959 from more than 60 entries in an Australia-wide competition. Construction was completed at the end of 1962 at a cost of $2.9 million.

Almost 35 years after its official opening, it was decided to refurbish the building, to enable it to meet the commercial needs of the new millennium. Prior to refurbishment, the building, in its pleasant parkland setting, housed all of Perth's council offices, the Council Chamber, a civic reception area and the Lord Mayor's suite.

The existing building

The 12 storey steel-framed building incorporates steel columns and beams. The columns and some of the beams, particularly those extending around the perimeter of the building, are encased in concrete which was applied to a metal lathe. The other floor beams in the building and the length of the columns between the soffit of the floor and the ceiling were sprayed with asbestos- based fire protection material. The building contains non-load bearing masonry shafts which contain exit stairs, staff facilities and services. Exit stairs are located at both ends of the building. The lateral load resistance of the building is provided by two-way framing action from the steel columns and beams. Connections between the beams and columns are detailed as 'fully rigid' moment connections.

The floors of the building are generally glazed around the perimeter with the height of glazing approaching 3 metres. The plan dimensions of the floor are 16 metres by 53 metres.

In its original state, the building had no stair pressurisation and no sprinklers.

Typical floor construction consists of non-composite 115mm thick reinforced concrete slabs supported on 410UB60 secondary and 610UB140 primary beams with the beam grid being 7.5m x 7.75m.

All steelwork is 250 Grade. Columns include both fabricated and rolled sections.

The refurbished building

Council House is currently being refurbished and amongst other tasks, this necessitated the removal of the asbestos-based fire protection spray applied to steelwork. Perth City Council was faced with the decision of whether it would be necessary to again apply fire protection material to the steelwork, or have unprotected steel members. Two options were examined.

Background

1. Approach using current BCA deemed-to-satisfy requirements:

Upgrading the building to current BCA deemed-to-satisfy requirements would necessitate protection of the steel beams such that a fire-resistance level of 120/120/120 could be achieved by the floor beams. In addition, the building is required to be sprinklered and stair pressurisation provided. Such a building represents a situation which satisfies the minimum requirements of the BCA.

2. Approach using Rational Fire Engineering :

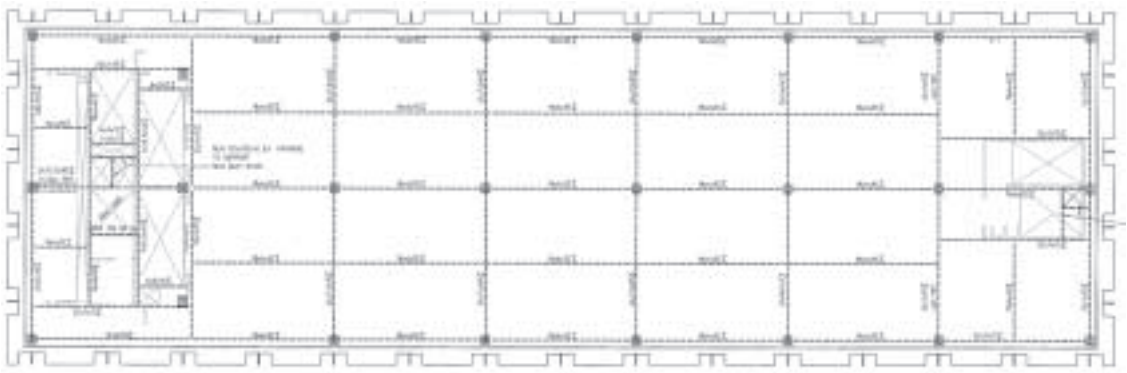
The possibility of leaving the steel floor beams unprotected was first considered in relation to the building at 140 William St in Melbourne. The fire safety of this building was considered by BHP Research - Melbourne Laboratories using a combination of fire tests and a comprehensive risk assessment. Other detailed studies of the building structure were also undertaken and reports have been published.

It was found that provided the refurbished building incorporated a sprinkler system with an improved level of reliability, the building with unprotected steel beams, would offer a higher level of life safety than that associated with a building which satisfied the minimum

Fire test at BHP Research, Melbourne Laboratories.

