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Mid-rise Timber Buildings
Multi-residential
Class 2 and 3

Technical Design Guide issued by Forest and Wood Products Australia

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Introduction

The National Construction Code Volume One, Building Code of Australia 2019 (NCC), allows the use of timber construction systems under the Deemed-to-Satisfy (DTS) Provisions for all buildings up to 25 metres in effective height ('mid-rise construction', see Figure 0.1).

The DTS provisions cover both traditional 'lightweight timber framing' and 'massive timber' products such as Cross-laminated Timber (CLT) in conjuction with the use of appropriate non-combustible fire-protective coverings – termed 'fire-protected timber' in the NCC – and the use of appropriate compliant automatic sprinkler systems. With mid-rise timber construction design, fire and sound are two of the major considerations: appropriate fire-resisting construction is critical to providing acceptable levels of fire safety, while sound or acoustic performance is essential because of its daily impact on inhabitant amenity and quality of life.

This Guide applies to Class 2 and 3 Residential Buildings or parts of buildings. It aims to assist in providing specific advice on both of these areas and is specifically written for use by designers, specifiers, builders, regulatory and certifying authorities. It is set out according to a simple step-by-step process as presented in Figure 0.2. The steps are then used as the basis for headings throughout the main body of this Guide. Details on the scope and other important aspects of the Guide are set out below.

Scope

This Guide explains how to achieve the targeted fire and sound Performance Requirements in the National Construction Code (NCC) for Class 2 (apartments) and Class 3 (e.g. hotels, motels) mid-rise timber buildings using the Deemed-to-Satisfy pathway for fire-protected timber introduced in the 2016 edition of the NCC, with further developments included in the 2019 edition.

Mid-rise timber buildings are typically 4 to 8 storeys high

Low-rise timber buildings
are buildings of:

- Type C construction (1 or 2 storey)

or

- Class 2 and 3 buildings up to 3 storeys; 4 storeys if the ground level is a concrete or masonry garage. (Timber concession)

Mid-rise timber buildings
have an effective height of not more than 25 metres

Typically, they are 4-8 storeys high (the maximum number of storeys depends on the floor-to-floor height)

High-rise timber buildings
have an effective height greater than 25 m.

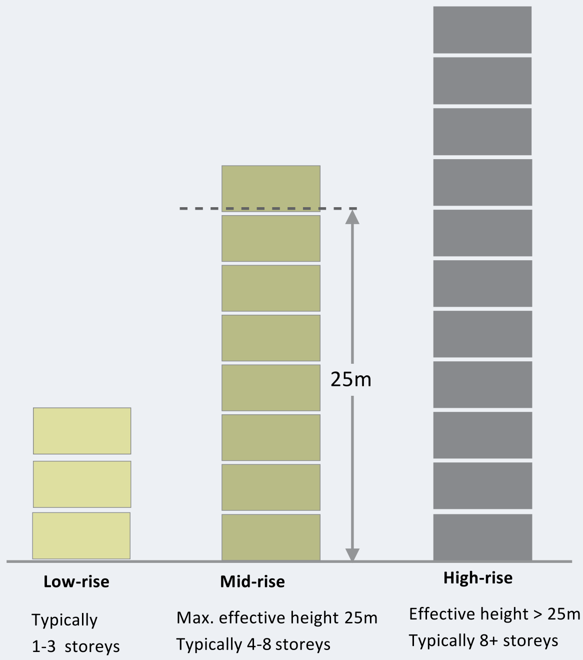


Figure 0.1: Comparison of low, mid and high-rise buildings.

The guide provides some advice relating to good practice where the NCC leaves off in areas of increasing interest to users

This Guide specifically focuses on:

- sound insulation of wall, floor and ceiling elements relevant to sole-occupancy units (SOUs) and surrounding construction in multi-residential buildings
- fire-resisting construction (including fire-protected timber provisions) of wall, floor and ceiling elements for multi-residential and office buildings
- additional fire safety measures required for mid-rise timber buildings.

In addition, this Guide provides advice on good practices to facilitate compliance, ease of maintenance and enhancements to the minimum NCC prescriptive provisions relating to fire and sound.

This Guide does not deal with all aspects of fire safety and sound insulation. Nor does it provide advice on which specific wall, floor and related systems should be used as there are many suppliers of proprietary systems and the intention is to encourage innovation. Generic details are provided for demonstration purposes. Before adopting these details, designers should check the availability of appropriate Evidence of Suitability with the material suppliers and, if necessary, modify the details accordingly.

Design Process for Sound- and Fire-Resisting Construction

Although national, some NCC provisions vary by State. It is vital to know the applicable provisions

Regulatory Differences between States and Territories

This Guide focuses on the NCC requirements of the 2019 edition. From time-to-time, State and Territory-based NCC amendments or other State legislation may vary requirements. Users of this Guide should make themselves aware of any differences and should develop a full understanding of the resulting implications. This Guide should be used on this basis.

Timber Construction Options for Mid-rise Timber Buildings

General Construction Options for Timber Buildings

A number of timber system options are available for the construction of mid-rise timber buildings with a range of possible options shown in Figure 0.2. Note: Under the NCC DTS provisons only fire-protected timber building systems are permitted, where an element is required to be of non-combustible construction or of masonry or concrete construction.

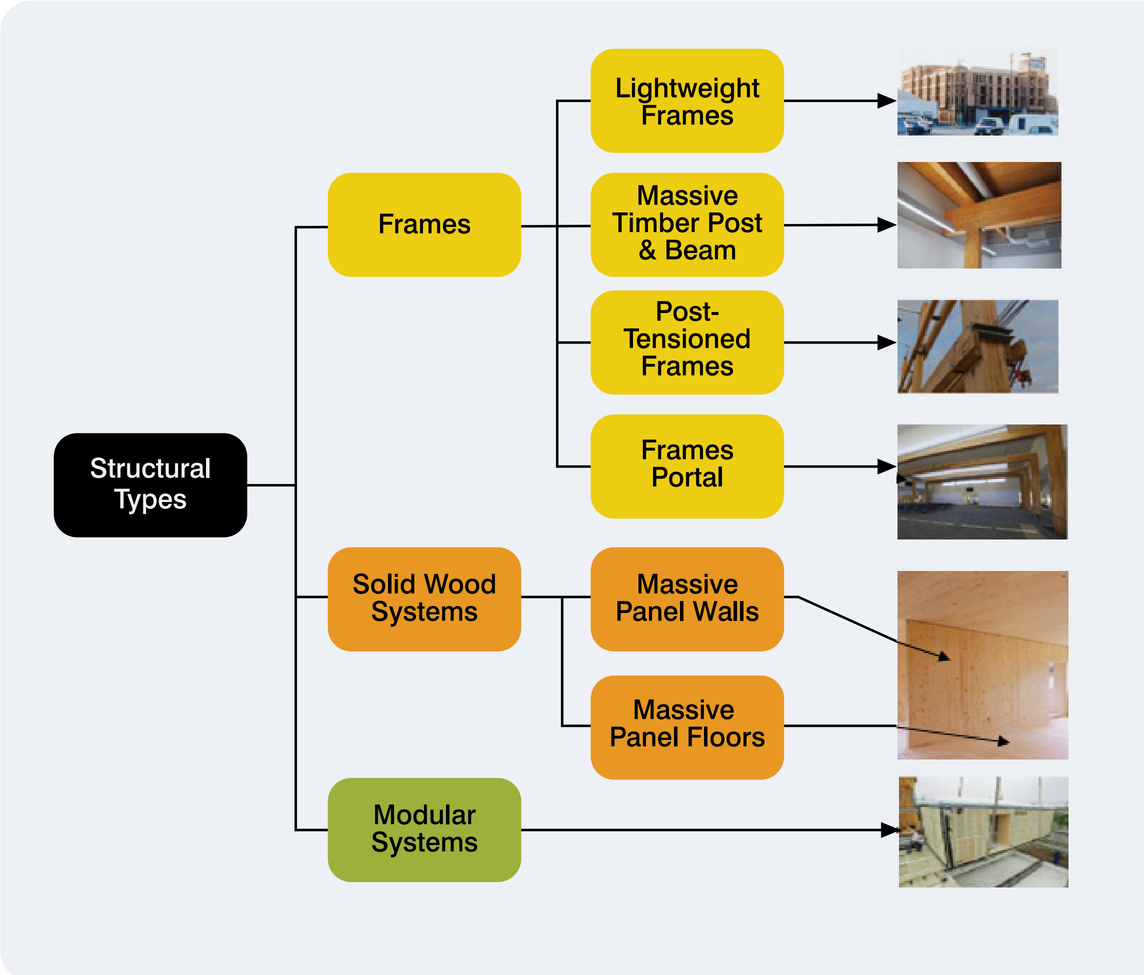
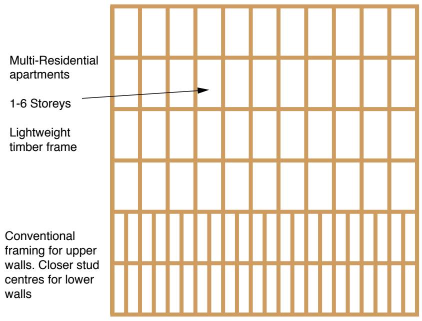


Figure 0.2: Summary of structural timber construction options.

