Crafty fire engineering cuts project costs

The redevelopment of an apartment block in the seaside suburb of Bronte in Sydney's Eastern Suburbs has clearly shown how fire engineering solutions allow for more economical designs along with better informed assessment of fire performance.

Built in the late 1960s and located less than 200 metres from Bronte Beach, the Winbourne project has been buffeted by coastal weather for decades like many coastal properties from this period, substantially degrading the building façades.

Collingridge & Associates Architects for the Owners Corporation and Arcadis collaborated to resolve a design that resulted in the balcony replacement and support revitalising the building façades without compromising the car parking arrangements in the basement.

As part of a major fire safety upgrade and replacement of all balconies at an estimated project value nearly $7 million, the new balconies are supported by an innovative lightweight steel structure 'hung' from the building's roof.

The project was being designed using 'deemed to satisfy' (DTS) BCA requirements which imposed unacceptable cost on the fire rating treatment for the structural steel so Arcadis advised that fire engineering consultants be engaged to assess fire protection requirements to develop cost saving strategies.

However, DTS fire protection installation quotations at tender exceeded the initial cost plan by a factor of 11. While an allowance of $180k was initially provisioned, these costs ballooned to a staggering $2 million - or nearly one-third of the total project value once tendered.

Technical Director at Arcadis, **John Merrick** said a key driver for the innovative structural design was the need to maintain existing carpark facilities in the basement as the centre-to-centre balcony column locations conflicted with the existing car park spacing.

"Ensuring the hanging columns terminated above the carpark facilities required the new balcony loads to be supported by the roof structure and in turn the internal load bearing masonry," he said.

"It was important for the new balcony support frame to be of lightweight steel construction to ensure the masonry was not overloaded. The support of an innovative design approach for their building by the Winbourne Owners Corporation was much appreciated."

Fire Engineering Design

"It is not an easy task to identify the fire protection costs associated with a particular structure, especially in the early stages of design, given that the structural design normally does not include fire generated thermal considerations," Merrick said.

"In many cases, it is not until the latter stages of the design that fire protection costs can be accurately priced and value engineering exercises undertaken.

"For high budget buildings, fire protection costs usually account for 20 percent of structural frame costs. It is not surprising then that for large buildings, fire protection can pose significant cost.

"By engaging an experienced costs planner, savings associated with value fire engineering for a particular structure can be identified early.

"Projects adopting fire engineered solutions can usually adopt fire resistance level (FRL) requirements which are less arduous than the DTS provisions."

He said the ASI book, *Design aspects for construction – Composite Steel Framed Structures* (Clause 5.1.4) is a useful reference detailing the benefits of such solutions.

"A beneficial side-effect, often not considered with fire engineering solutions, is that the associated analysis can often flag potential weaknesses of structural design and the impact of scenarios not comprised within the concept of a typical compartment fire. For example, if a fire occurs over two levels due to the failure of an active fire protection system," Mr Merrick said.

"The benefits of undertaking a fire engineering assessment are two-fold: less over-dimensioned definition of fire proofing and an informed assessment of fire performance rather than an assumed one."

Arcadis worked with fire engineers, Stephen Grubits & Associates to undertake a structural analysis of steel members at elevated temperatures which took three weeks to complete.

According to Arcadis structural engineer **Nicolas Roe**, assessing how much a structural member is used in a fire limit state through a single member analysis is a common approach.

"We assessed each structural element in isolation and used the fire engineers' outputs from fire modelling software which predicted the maximum temperatures in an ultimate fire case, determining the loss in steel strength as per AS 4100 Clause 12.4," Mr Roe said.'

"We noted that despite a loss in steel strength of 50 to 70 percent in most structural members, the structure maintained integrity which we attribute to lower loading requirements in ultimate fire conditions and the choice of larger sized steel members at project outset to facilitate ease of construction.

"Design studies on fire protection should review whether it would be more economical to use slightly heavier structural members which may allow the fire rating to be achieved with a reduced volume of fire protection materials (or none at all) and therefore at a reduced overall construction cost.

"For this project we were lucky that the steel members were sizeable and had sufficient residual capacity as we were able to reduce the overall fire protection costs from a total of $2 million down to $22,000 - the cost associated with undertaking the fire analysis."

He said that with the emergence of performance-based design, a new breed of structural engineers have embraced the premise of robust design at elevated temperatures.

As demonstrated by the Bronte project, fire impact analysis is becoming a more intrinsic component of structural engineering which should not be confined solely to the realm of big-budget projects and should be undertaken as early as possible in the design process.