BUILDING PERFORMANCE

Practice Advisory 18: Fire safety design for tall buildings

It's important that reliable and resilient fire design features are used in the design of tall buildings. This advisory highlights the specific considerations for designing tall buildings to achieve the fire safety performance requirements of the Building Code.

This information was confirmed as current in December 2016.

Published on 6 July 2016

Of interest to Building owners, Building services engineers, Building consent authorities, Developers, Architects, Structural engineers

This Practice Advisory is issued as guidance information in accordance with section 175 of the Building Act 2004 and, if used, does not relieve any person of the obligation to consider any matter to which the information relates according to the circumstances of the particular case. This document is not a compliance document in terms of the Act and not a substitute for professional advice.

Purpose

To highlight the specific considerations for designing tall buildings to achieve the fire safety performance requirements of the Building Code.

Background

This guidance is provided for fire design of tall buildings. There is no single all-purpose definition for the height of a tall building (different heights affect the design of different parts of the fire system). However, recent proposals for buildings much taller than current New Zealand structures have focussed attention on the need to consider the unique challenges for fire safety design.

Tall buildings present specific challenges:

- Typically, the building design provides safe means of escape from fire for all occupants in the same single direction (downwards). Similarly, firefighter access is restricted to occur in the opposite direction (upwards), which differs from low-rise buildings which may offer access (and egress) to multiple sides of the building.
- As the height above ground increases, this directly influences the time to descend to disperse (and ascend) from a place of safety outside the building. The timeframes associated with fire egress and firefighter access dominate the performance requirements for the fire safety solution for tall buildings.
- Although extended egress and firefighter access times are not restricted to tall buildings, the shape and height of tall buildings usually constrain the options for avoidance strategies in a fire emergency (eg all alternative escape routes usually still involve descent through the enclosure of fire origin).

Designers should consider these specific tall building challenges carefully and adopt solutions with appropriately increased effectiveness, reliability and resilience. Occupant load, occupancy type, building use and building height will all influence the range and types of solution to protect occupants, firefighters and other property. The reduced tolerance for an adverse consequence in a fire event needs to be matched by providing more reliable and effective fire safety systems. For example, recent overseas tall building fires have highlighted the vulnerability of rapid external fire spread resulting from poor choices of external cladding.

Scope and application

This Practice Advisory is issued as guidance under section 175 of the Building Act 2004 to assist designers to comply with the performance requirements of the Building Code for tall buildings. The specific issues relating to fire design and tall building vary with building type and height. In buildings where firefighters need to commit to an internal fire-protected access route for firefighting operations, maintaining structural stability is necessary for their protection through the duration of the fire (to withstand complete burnout of a firecell).

For buildings taller than around 70 metres in height (or 20 levels, being the height limit for using an Acceptable Solution), the consequences of the more challenging physical effort to descend stairs or to move vulnerable or less mobile occupants need to be explicitly considered.

The C/VM2 framework does not explicitly highlight additional considerations for buildings taller than what has been the current norm in New Zealand. MBIE, in partnership with the Society of Fire Protection Engineers (SFPE) is undertaking a review of the Verification Method C/VM2 to make it clear and explicit that these issues are addressed. It is expected the proposed changes to C/VM2 will be available for public consultation by the end of the year. MBIE is also developing further guidance on the Fire Engineering Brief (FEB) process, also in partnership with SFPE.

In the interim, specific consideration of structural stability, fire severity for full burnout, firefighting facilities, evacuation procedures and resilience of fire systems should be included during the FEB process.

Objective

Do use a Fire Engineering Professional with relevant qualifications and experience and an equally competent Peer Reviewer to test the design complies with the Building Code.

Do carry out a thorough FEB process involving all key stakeholders early in the design process to enable an appropriate risk-informed design to be developed.

Do specifically consider:

- structural stability
- fire severity for full burnout
- firefighting facilities
- evacuation systems
- resilience of fire systems.

International guidance

A useful reference for identifying appropriate fire safety measures for high-rise buildings is the Society of Fire Protection Engineers Engineering Guide: Fire safety for very tall buildings.

Engineering Guide: Fire safety for very tall buildings (https://www.sfpe.org/store/ViewProduct.aspx?id=4603146) can be purchased from the Society of Fire Protection Engineers' online store.

In the United Kingdom, the recently updated draft amendment to BS9999 recognises the need for additional measures in tall buildings, stating that "… the increased demand on structural integrity, services, fire safety systems, means of fire-fighting and evacuation … might mean that specific evaluation of all fire safety provisions is needed using a qualitative design review in accordance with BS 7974. This is to determine whether the recommendations of BS9999 are appropriate, or whether a full fire engineered solution is required."