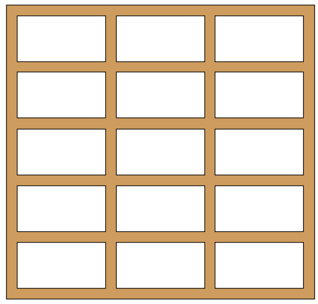
Note: No exposed structural timber is currently permitted under Deemed-to-Satisfy Provisions where an element must be of non-combustible construction.

The most appropriate system is influenced by the function and floor plan of the building.

- In general, apartment (Class 2) and hotel/motel (Class 3) buildings tend to have sole-occupancy units (SOUs) or individual rooms with quite closely spaced walls. In effect they form a 'honeycombed' structure with many individual load paths and, as such, the use of lightweight timber-framed systems (up to around six storeys) combined with fire- and sound-rated plasterboard is an effient form of construction. Alternatively, a solid wood system, or a mixture of solid and lightweight timber construction might be considered.



- Commercial buildings by contrast generally require larger open-plan spaces for either work amenity or flexibility in fitout and as such these buildings are often constructed utilising a post and beam approach for the overall structure and non-loadbearing lightweight partitions as needed. Typically, the main columns and beams might be constructed using glued-laminated timber (Glulam) with floors being either lightweight prefabricated cassettes or solid massive panel floor plates.



There are significant efficiency, speed and cost benefits in using timber structural systems compared to alternative material such as reinforced concrete. These include:

- Reduced on-site construction infrastructure (preliminary costs) such as fixed cranes, site accommodation, storage areas, scaffolding and edge protection, hoists, etc.
- Direct savings from faster methods of construction compared to traditional steel and concrete structures due to:

  – increased scope for off-site prefabrication and panelisation, and

  – lighter and more easily manoeuvred and installed materials.
- Reduced foundation requirements due to a lighter above-ground structure.
- Significantly reduced on-site costs and Work, Health and Safety (WHS) issues, particularly with a shift to more prefabricated solutions.
- Increased ability to commence follow-on trades earlier in the construction process, reducing the overall construction time.
- Increased accessibility of the construction site and significantly lower impacts of noise and site activities on local neighbourhoods (less truck movements); a major benefit for suburban multi-residential developments.

Detailed information on the specific construction cost benefits of timber systems in different Class buildings can be found in the following WoodSolutions Technical Guides:

Further information on the cost benefits of using timber can be found in the Rethinking Series of WoodSolutions Design Guides

#26 Rethinking Office Construction – Consider Timber – a material cost comparison of a typical office building

#27 Rethinking Apartment Building Construction – Consider Timber – a material cost comparison of a typical apartment building

#28 Rethinking Aged Care Construction – Consider Timber – a material cost comparison of typical aged care accommodation

#29 Rethinking Industrial Shed Construction – Consider Timber – a material cost comparison of a typical industrial shed.

The NCC prescriptive Deemed-to-Satisfy (DTS) solution for mid-rise buildings requires non-combustible fire-protective coverings to be applied to timber elements.

Refer Section 4.3

Fire-protected Timber Options for Mid-rise Timber Buildings

Whichever timber construction option is selected the prescriptive Deemed-to-Satisfy (DTS) solutions for mid-rise timber buildings require timber members to be fire-protected, where an element is required to be of non-combustible construction or concrete or masonry construction..

The 'general timber' requirements that apply for fire-protected timber are:

- the building element must be protected to achieve the required FRL, and
- a non-combustible fire-protective covering must be applied to the timber that achieves a Resistance to the Incipient Spread of Fire (RISF) of not less than 45 minutes when tested in accordance with AS1530.4.

The NCC permits a 'relaxation' to the general requirements in the case of fire-protected massive timber panels if the following additional criteria are satisfied:

- the timber panel is at least 75 mm thick, and
- any cavity between the surface of the timber and the fire-protective covering is filled with non-combustible materials.

If both these conditions are satisfied it is still necessary for the fire-protected timber member to achieve the required FRL and have a non-combustible fire-protective covering. However, the thickness of the fire-protective coverings, based on the covering's RISF performance, can be modified depending on the application (e.g. internal SOU wall, external wall).

The basis for allowing specific provisions for massive timber panels is that timber with a large cross-section can achieve high fire-resistance due to the formation of a char layer that protects the timber core and allows it to continue to support an imposed load or maintain a fire separating function for significant periods. If there is an early failure of the fire-protective covering, the timber structure is likely to maintain its loadbearing capacity for longer than lighter forms of construction; and by not permitting any concealed spaces between the massive timber members, or between the timber and fire-protective coverings, the risk of fire spread is addressed.

Further details relating to fire-protected timber are provided in Section 4.3.

The different timber construction systems generally use one or more of a range of different sawn or engineered timber products, including:

- Sawn timber – softwood (MGP) and hardwood (F- and A-graded).
- Engineered timber – particleboard, plywood, Oriented Strand Board (OSB), Laminated Veneer Lumber (LVL), Parallel Strand Lumber (PSL), I-beams, fabricated floor and roof trusses, Glued Laminated Timber (Glulam) and Cross-laminated Timber (CLT).

Depending on the dimensions of the element and configuration, some of these construction systems may satisfy the requirements that allow the massive timber provisions to apply.

Timber-framed Construction

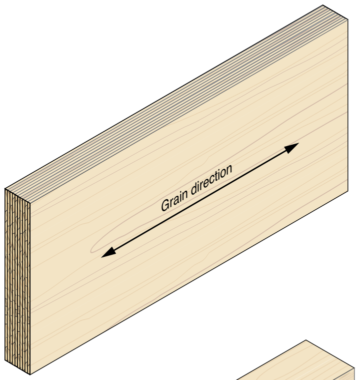
Lightweight timber-framed construction systems use commonly available structural timber framing products assembled into lightweight systems such as wall frames, floor and roof trusses, and prefabricated cassette floor modules.

Sawn Timber Products

Sawn timber products include seasoned structural softwood (MGP10, 12 & 15) or seasoned structural hardwood (typically F17 or F27). Typical thicknesses are 35 and 45 mm and depths include: 70, 90, 120, 140, 190, 240,* and 290* mm.

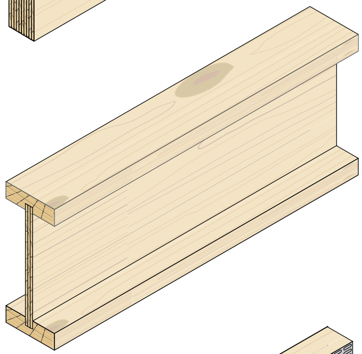
* available on order

Laminated Veneer Lumber (LVL)



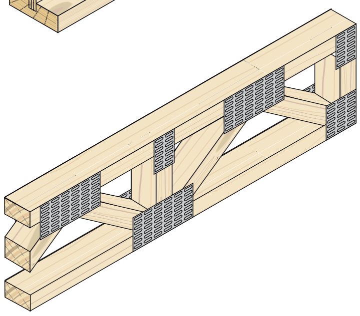
Lightweight framing elements are available in Laminated Veneer Lumber (LVL), a widely used softwood engineered wood product, available in all the standard framing sizes. LVL is manufactured by bonding together rotary peeled or thin sliced wood veneers under heat and pressure. As LVL is typically used in a beam or stud application, the grains of the veneers are all oriented in the same direction. LVL is typically manufactured in slabs 1200 mm wide, known as billets, which are then cut into the commonly available framing member depths required. LVL is typically manufactured in lengths up to 12 metres in 0.3 metres increments.

I-Beams



I -Beams are lightweight, high-strength, long-span structural timber beams. They typically comprise top and bottom flanges of LVL or solid timber – which make the distinct shape. The flanges are separated by a vertical web, usually manufactured from structural plywood, Oriented Strand Board (OSB) or light gauge steel. Typical depths are: 200, 240, 300, 360 and 400 mm and lengths are available up to 15 metres.

Parallel Chord Trusses

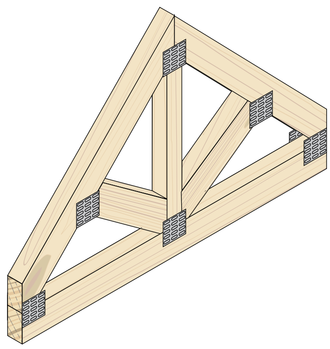


Parallel Chord Trusses are similar to I-beams in that they have top and bottom chords (flanges) of LVL or solid timber but instead of solid webs, web struts are used.

