

Fire safety in multi-storey apartments

Is New Zealand striking the right balance of fire safety measures in multi-storey apartment buildings? We look at requirements in several countries to see how we compare.

AS THE NUMBER of multi-storey apartment buildings in New Zealand grows to meet increasing housing needs, is an acceptable level of fire safety provided? A risk-informed basis for fire resistance requirements in densified housing in Aotearoa New Zealand is being investigated to help answer this question.

A useful starting point is to compare our regulatory settings to other jurisdictions with similar societal expectations and regulatory systems but greater numbers of buildings, people and fires.

This article compares prescriptive requirements in New Zealand with those in Australia, Canada, the United States and England and asks do we have the balance between competing goals right? Requirements include structural fire resistance, combustible and non-combustible construction and using automatic sprinklers in multi-storey apartment buildings.

Regulate by disaster?

Following the 2017 Grenfell Tower fire in London and other well-publicised international cladding fires, a critical re-examination of fire safety in multi-storey buildings has been under way around the world.

In England, the Building (Amendment) Regulations (2018) resulted in an in-effect ban on combustible materials within external walls of buildings above 18 m that contain dwellings. In addition, fire sprinklers were required by the prescriptive guidance for blocks of flats taller than 11 m.

In some jurisdictions, retrofit programmes to remove combustible cladding on existing buildings have been undertaken to reduce a fire risk judged to be intolerable. This is costing billions of dollars in places like England and the Australian state of Victoria. Contributory costs for some individual apartment owners have been comparable

to those experienced in New Zealand for leaky buildings.

Performance-based versus prescriptive fire design

New Zealand was an enthusiastic adopter of performance-based fire safety engineering when the New Zealand Building Code came into force in 1992. This allowed Code compliance to be established either by following prescriptive (or deemed-to-satisfy) Acceptable Solutions or by demonstrating compliance with performance-based criteria using an alternative approach.

Performance-based approaches were intended to allow new materials and approaches to be adopted, while the prescriptive requirements established a benchmark for acceptability.

The Acceptable Solution fire safety design requirements were established based on ➤

Storeys	New Zealand		USA		Australia		Canada		England**	
	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers	With sprinklers	Without sprinklers
20	30		180		90		120		120	
19	30		180		90		120		120	
18	30		180		90		120		120	
17	30		180		90		120		120	
16	30		180		90		120		120	
15	30		180		90		120		120	
14	30		180		90		120		120	
13	30		180		90		120		120	
12	30		120		90		120		120	
11	30		120		90		120		120	
10	30		120		90		120		120	
9	30	60	120		90		120		90	
8	30	60	120		90		120		90	
7	30	60	120		90		120		90	
6	30	60	60		90		60		60	
5	30	60	60		90		60		60	
4	30	60	60		90		60		60	60
3	30	60	0*		90	90	45	45	60	60
2	30	60	0*		90	90	45	45	30	30
1	0*	0*	0*	§	0*	0*	0*	0*	0*	0*
	FRR	FRR	FRR	FRR	FRR	FRR	FRR	FRR	FRR	FRR

§ International Residential Code can be used for one and two-family dwellings and townhouses up to 3 storeys without fire sprinklers.

* FRR may be required to protect tenancies and egress routes, or to limit fire spread across boundaries.

** Approved Document B only applies to 'common building situations' and may not apply to some buildings with a combustible structure.

Key:

- Combustible materials generally permitted.
- Fire-protected timber (typically requires two layers of fire grade plasterboard).
- Fire-protected timber (limited areas of wood can be exposed on walls and ceiling).
- Non-combustible materials required.
- Primary structure can be combustible, except external wall (unless proven by test).
- Primary structure can be combustible except external wall.

Figure 1: FRR (in minutes) for the primary structure of apartment buildings of all material types based on prescriptive solutions for buildings up to 20 storeys. Information is indicative only as requirements may also depend on other factors, such as the number of escape routes.

the knowledge, societal expectations, construction practices and building demographics at the time. The quarter-acre approach with well-separated single-family homes was still by far the most prevalent New Zealand housing solution at the time.