Top: Council House, Perth.

Right: 7th floor framing plan.



deemed-to-satisfy requirements of the BCA. The improvements to the sprinkler system for the proposed refurbished building included monitored subsidiary valves for each floor and a facility for testing the presence of water on each floor on a regular basis. The major uncertainty (albeit very small) associated with sprinkler systems for high-rise buildings, arises from the fact that parts of the system may be isolated to allow refurbishment and modifications during the life of the building. Thus, any means that reduce the number of floors isolated at the time of such work will improve the reliability of the sprinkler system compared with the conventional situation where multiple floors (and sometimes the entire building) are isolated each time such work is undertaken.

It was also found from the fire tests that a significant fire resistance was offered by the unprotected steel floors. The building at 140 William St has been refurbished on this basis as have at least three other high-rise buildings in Melbourne. This has resulted in major cost savings.

One such building is a residential building that incorporates plasterboard ceilings throughout. The others are predominantly office buildings. In all cases, specific management and maintenance requirements have been specified for the sprinkler system to ensure that the system is rarely isolated and is well maintained.

For all of the above situations, it had to be demonstrated that the proposed refurbished building (with unprotected steel floor beams) would offer a level of life safety equal to that associated with a building which satisfies the minimum deemed-to-satisfy requirements of the BCA.

Preferred option

The approach adopted for Council House was very similar to that described in the Rational Fire Engineering option – although there were some notable differences and a detailed study was undertaken by BHP Research. It was proposed that Council House be refurbished in accordance with procedures followed in the buildings mentioned above, with an improved sprinkler system being installed coupled with related management protocol. The steel beams therefore remain unprotected. However, since the lateral load resistance and stability of Council House is dependent on the framing stiffness of the structure (i.e. the building does not have a lateral load-resisting frame) it was also necessary to demonstrate, that should a fully developed fire occur on one level, the stability of the building would not be compromised. Such a fire could only occur if the sprinklers failed on that level. This is a very unlikely circumstance. Nevertheless, calculations of fire severity were undertaken taking into account the likely fire load and the geometry of the floor and window openings. As the building is narrow and has extensive glazing, the fire severity is quite limited. It was found that the stability of the building under lateral wind loads will be maintained in the event of a fully developed fire on one level.

The likelihood of fire spread between levels, in the event of a major fire on one level, is very much less for the refurbished building than if minimum BCA requirements had been adopted, due to the incorporation of subsidiary sprinkler valves for each floor and the associated management protocol for sprinkler isolation.

Versatility of steel beams

In terms of services, a new pipe and ducting layout was required which called for extra web penetrations to be cut and reinforced on site, in existing beams.

The existing building did not provide for sufficient air movement. The flexibility of steel allowed this problem to be overcome with the installation of additional ductwork in the building. "This would not have been easy had the building been constructed in concrete", said Abe Ashbil, Project Officer for the City of Perth.

Steel allowed all these changes to be made with minimal modification to existing structural elements and with minimal amounts of material needed to be brought on site.

Conclusion

It was concluded that the use of unprotected steel beams for Council House, in association with the improved sprinkler system and related management protocol, would give a level of life safety well in excess of the existing building and greater than that achieved if the building had been refurbished in accordance with the minimum requirements of the BCA. This conclusion was accepted by the relevant authorities (Perth City Council and West Australian Fire Brigades) and the building is being refurbished accordingly.

The above approach can be used for *new* construction as well as existing buildings subject to refurbishment. Each case needs to be considered carefully but a rational fire engineering approach can be used to offer significant cost savings by eliminating fire spray protection to steel beams in high-rise building construction.

Melbourne landmarks benefit from BHP fire research – 140 William Street, 1 William Street, 120 Spencer Street and 360 Collins Street.

Client:	City of Perth
Architect:	Peter Hunt & Daryl Jackson
Structural Engineer:	Connell Wagner
Mechanical Engineer:	Steens Gray & Kelly
Builder:	John Holland Construction & Engineering
Fabricator:	Metro Lintels