The struts may be either timber or light gauge steel and are secured to the chords typically with nailplates. The struts may be diagonal (more common for steel struts) or a mix of vertical and diagonal (more common with timber struts).

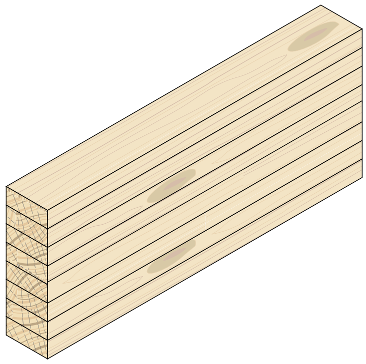
Figure 0.3: Hybrid floor system with parallel-chord trusses supported from a steel I-beam.

Roof Trusses



Timber roof trusses provide an engineered roof frame system designed to carry the roof or roof and ceiling, usually without the support of internal walls. The characteristics of a roof depend on the purpose of the building it covers, the available roofing materials and the wider concepts of architectural design and practice. Light truss roofs are formed from sawn or LVL timber elements connected with nailplates or other mechanical fixings designed and supplied by frame and truss manufacturers.

Glued-laminated Timber (Glulam)



Glued-laminated Timber (Glulam) consists of a number of strength graded, kiln-dried laminations face bonded and finger-jointed together with adhesives. Elements can be manufactured to practically any length, size or shape: beams are often manufactured with a built-in camber to accommodate dead load deflection or curved for aesthetic appeal.

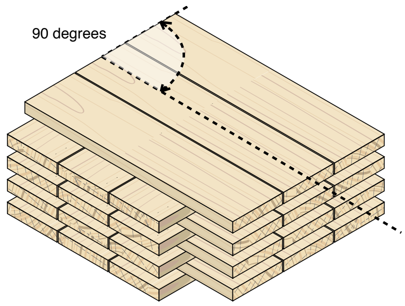
A range of GL Grades are produced in Australia or imported depending on the timber species used in manufacture: GL10 (Cypress), GL13 (Radiata Pine, Oregon), GL17 (Slash Pine, Merbau), GL18 (Tas Oak, Vic Ash), GL21 (Spotted Gum) – the GL descriptor refers to the element's Modulus of Elasticity (E), i.e. GL10 describes a Glulam member that has an E-value of 10GPa.

A wide range of depths are available in increments from 90 mm to over 1,000 mm; and thicknesses from 40 mm to 135 mm; with 65 mm and 85 mm being two commonly used. Lengths up to 18 metres are available in 0.3 metre increments from traditional suppliers and up to 27 metres in length from specialist manufacturers.

Solid Massive Wood Panel Construction Systems

Solid wood panel construction systems utilise massive timber engineered wood panels such as Laminated Veneer Lumber, Cross-laminated Timber (CLT), or Glue/nail-laminated Mass Timber panels, in minimum panel thicknesses of 75 mm when used in accordance with the NCC DTS provisions. Solid wood panels can be used to form complete floors, walls and roofs and construction methods have more in common with precast concrete panels than timber framing; except that timber panels are much lighter, more easily worked and easier to erect.

Cross-laminated Timber (CLT)



Cross-laminated Timber (CLT) utilises individual planks of timber 12-45 mm thick and 40-300 mm wide face-glued together (and edge-glued in some instances), each layer at 90° to its neighbouring lamella; effectively 'jumbo plywood'. CLT panels are typically 57 mm – 320 mm thick and made up of 3, 5, 7 or 8 layers depending on application. Panels are available in 2.2 to 2.95 metres wide and up to 11.9 metres in length (dictated mainly by shipping containers as all product used in Australia is currently imported).

More detailed information on CLT can be found at the WoodSolutions website or in *Technical Guide #16 Massive Timber Construction Systems: Cross-laminated Timber (CLT)*, which introduces the use of CLT in construction and provides an overview of CLT building systems as well as fire, acoustic, seismic and thermal performance.

Prefabrication and Modular Wood Construction Systems

A major benefit in utilising timber structural systems in mid-rise construction is the ability to prefabricate off-site and manufacture frames or cassettes, panelised elements or full volumetric modules to minimise the on-site construction requirements and costs.

Prefabricated Cassette Floor Systems

Prefabricated Cassette floor systems utilise a range of timber structural products, typically for flooring (particleboard, plywood or OSB panels) and for floor joists and bearers (sawn timber, LVL, OSB beams, floor trusses or I-beams). Cassettes tend to be around 3 metres wide and up to around 12 metres long (due to travel restrictions). Cassette floor systems are highly effective in mid-rise construction as they are extremely fast to install and far safer for on-site workers, dramatically reducing 'fall-from-height' risks for workers.

With mid-rise construction, where effective acoustic separation is required, a Timber/Concrete Composite Cassette Floor might be considered; the concrete screed adding mass for acoustic and vibration control as well as acting compositely with the timber components for improved structural performance. For more detailed information on this refer to *WoodSolutions Technical Guide #30, Timber Concrete Composite Floor Design Guid*e.

Panelised Elements

Fully panelised elements involve the total off-site manufacture of all components including; structural members, insulation, sarking, plumbing and electrical fittings, window and/or door installation and internal lining installation (and external cladding if appropriate).

Modular Wood Construction Systems

Modular wood construction systems (volumetric modules) utilise either light-frame systems (mainly) or solid wood panel systems. The main principle is that the entire volumetric box consisting of walls, floor and ceiling, as well as inner lining and all services are assembled in a factory and transported to the construction site for erection. To assemble the modules on top of each other a male-female connector arrangement is often used. The size of the modules is generally limited by transportation restrictions with maximum dimensions of around 4.2 metres wide, up to 13 metres long and 3.1 metres high. The overall building height is generally the same as for light-frame systems, around 6–7 storeys. Modular systems are used in a range of applications including apartments, student housing, hotels and aged care facilities.

Options for fire precautions during construction should be considered as part of the overall design process

Hybrid Construction

Mid-rise timber buildings may also use a ‘mix’ of materials – hybrid construction – to achieve cost-effective, practical and robust solutions.

For example, a common configuration is to use concrete construction for below ground structures, such as car parks and basements to reduce the risks to timber elements associated with groundwater and for ground floor construction to provide a physical separation from the ground as part of a termite management strategy (where required).

Other forms of hybrid construction may use timber and other structural materials within the same element of construction, for example:

- concrete toppings to timber floors with shear connections to use composite action
- floors constructed with a mix of steel beams and timber beams to manage a mix of spans as shown in Figure 0.3 (LVL timber beams are increasingly used to replace steel beams for this application).

Robust Structural Design

The structural design of mid-rise timber buildings must comply with the relevant NCC requirements, including design to sustain local damage, with the structural system as a whole remaining stable and not being damaged to an extent disproportionate to the original local damage – refer NCC Clause BP1.1(a)(iii).

Further guidance is provided in *WoodSolutions Technical Design Guide #39 Robustness in Structures.*

Fire Precautions during Construction

Mid-rise timber buildings, when complete, provide a high level of safety because of the combination of automatic fire sprinklers and fire-protected timber, among other things.

While the use of timber significantly reduces a number of risks during construction, the fire risk can be increased as a result of the increased volumes of unprotected timber. *WoodSolutions Technical Design Guide #20 Fire Precautions during Construction of Large Buildings* provides advice relating to fire precautions during construction to help building professionals and organisations with responsibilities for fire safety on a construction site reduce the risk of fire.

Other Design Considerations

Designers need to take account of a broad range of design considerations to ensure that a building is fit-for-purpose and complies with all requirements of the NCC and other legislation. These include:

- structural design (for safety and serviceability)
- weatherproofing
- safe access and egress
- light and ventilation (including condensation control)
- energy efficiency
- durability (including termite management)
- design in bushfire-prone and flood-prone areas.

Some sources of information on these matters are referenced in the Appendices of this Guide.

1

Step 1 – High-Level NCC Design Issues (Schematic Design)

The National Construction Code (NCC) is the regulatory framework for determining the minimum design and construction requirements for buildings in Australia. This Step covers a selection of high-level design issues relating to fire-resisting and sound-insulating construction.

1.1 Determine the Type of Construction Required

The NCC contains mandatory performance requirements that apply to 10 primary classes of building that are determined by the building's purpose. The classes directly relevant to this Guide are:

Refer NCC Volume One A6 for details of all classes of building

- **Class 2 buildings** – buildings containing two or more sole-occupancy units each being a separate dwelling, e.g. apartment buildings
- **Class 3 buildings** – a residential building that is a common place of long-term or transient living for a number of unrelated persons, including:
  - a boarding-house, guest house, hostel, lodging-house or backpackers accommodation
  - a residential part of a hotel, motel, school, detention centre or health-care building (where accommodating members of staff)
  - accommodation for the aged, children or people with disabilities.