Tall residential building structures generally used non-combustible materials by default. Fire resistance rating (FRR) requirements were based on simplified fire severity calculations that accounted for the assumed fuel loads and the expected ventilation in a fire. Some changes have been made to these requirements over the intervening 30 years but mainly to simplify and remove the need for calculations to be done as part of the Acceptable Solution.

New Zealand also prioritised FRRs over combustibility - as did England - and has had few restrictions on using combustible materials provided construction elements achieved the specified FRR as demonstrated in standard fire resistance tests.

In contrast, prescriptive requirements in Australia, Canada and the US have had more stringent controls on the use of combustible materials in residential buildings of more than a few levels. They have also typically required greater FRRs compared to New Zealand, especially for taller buildings of all materials.

Mass timber buildings bring challenges

The use of combustible building materials can contribute to creating buildings that are cost-effective, healthy, sustainable, functional and with low associated carbon emissions. They also may lead to potential fire safety issues when allowed to contribute fuel to the fire. For example, mass timber construction can potentially provide the benefits above, but it also has associated fire safety challenges that are the subject of ongoing research around the world.

Mass timber structures can be designed with excellent structural fire resistance, but when calculating the fire load, it is important to include the contribution of large wood surfaces that are not protected. It may also be necessary to consider any charring that occurs as the fire decays.

Performance-based alternative methods have been used to construct demonstration mass timber buildings internationally. This has led to recent amendments that relax the tough prescriptive building regulations in Australia, Canada and the US by permitting the construction of taller mass timber buildings. Generally, this has required fire sprinklers to be installed and non-combustible linings - such as plasterboard - to be applied to some of the mass timber in medium-rise buildings.

How do we compare to other countries?

Figure 1 provides a comparison of the FRR (in minutes) for the primary structure of apartment buildings of all material types based on prescriptive solutions in selected countries for buildings up to 20 storeys. Height limits for permitted use of combustible materials are also shown. These prescriptive requirements are based on the following:

- New Zealand - New Zealand Building Code Acceptable Solution C/AS2 (2020).
- USA - International Building Code (2021). The International Residential Code can be used for one and two-family dwellings and townhouses up to 3 storeys without sprinklers.
- Australia - National Construction Code 2019.
- Canada - National Building Code of Canada (2015 + 2020 Amendments).
- England - The Building Regulations Approved Document B Volume 1 (2020).

While Figure 1 indicates the FRR for the primary structure, the inter-tenancy walls between occupancy units can often be a lesser rating - for example, 60 minutes for the USA and Australia.

Some observations from Figure 1 apply to buildings of all materials (combustible and non-combustible):

- For apartment buildings taller than 6 storeys, the FRR required in New Zealand is significantly lower than the other countries. This is a concern for taller buildings where occupant escape times are longer. Additionally, in most locations in the country, the fire service does not have

equipment to externally access upper levels of buildings over that height.

- For apartment buildings up to 6 storeys, the FRR in New Zealand is similar to other countries when not sprinklered but often lower for the sprinklered case.
- The building height at which fire sprinklers are required for apartments is 25 m or about 9 storeys in New Zealand. This is higher than for the other countries in Figure 1, where the threshold is typically 3 or 4 storeys.
- Unprotected combustible materials use is generally restricted to lower heights in the other countries, particularly for unsprinklered buildings.

What is best for New Zealand?

New Zealand Building Code Acceptable Solution C/AS2 has not kept pace with the growing demand for taller apartment buildings, the increased desire to use combustible materials and the considerable worldwide research to better understand their fire performance. This is concerning for tall buildings, particularly when considering the combination of low FRRs with the lack of any requirement to consider the contribution of large unprotected wood surfaces.

Although well-maintained fire sprinkler systems are a critical fire safety measure in taller buildings, they are only part of a package of fire safety measures. Current levels of structural fire safety in new tall multi-storey apartment buildings of all materials in New Zealand, when constructed to the minimum Acceptable Solution requirements, appear to fall short of the other countries discussed.

Do New Zealanders expect their homes to be as fire safe or resilient as those in other comparable countries? Are we willing to tolerate higher levels of fire risk to meet other goals such as affordability or a low-carbon future?

The challenge is to find the balance that works best for New Zealand. ◀

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