Structure stability, resilience and fire resistance

The protracted time usually required for occupant evacuation and firefighter operations requires the structure of tall buildings to remain stable for the full duration of a fire. Overall global structure instability is not an acceptable performance outcome while occupants or firefighters are in the building, or where structural collapse due to the effects of fire causes damage to other property. A cautious assessment of the fire severity associated with complete fire burnout and design strategies for maintaining structure stability is needed. This structural fire performance requirement applies to tall buildings in order to comply with Building Code Clauses B1 and C6.

Therefore, structural systems in tall buildings need to be designed to remain stable for the complete duration of a fire (for complete burnout and cooling to ambient temperature) to maintain safe access and egress for firefighters and building occupants. Consequential collapse of elements not required for structural stability must not compromise occupant safety or firefighting access. This usually requires particular attention to fire resilience of shafts containing stairs and lifts used for fire egress and firefighter access, and areas adjacent to final exits. The likelihood and consequence of fire in podium spaces, car parks, transportation hubs, retail areas and similar spaces at lower levels of tall buildings need to be considered to the extent it affects overall structural stability.

Useful guidance is provided in the following publications:

- Eurocodes: Background & Application Structural Fire Design - worked examples 2014 (http://eurocodes.jrc.ec.europa.eu/doc/2012_11_WS_fire/report/2012_11_WS_fire.pdf) on the EN Eurocodes website.
- Best Practice Guidelines for Structural Fire Resistant Designs of Concrete and Steel Buildings 2010 (http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1681.pdf) on the United States' National Institute of Standards and Technology website.
- SCI Publication P288: Fire safe design: A New Approach to Multi-Storey Steel-Framed buildings (Second edition) 2000 (http://www.newsteelconstruction.com/wp/fire-safe-design-a-new-approach-to-multi-storey-steel-framed-buildings-second-edition/) on the New Steel Construction website.

Fire fighting access and facilities

Firefighting operations in tall buildings present a challenge for the Fire Service because firefighters typically need to move equipment vertically in the building. Firefighters often stage operations from a floor below the fire floor and use hydrant outlets in one or more stairwells to feed hoses to the fire floor. They might use a lift to evacuate occupants who need assistance. With increasing height and distance, greater reliance is placed on effective radio communication. Specific facilities to support fire service operations may be needed, such as fire-protected lift systems to facilitate firefighter access and operations, resilient firefighting water supply systems and smoke protected lobbies.

Phased evacuation and evacuation to a place of safety inside the building

A variety of evacuation strategies are used in tall buildings, including evacuation to a place of safety inside the building, phased/sequenced evacuation, relocation and defend in place (refuge areas/floors), and complete simultaneous evacuation. Evacuation strategies need to account for the increased time required to evacuate part or all of the building, and may need to consider additional egress capacity to compensate for reduced availability of a stairwell due to firefighting operations. Depending on the type of occupancy and occupant load, evacuation strategies may use refuge areas, allow lifts to be used for evacuation, or combinations of approaches, to ensure occupants can eventually reach a place of safety outside the building.

Systems which provide situation awareness are essential for firefighters, and for occupants whose evacuation procedures are delayed or managed using sequencing or refuge areas.

Effectiveness and resilience of systems

Increased escape times and complexity around firefighting operations for tall buildings mean there is an increased reliance on the effectiveness and resilience of the overall fire safety system. Failure of components which are critical to the effectiveness of the fire strategy may need additional resilience, including: redundant power supply to lifts used for evacuation of occupants and/or the Fire Service; dedicated or dual independent firefighting water supplies; risers for control systems; and alerting and communication systems.

Depending on the height and construction of shafts, internal smoke and fire spread vertically in riser shafts may have more onerous consequences in tall buildings compared with low-rise buildings. Increased resilience of systems to mitigate this may be required.

External cladding systems

The adverse consequence of extensive external fire spread involving external cladding containing combustible materials (such as coatings and insulation) is more significant for tall buildings. Recent overseas fires in tall buildings have highlighted the vulnerability of rapid external fire spread resulting from poor choices of external cladding.

Fire Engineering Brief (FEB)

The Building Consent Authority, peer reviewer and the New Zealand Fire Service are key stakeholders in the FEB process. The fire safety issues relating to tall buildings noted above should be considered in the FEB process so they can be included in the building consent documents.

The key fire safety issues, assumptions, decisions and requirements for the design of tall buildings should be included in the documents of record. In deciding whether to approve a building consent application for tall buildings, the Building Consent Authority will evaluate whether the building consent documents have addressed Building Code's performance requirements.

All guidance related to B1 Structure (https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/)