The building class in conjunction with the building height, expressed in terms of the rise in storeys, and the maximum size of fire components are used to determine the type of construction required.

The rise in storeys is the sum of the greatest number of storeys at any part of the external walls of the building and any storeys within the roof space:

Refer NCC Volume One C1.2 for calculation of rise in storeys

- above the finished ground next to that part; or
- if part of the external wall is on the boundary of the allotment, above the natural ground level at the relevant part of the boundary.

The maximum size of fire compartments (floor area, volume) is defined in the NCC Clause C2.2.

Type C construction is applicable to most low-rise buildings. It is the least fire-resisting form of construction and places few fire-related restrictions on the use of structural timber members.

Type B construction, while not requiring as high FRLs as Type A construction, applies similar constraints to the use of timber.

Type A construction is the most fire-resisting and the prescriptive solutions within the NCC have, in the past, imposed severe limitations on the use of timber through the prescription of masonry and concrete construction and non-combustibility for elements required to achieve a prescribed Fire Resistance Level (FRL).

Table 1.1 shows the required types of construction specified by the NCC.

Table 1.1: Types of construction required by NCC Volume One.

Rise in storeys	Multi-residential		Office	Retail	Car Park/ Storage	Factory/ Laboratory	Hospitals/ Public assembly
	Class 2	Class 3	Class 5	Class 6	Class 7	Class 8	Class 9
4 or more	**A**	**A**	**A**	**A**	**A**	**A**	**A**
3	**A***	**A***	**B**	**B**	**B**	**B**	**A**
2	**B***	**B***	**C**	**C**	**C**	**C**	**B**
1	**C**	**C**	**C**	**C**	**C**	**C**	**C**

** Refer low-rise concessions (e.g. Specification in C1.1 Clause 3.10 and Clause 4.3).*

Design parameters such as the building class, rise in storeys, effective height and type of construction should be confirmed with the building surveyor/certifier.

1.2 Determine NCC Compliance Pathway

1.2.1 NCC Compliance Pathway

To comply with the NCC the relevant Performance Requirements must be satisfied, as demonstrated by means of the Assessment Methods specified in the NCC. There are two pathways that can be followed (or a combination of the two).

- For a Deemed-to-Satisfy solution, it is necessary to provide Evidence of Suitability to show that the Deemed-to-Satisfy Provisions have been met.
- For a Performance Solution (previously referred to as an 'Alternative Solution'), specific building solutions are developed for a building that may vary from the Deemed-to-Satisfy Provisions.

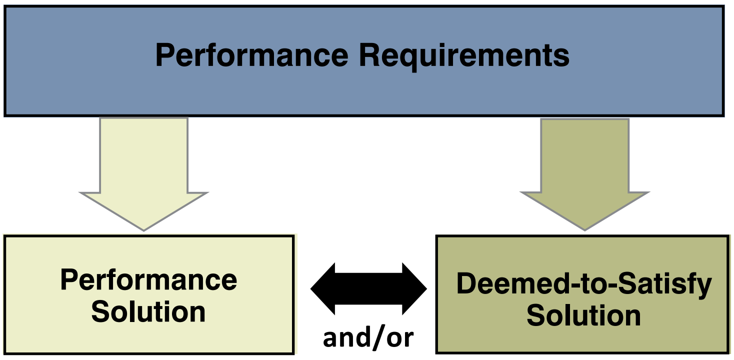


Figure 4: Pathways for demonstrating compliance with NCC performance requirements.

The construction systems and details in this Guide are based on the Deemed-to-Satisfy (DTS) Solution pathway for mid-rise timber buildings which was first introduced into the 2016 edition of the NCC for Class 2, 3 and 5 buildings and extended to all classes of buildings in the 2019 edition. This does not prevent designers using Performance Solutions but variations from the DTS Solution should ensure the fire safety strategy for the building is not adversely affected. Further guidance is provided in *WoodSolutions Technical Design Guide #38 Fire Safety Engineering Design of Mid-Rise Buildings*.

1.2.2 NCC Compliance Options for Timber Buildings

In the context of this Guide, timber buildings are defined as buildings where timber is the predominant material in the structure. There are still opportunities to use timber for some structural and non-structural applications in buildings using other materials for the primary structure.

Table 1.2 summarises options for complying with the NCC Performance Requirements for Class 2 to 9 buildings with further details provided below. DTS Solutions are available for the building configurations shaded in green (light and dark green) with this Guide being directly applicable to the applications shaded in dark green. At the time of writing, Performance Solutions needed to be developed for the areas shaded in blue.

Mid-rise Class 2 and 3 buildings are addressed in this Guide

Table 1.2: Design options for timber buildings.

Rise in storeys or effective height	Multi-residential		Office	Retail	Car Park/ Storage	Factory/ Laboratory	Hospitals/ Public assembly/ Schools
	Class 2	Class 3	Class 5	Class 6	Class 7	Class 8	Class 9
Effective height greater than 25m	High	High	High	High	High	High	High
8[EH]	Mid	Mid	Mid	Mid	Mid	Mid	Mid
7	Mid	Mid	Mid	Mid	Mid	Mid	Mid
6	Mid	Mid	Mid	Mid	Mid	Mid	Mid
5	Mid	Mid	Mid	Mid	Mid	Mid	Mid
4	Mid[1]	Mid[1]	Mid	Mid	Mid	Mid	Mid
3	Low[1]	Low[1]	Mid	Mid	Mid	Mid	Mid
2	Low[1]	Low[1]	Low	Low	Low	Low	Mid
1	Low	Low	Low	Low	Low	Low	Low

EH: Effective height of not more than 25 metres

Note 1: Refer to Technical Design Guide #02 to check if low-rise timber concessions apply.

Low	Deemed-to-Satisfy Solution – Guide #02 or 03
Mid	Deemed-to-Satisfy – Guide #37 (this Guide)
Mid	Deemed-to-Satisfy – Guide #37C for Class 5, 6, 7, 8 and 9b commercial and educational buildings and Guide #37H for Class 9 healthcare buildings
High	Performance Solution

Low-rise timber buildings

Refer NCC Spec C1.1 Clauses 3.1 and 4.3 and WoodSolutions Design Guides #01, #02 and #03

There are relatively few fire-related restrictions on the use of structural timber members in Buildings of Type C construction irrespective of the Class of Building under the DTS Solution pathway and for domestic housing.

The NCC Volume One Deemed-to-Satisfy Solution pathway includes concessions that facilitate the use of timber-framed construction for Class 2 and 3 buildings up to a rise in storeys of 3 and, in limited cases, up to 4 storeys. Guidance in relation to construction of these low-rise options is provided in the following WoodSolutions Technical Design Guides:

#01 Timber-framed Construction for Townhouse Buildings Class 1a – information about the fire safety and sound insulation performance requirements in the NCC for Class 1a attached buildings.

#02 Timber-framed Construction for Multi-residential Low-rise Buildings Class 2 and 3 – information about the fire and sound performance requirements in the NCC for Class 2, 3 low-rise buildings.

#03 Timber-framed Construction for Commercial Low-rise Buildings Class 5, 6, 9a & 9b – information about the fire performance requirements in the NCC for Class 5, 6, 9a and 9b buildings

These buildings would normally be designed following the Deemed-to-Satisfy Solution pathway with Performance Solutions being used to address minor variations and/or unusual design circumstances.

The construction systems and details in this Guide are based on the Deemed-to-Satisfy (DTS) Solution pathway for mid-rise timber buildings as detailed in the 2019 edition of the NCC.

This does not prevent designers using Performance Solutions but variations from the DTS Solution should ensure the fire safety strategy for the building is not adversely affected. Further guidance in relation to this is provided in *WoodSolutions Design Guide #38 Fire Safety Engineering Design of Mid-Rise Buildings.*

Mid-rise timber buildings

Mid-rise buildings are of Type A or B construction up to an effective height of not more than 25 metres. The use of timber structural members under the NCC prescriptive pathway is restricted for mid-rise buildings unless the option to use fire-protected timber in conjunction with automatic fire sprinklers is adopted. This Guide addresses Class 2 and 3 buildings applying these design principles.

Guidance on the technical derivation of the mid-rise fire-protected timber solution for Class 2 and 3 buildings is provided in *WoodSolutions Technical Design Guide #38 Fire Safety Engineering Design of Mid-rise Timber Buildings* which may assist with the development of a Performance Solution.

The NCC defines effective height as *"the vertical distance between the floor of the lowest storey included in the calculation of rise in storeys and the floor of the topmost storey (excluding the topmost storey if it contains only heating, ventilating, lift or other equipment, water tanks or similar service units)"*. If there is any doubt as to whether a building's effective height does not exceed 25 metres, it is recommended that the effective height is checked with the relevant authorities.

Check with the regulatory authority that the building effective height does not exceed 25 metres if applying the mid-rise fire-protected timber solution

High-rise buildings

All high-rise timber buildings (effective height greater than 25m) need to follow the Performance Solution pathway.

1.2.3 Overview of the Deemed-to-Satisfy Solution for Mid-rise Timber Buildings

The NCC 2019 includes Deemed-to-Satisfy Provisions that allow the construction of mid-rise timber buildings. The main features of the mid-rise timber building DTS Solutions are:

- the building has an effective height of not more than 25 metres
- fire-protected timber complying with Specification C1.13a of the NCC is used for loadbearing timber elements, non-loadbearing timber walls required to achieve an FRL and for elements of construction required to be non-combustible
- the building has a sprinkler system, other than a FPAA101D or FPAA101H system, complying with Specification E1.5 of the NCC throughout
- any insulation installed in the cavity of the timber building element required to have an FRL is non-combustible
- cavity barriers are provided in accordance with Specification C1.13 of the NCC.

These fire safety precautions aim to provide a robust building solution on the following basis:

Automatic sprinkler suppression system: Objective is to suppress a fire before the structure is threatened and greatly reduce the risk to people and property.

Fire-protected timber (NCC prescribes FRLs AND non-combustible fire protective coverings): Objective is to prevent or delay ignition of the timber structural members so that the response to an enclosure fire will be similar to non-combustible elements, masonry or concrete during the growth period and prior to fire brigade intervention.

Cavity barriers: Objective is to prevent uncontrolled spread of fire through cavities in the low probability events of either failure of the protective covering or fire starting within the cavity.

Non-combustible insulation: Objective is to minimise the risk of fire spread through cavities by removing a potential source of fuel, i.e. combustible insulating materials.

1.2.4 Performance Solution Options

For high-rise timber buildings, the Performance Solution pathway has to be adopted. Refer to the following WoodSolutions Technical Guides for further information.

#16 Massive Timber Construction Systems: Cross-laminated Timber (CLT) – introduces the use of CLT in construction, outlining the history, environmental performance and mechanical properties. Also provides an overview of CLT building systems as well as fire, acoustic, seismic and thermal performance.

#38 Fire Safety Engineering Design of Mid-rise Timber Buildings – reference source describing methods and supporting data that can be used for the fire safety engineering design of mid-rise timber buildings based on the research undertaken to develop and justify the changes to the NCC 2016.

1.2.5 Evidence of Suitability

The NCC requires every part of a building to be constructed in an appropriate manner to achieve the performance requirements using materials and construction that are fit for the purpose for which they are intended, including safe access for maintenance.

The NCC Volume One specifies requirements for Evidence of Suitability in Clause A5.2 but there are the following additional specific requirements that apply to certain aspects of fire safety under NCC prescriptive requirements:

- NCC Clause A5.4 Fire-Resistance of Building Elements
- NCC Clause A5.5 Fire Hazard Properties
- NCC Clause A5.6 Resistance to the Incipient Spread of Fire.

In most instances, for the materials and systems considered in this Guide, the Evidence of Suitability for the fire resistance or Resistance to the Incipient Spread of Fire of an element of construction will be a report from an Accredited Testing Laboratory.

If a Performance Solution is proposed, compliance should be demonstrated using the procedures prescribed in Clauses A5.4 and A5.6 of the NCC as appropriate.

1.3 Determine Schematic Building Layout

1.3.1 Mixed Class Buildings

Evidence of Suitability for fire resistance and Resistance to the Incipient Spread of Fire should be a report from an Accredited Testing Laboratory as prescribed in the NCC

The NCC DTS Solution for Class 2 and 3 mid-rise buildings using fire-protected timber in conjunction with automatic fire sprinklers can also be applied to the Class 2 and 3 parts of mixed class buildings, provided the different classes are adequately fire separated (refer Step 4) and the entire building is protected by an automatic fire sprinkler system complying with NCC Volume One Specification E1.5 other than a FPAA101D or FPAA101H system.

This provides added flexibility for the design of new buildings and facilitates the recycling of existing buildings. For example, fire-protected timber apartments (Class 2) could be constructed above existing concrete-framed carpark levels minimising the increase in foundation loads as shown in Figure 1.2.

Fire-protected timber can be used in conjunction with other forms of construction in mixed class buildings

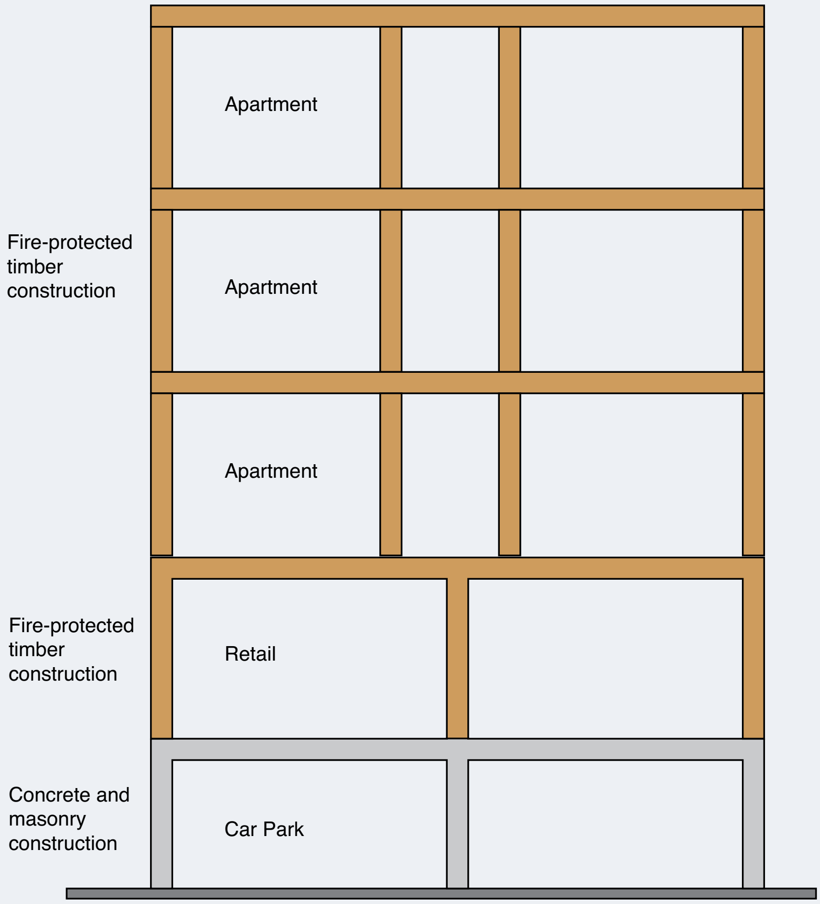


Figure 1.2: Multi-class and mixed forms of construction.

Note: Sprinkler protection required throughout entire building development.

1.3.2 Definition of Sole Occupancy Units

A Sole Occupancy Unit (SOU) is a room or other part of a building for occupation by an owner, lessee, tenant or other occupier to the exclusion of others.

The concept of an SOU is central to addressing many issues concerning fire and sound performance in Class 2 and 3 buildings. For these buildings, the SOU boundaries are used to separate a given building into manageable units for dealing with fire and sound performance.

The wall and floor/ceiling elements that bound an SOU are important in achieving NCC sound and fire performance, but specific requirements vary depending on whether the SOUs are:

- side-by-side
- stacked on top of each other (as well as side-by-side)
- adjoining rooms of a different type or space (such as a public corridor)
- adjoining rooms of similar usage back-to-back, e.g. back-to-back habitable areas or back-to-back service rooms such as laundries or kitchens.

Note: Though bounding wall and floor elements of a SOU identify the main sound and fire-rated elements, it is also highly likely that certain internal walls and floors will also need to be fire-rated when they are supporting fire rated walls/floors located above.

1.3.3 Check Compliance with Fire Compartment Size Limits

For Class 2 and 3 buildings, additional size limits are not needed because of the requirements to provide fire-separating boundaries to SOUs, which generally have relatively small areas and volumes.

The fire safety strategy should be specified at the start of the project and refined as the design progresses

1.3.4 Determine Schematic Fire Safety Design Strategy

The preliminary specification of a fire safety strategy for a building is important since it may impact significantly on the building layout. This is applicable irrespective of the compliance pathway chosen (Performance Solution or DTS Solution) since, even within the DTS pathway, options have to be selected that affect the building layout, detailed design and on the use of the building through its life cycle.

The schematic fire safety design strategy should at the preliminary stage provide as a minimum:

- A summary of the fire safety objectives.
- Building uses that the design needs to address.
- Occupant characteristics that the design addresses.
- Approach to demonstrating compliance with the NCC (Performance Solution, DTS solution or a combination).
- Where a DTS Solution is specified it is still necessary to provide details of the DTS options selected as detailed below.
- Schematic drawings and brief descriptions as appropriate indicating
  - design requirements for automatic fire sprinkler systems
  - design requirements for detection and alarm systems
  - general layout showing fire / smoke resistant compartmentation and structural elements
  - active smoke control measures if provided
  - means of egress during a fire emergency including travel distances to exits, discharge of exits, door operations, etc
  - evacuation strategy and associated emergency warning and intercom system (EWIS)
  - means to alert the fire brigade and equipment to facilitate fire brigade intervention
  - any other fire protection measures.
- An implementation plan stating who is responsible for ensuring compliance and measures that will be in place to facilitate compliance (e.g. inspection schedule).
- Protection measures required during construction.
- Fire safety management measures after completion to ensure ongoing effectiveness of the fire safety strategy through the life of the building.

With a DTS solution critical decisions still need to be made such as the application of concessions (e.g. Specification E1.5a) that impact on the layout options for a building

This preliminary strategy should be regularly reviewed and updated with further details added as the design develops.

Consider building services throughout the design process

1.3.5 Determine Building Services and Preliminary Layout

The preliminary selection of building services and service locations should be considered when determining the general building layout and provision allowed for safe maintenance, modification and addition of services without compromising fire safety and sound separation.

Typical matters for consideration include:

- in residential buildings, will each SOU be serviced by self-contained heating and air-conditioning systems or will centralised systems be provided?
- locate service shafts to minimise nuisance noise and facilitate fire compartmentation
- minimise service penetrations through fire barriers (e.g. mount ceiling lights in false ceilings)
- group service penetrations together and select treatments that minimise the risk of fire spread to cavities
- avoid the need for hot works (e.g. welding, grinding) on services at the position of penetrations through fire-resistant elements
- provide for maintenance and additional services
- select services and materials that minimise the need for hot works (e.g. welding, grinding, soldering, etc).

Consider fire safety during construction throughout the design process

1.4 Safe Design

Safe design principals should be applied throughout the design process and consider the entire building life cycle. Some general guidnce in relation to mid-rise timber buildings is given in this section.

1.4.1 Building Life Cycle

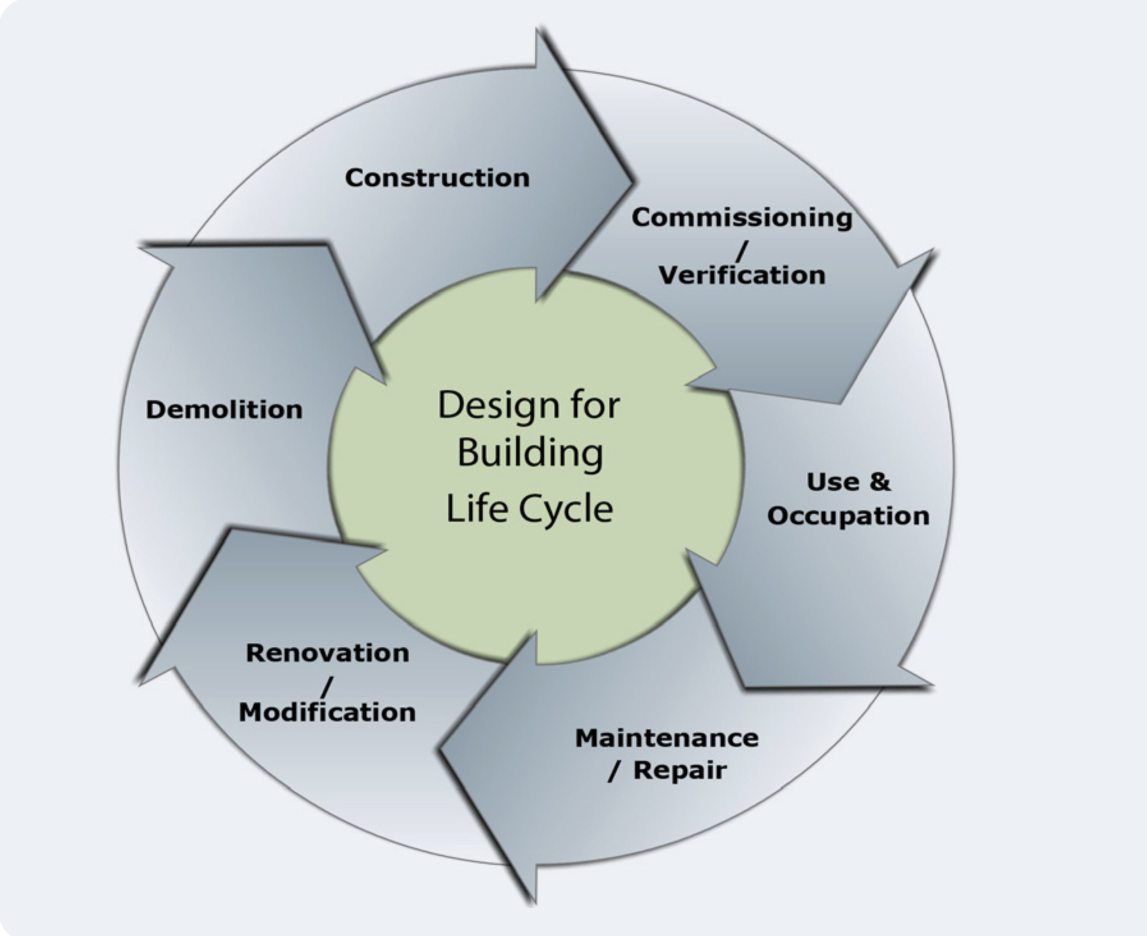


Figure 1.3: Typical building life cycle.

It is important to consider the impacts of design decisions on all phases of the cycle.

For example, the NCC Deemed-to-Satisfy Provisions may require a particular fire safety feature to be incorporated into a building. During the design process it is necessary to determine:

- how the provision can be installed/constructed safely to achieve its required performance
- how the feature will be commissioned and its performance verified
- that the feature will not present a hazard during occupation of a building
- how the feature can be maintained and repaired safely
- measures to be taken to ensure the feature does not present a hazard during renovation/ modification or demolition and to ensure that the performance of the feature is not compromised during the renovation/modification process.

Many of these matters lie outside the scope of the NCC but they are addressed through State and Territory Building Acts and regulations and workplace health and safety (WHS) legislation.

1.4.2 Responsibilities for Safe Design

For further details on how to address WHS requirements refer to the Safe Work Australia Code of Practice on Safe Design of Structures

While this Guide focuses on NCC 2019 requirements relating to Deemed-to-Satisfy solutions for mid-rise timber buildings, the NCC provides a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. The NCC does not regulate matters such as the roles and responsibilities of building practitioners and maintenance of fire safety measures that fall under the jurisdiction of the States and Territories.

State and Territory building legislation is not consistent in relation to these matters, with significant variations with respect to:

- registration of practitioners
- mandatory requirements for inspections during construction
- requirements for maintenance of fire safety measures.

Workplace Health and Safety (WHS) legislation requires safe design principles to be applied. A *Code of Practice – Safe Design of Structures* published by Safe Work Australia provides guidance to persons who design structures that will be used, or could reasonably be expected to be used, as a workplace. It is prudent to apply these requirements to all buildings as they are generally a workplace for people doing building work, maintenance, inspections and the like.

The Code defines safe design as: *"The integration of control measures early in the design process to eliminate or, if this is not reasonable practicable, minimise risks to health and safety throughout the life of the structure being designed."*

It indicates that safe design begins at the start of the design process when making decisions about:

- the design and its intended purpose
- materials to be used
- possible methods of construction, maintenance, operation, demolition or dismantling and disposal
- what legislation, codes of practice and standards need to be considered and complied with.

The Code also provides clear guidance on who has health and safety duties in relation to the design of structures and lists the following practitioners:

- architects, building designers, engineers, building surveyors, interior designers, landscape architects, town planners and all other design practitioners contributing to, or having overall responsibility for, any part of the design
- building service designers, engineering firms or others designing services that are part of the structure such as ventilation, electrical systems and permanent fire extinguisher installations
- contractors carrying out design work as part of their contribution to a project (for example, an engineering contractor providing design, procurement and construction management services)
- temporary works engineers, including those designing formwork, falsework, scaffolding and sheet piling
- persons who specify how structural alteration, demolition or dismantling work is to be carried out.

In addition, WHS legislation places the primary responsibility for safety during the construction phase on the builder.

The design team in conjunction with owners/operators and the builder have a responsibility to document designs, specify and implement procedures that will minimise risks to health and safety throughout the life of the structure being designed.

WoodSolutions Technical Design Guide #20 Fire Precautions During Construction of Large Buildings provides further guidance

1.4.3 Applying Safe Design Principles

A key element of safe design is consultation to identify risks, practical mitigation measures and to assign responsibilities to individuals/organisations for ensuring the mitigation measures are satisfactorily implemented.

This approach should be undertaken whichever NCC compliance pathway is adopted and applies to all forms of construction.

Some matters specific to fire safety are summarised below:

- The NCC and associated referenced documents represent nationally recognised standards for fire safety for new building works.
- The NCC's limited treatment of fire precautions during construction focuses on manual fire-fighting, egress provisions and fire brigade facilities. Additional precautions are required to address WHS requirements such as fire prevention and security. Refer to Section 1.4.4 and *WoodSolutions Technical Design Guide #20 Fire Precautions During Construction of Large Buildings,* for further information.
- Minimising service penetrations through fire-resisting construction.
- Grouping of service penetrations through fire-resisting walls with safe access for installation, inspection and maintenance.
- Detailed design of fire safety measures to optimise reliability and facilitate safe installation, maintenance and inspection where practicable. Special attention should be given to protection of service penetrations and cavity barriers.
- Documentation of procedures and allocation of responsibilities for determining Evidence of Suitability for fire safety measures.
- Documentation of procedures and allocation of responsibilities for the verification and commissioning of all fire safety installations.
- Provision of specifications and drawings of all fire safety measures within the building, Evidence of Suitability, commissioning results and requirements for maintenance and inspection to the owner as part of the fire safety manual. (Note: Some State and Territory legislation contains minimum requirements for inspection of fire safety measures).
- The fire safety manual should also provide information on how to avoid compromising fire safety through the life of a building (e.g. preventing disconnection of smoke detectors or damage to fire resisting construction).

1.4.4 Fire Precautions during Construction

Refer NCC Volume One Cl E1.9 for NCC precautions during construction

Fires may occur on building construction sites due to the nature of the works.

Typical causes include:

- hot works (cutting and welding)
- heating equipment
- smoking materials
- other accidental fires
- arson.

Mid-rise timber buildings complying with the NCC 2019 Deemed-to-Satisfy Provisions offer a safe and economical building option. The addition of the fire-protective coverings plays an important role in providing this fire safety and, due to the construction sequencing, there may be a period where the timber is not fully protected and/or automatic fire sprinkler protection is not fully operational. During this period timber buildings are at their highest risk from construction fires.

The builder and design team needs to consider fire precautions during construction. The scope of the NCC is limited to specifying minimum requirements for fire hydrants, hose reels and extinguishers and egress provisions (NCC Clause E1.9).

Consider fire safety during construction throughout the design process

Addressing WHS requires a broad holistic approach that considers the building layout and site layout throughout the construction process to minimise the fire risk at a time when the building could be at its most vulnerable. Typical matters that should be considered include:

- progressive installation of services
- progressive installation of fire-protective grade covering of timber members and compartmentation of the building
- prefabrication and delivery to site with full or partial encapsulation of timber
- access for fire fighters and egress provisions for staff and visitors on the building site
- selection of materials and work methods that minimise the need for hot works
- security provisions (to address arson)
- safe access for maintenance of equipment and minimising the down time of fire safety equipment during maintenance
- detailing service penetration and construction interfaces to minimise the risk of cavity fires during installation.

WoodSolutions Technical Design Guide #20 Fire Precautions During Construction of Large Buildings provides additional information that can be applied to the design and planning stages as well as the actual construction phase.

2

Step 2 – Define NCC Design Requirements for Sound, Thermal Resistance, Damp and Weatherproofing and Structural Tests

Timber building systems can be designed to meet the regulatory requirements of the National Construction Code Volume One (NCC). From a performance perspective, the NCC sound provisions tend to govern the choice of timber building systems more so than the fire provisions due to the lightweight nature of these systems. The design of sound-resisting construction systems involves understanding the NCC Performance Requirements and Deemed-to-Satisfy (DTS) Provisions, then selecting the appropriate timber building systems to meet these requirements. The NCC Provisions are minimum requirements and further consideration may be given as to whether or not the NCC DTS Provisions will meet the expectations of the building occupants.

2.1 Utilising the Deemed-to-Satisfy Provisions for Sound

Part F5 of the NCC is concerned with safeguarding '*occupants from illness or loss of amenity as a result of undue sound being transmitted*'. The NCC Performance Requirements for Class 2 and 3 buildings focus on limiting the transmission of both airborne and impact-generated sound via floor and wall building elements bounding sole-occupancy units (SOUs) where separating:

- adjoining SOUs
- SOUs from a common space (e.g. public corridor)
- SOUs from another building classification within the building.

The sound performance of these floor and wall building elements must consider the impact of any pipe penetrations or other service elements (e.g. air-conditioning) as well as door openings on bounding construction. (Note: The provisions include the sound isolation of pumps but issues pertaining to this are not dealt with in this Guide). When interpreting these requirements, it is important to understand the difference between airborne and impact sound (Figure 2.1).

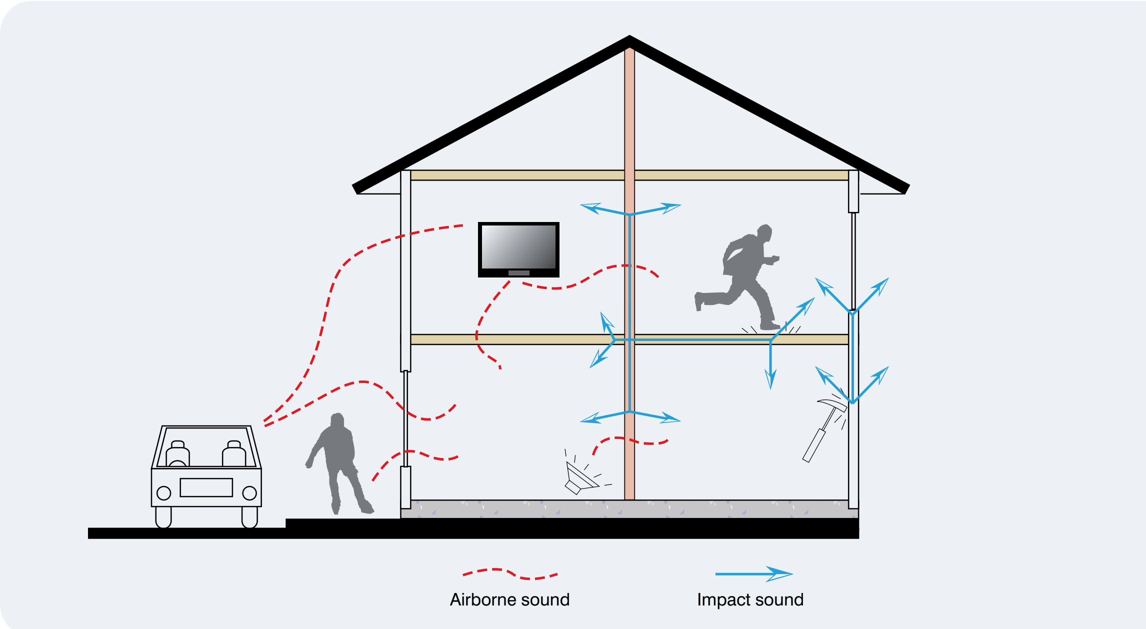


Figure 2.1: Examples of impact and airborne sound.

It is also important to understand how each type of sound is measured in order to select appropriately sound-insulated wall, floor and ceiling elements. The nomenclature used in the Deemed-to-Satisfy Provisions using results from laboratory requirements, is explained in Figures 2.2 and 2.3.
Note: Alternative methods of sound measurement also exist.

Refer to:
NCC Volume One Cl F5.0 to F5.7

Airborne sound is typically measured in the Deemed-to-Satisfy Provisions using the Weighted Sound Reduction Index and is expressed as R_w (e.g. R_w 50).

- It is typically applied to both wall and floor elements.
- The higher the number the better the performance.
- It can be used on its own or modified using the spectrum adaption term C_{tr} (see below).

A C_{tr} modification factor can be added to the R_w measurement to bias the overall measurement to take greater account of low frequency noise (bass, sub-woofer).

C_{tr} is usually a negative number with a typical range of -1 to -15. It is added to the R_w value and the net result is a lower number than the R_w value on its own. It is therefore significantly harder to achieve $R_w + C_{tr}$ 50 than R_w 50 on its own.

Applying the above involves finding out the minimum stated R_w or $R_w + C_{tr}$ for a given building element (as determined using the Deemed-to-Satisfy Provisions) as dealt with in Section 2.2.

Figure 2.2: Airborne sound.

Impact sound is typically measured in the Deemed-to-Satisfy Provisions using the Weighted Normalised Impact Sound Pressure Level expressed as $L_{n,w}$ (e.g. $L_{n,w}$ 62).

- It is usually applied to floor elements.
- The lower the number the better the performance.

Note: Although not required by NCC 2019, a C_I modification factor can be added to the $L_{n,w}$ value to bias the overall measurement into taking greater account of low frequency impact sound such as footsteps. It is usually a positive number, and so when added to the $L_{n,w}$ measurement, the net result is a higher number than the $L_{n,w}$ measurement on its own. It is therefore significantly harder to achieve $L_{n,w} + C_I$ 62 than $L_{n,w}$ 62 on its own.

Applying the above involves finding out the maximum stated $L_{n,w}$ for a given building element (as determined using the Deemed-to-Satisfy Provisions) as dealt with in Section 2.2.

Figure 2.3: Impact sound.

2.2 Determining Sound Insulation Requirements for Individual Building Elements

As previously mentioned, the NCC specifies the minimum airborne and impact sound insulation requirements for individual wall and floor building elements. Tables 2.1 and 2.2 summarise key NCC requirements for the selection of the appropriate timber building systems.

Table 2.1: Walls – Deemed-to-Satisfy Sound Insulation Requirements in Class 2 and 3 Buildings

Wall Situation			Wall Rating	Entry Door Assembly Rating
First Space		**Adjoining space**		
SOU – generally all spaces except those noted below	Separates	**SOU – generally all spaces except those note below**	$R_w + C_{tr} \geq 50$	N/A
A bathroom, sanitary compartment, laundry or kitchen	Separates	**SOU – habitable room[1] (except kitchen)**	$R_w + C_{tr} \geq 50$ and of discontinuous[2] construction	N/A
A bathroom, sanitary compartment, laundry or kitchen	Separates	**SOU – non-habitable[3] room (including kitchen)**	$R_w + C_{tr} \geq 50$	N/A
Plant and lift shaft	Separates	**SOU – all spaces**	$R_w \geq 50$ and of discontinuous[2] construction	N/A
Stairway, public corridor, public lobby or the like or part of a different BCA building classification	Separates	**SOU – all spaces**	$R_w \geq 50$	$R_w \geq 30$ (except a part of a different NCC Building classification)

Notes:

1 Habitable room means a room used for normal domestic activities includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom.

2. Discontinuous construction refers to walls having a minimum 20 mm gap between separate leaves and with no mechanical linkages between wall leaves except at the wall periphery.

3. Non-habitable rooms are bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods. Refer to NCC definition.

Table 2.2: Floors – Deemed-to-satisfy Sound Insulation Requirements in Class 2 and 3 Buildings

Floor Situation			Floor Rating
First Space		**Adjoining space**	
SOU – all spaces	Separates	**SOU – all spaces**	$R_w + C_{tr\ (airborne)} \geq 50$, & $L_{n,w\ (impact)} \leq 62$
Public corridor or lobby or the like	Separates	**SOU – all spaces**	$R_w + C_{tr\ (airborne)} \geq 50$, & $L_{n,w\ (impact)} \leq 62$
Stair and lift shaft	Separates	**SOU – all spaces**	$R_w + C_{tr\ (airborne)} \geq 50$, & $L_{n,w\ (impact)} \leq 62$
Plant Rooms	Separates	**SOU – all spaces**	$R_w + C_{tr\ (airborne)} \geq 50$, & $L_{n,w\ (impact)} \leq 62$
Different BCA Building Classification	Separates	**SOU – all spaces**	$R_w + C_{tr\ (airborne)} \geq 50$, & $L_{n,w\ (impact)} \leq 62$

Where a wall required to have sound insulation has a floor above, the wall must continue to the underside of the floor above, or the ceiling must provide the equivalent sound insulation required for the wall. (Professional advice should be sought to upgrade the ceiling to the required wall sound insulation.)

2.3 Services

If a duct, soil, waste or water supply pipe serves or passes through more than one dwelling, it must be separated from the rooms of the dwellings by construction with an $R_w + C_{tr}$ not less than:

- 40 if it is adjacent to living areas in a dwelling
- 25 if it is adjacent to a kitchen or bathroom.

This is also required where a duct or pipe is within a wall or ceiling cavity.

2.4 The Next Step

The previous information provides an understanding of the NCC's minimum sound-insulation requirements. The next step is to:

- go to Step 3 to find out about improving and/or upgrading sound performance (e.g. beyond minimum NCC requirements); or
- go to Step 5 to select timber building systems that will comply with minimum NCC sound requirements.

Once sound-insulation requirements are satisfied, go to Step 4 Fire Design Requirements.

2.5 Other Design Considerations

There are other design considerations that need to be taken into account in meeting NCC requirements. The following are not covered in detail in this Guide but are listed as requiring consideration.

2.5.1 Thermal Resistance (R-value)

NCC Volume One, Section J provides the energy efficiency requirements that a building, including its services, must achieve. The energy efficiency provisions can be met via the Verification (calculation) Method or complying with the Deemed-to-Satisfy Provisions. These provisions will vary based on a range of factors including: the building's location (climate zone), direction of heat flow, level of external wall/window shading, size and performance of external glazing/windows and form of construction of the external building fabric.

The thermal resistance of timber building elements is dependent on the level of installed insulation (i.e. thickness), number and thickness of sheet lining layers (plasterboard, flooring), element construction (e.g. incorporating furring channels) and overall thickness of the building element.

Energy modelling software is used to simulate the potential thermal efficiency (Class 2) of the building envelope or the annual energy consumption (Class 3) of the building envelope and its services as described in the NCC. Typical external wall and floor/ceiling systems can be 'constructed' within the software packages using their internal product databases. Guidance on timber wall and floor/ceilings can be found in WoodSolutions' ***R-values for Timber-framed Building Elements***.

2.5.2 Damp and Weatherproofing

The requirements for the damp and weatherproofing of buildings are provided in NCC Volume One Part F1. The intent is to protect the building from external (rain) and internal water (e.g. laundry overflow) and the accumulation of internal moisture in a building causing unhealthy conditions for occupants and potential damage to building elements.

Key areas of consideration include:

- Internal wet areas (e.g. bathroom) need to be waterproofed in accordance with the NCC requirements and have adequate overflow systems (e.g. floor waste) in place to deal with the possibility of waste water overflow.
- External walls. There are currently no Deemed-to-Satisfy Provisions in the NCC and therefore suppliers of waterproofing products/membranes are relied on to demonstrate compliance with the NCC Performance Requirement (FP1.4). It is important that installed waterproofing membranes/systems are vapour permeable (i.e. allowing timber building components to breathe) but do not permit water to penetrate (i.e. water barrier) through to the structural timber building elements.
- Roof coverings. For the purposes of this Guide, and as required by the NCC, roof coverings must be of non-combustible materials (e.g. concrete, metal, terracotta) and be fixed in accordance with, and comply with, the relevant Standard as specified in the NCC Clause F1.5.

Note

The drawings in this Guide have either omitted damp, weatherproofing and waterproofing details or provided indicative details only. Specific details may vary with climatic conditions and in many instances the only compliance pathway is a Performance Solution that may yield solutions that vary from project to project. Care should be taken to ensure that the Performance Solutions for damp, weatherproofing and waterproofing do not conflict with NCC fire safety requirements.

2.5.3 Structural Tests

NCC Specification C1.8 describes structural tests for fire-resisting, lightweight wall construction that bounds lift, stair and service shafts, fire-isolated passageways and ramps as well as external and internal walls. The test methods and criteria for compliance are stated in relation to materials, damage, deflection (under static pressure and impact) and surface indentation.

Lightweight wall systems do not require testing if designed and constructed in accordance with the relevant design and loading standards specified in the NCC Part B1 Structural Provisions.

3

Step 3 – Improve and Upgrade Sound Performance

Sound performance can often be improved by simple attention to the form and spatial arrangement of the building design. Attention to flanking noise is another important way to improve sound performance. Many end users of dwellings want higher sound performance than the minimum levels required by the NCC. As a result, this Step in the Guide focuses on ways to improve and upgrade sound performance.

3.1 Attention to Building Design to Reduce Sound Transmission

Aspects of the form and spatial design of a building that can be adapted to improve sound performance are dealt with under the following headings.

3.1.1 Room Layout

Check that the room layout is beneficial rather than detrimental to sound transmission. Service rooms including bathrooms, laundries and kitchens create extra sound compared to living rooms and bedrooms. For instance, water movement through plumbing pipes and the vibration from washing machines and dishwashers create sound problems. It is best for the service rooms in one dwelling to back onto the same type of rooms in an adjoining dwelling rather than habitable rooms such as bedrooms or lounge rooms. Also, try to ensure entrances to dwellings are an appropriate distance from adjacent units (Figure 3.1).

3.1.2 Windows

Windows normally have lower sound insulation than the walls around them. As a result, highly sound-rated bounding wall systems may become ineffective by virtue of nearby poorly sound-rated windows. For improvement, consider one or more of the following:

- use thicker glass or double glazing
- use fixed glazing in lieu of opening windows (this may also require sound-insulated ventilation)
- locate windows so that they do not face noisy areas
- provide adequate separation between windows in adjoining SOUs
- reduce the area of windows in the facade
- fill voids between the wall frame and window frame with an appropriate acoustic sealant
- use acoustic sealing strips/gaskets around the edges of open-able sashes.

3.1.3 Doors

As with windows, doors tend to be a weak link in sound-rated wall systems. Where sound control is desired, solid core doors should be used and be treated with soft acoustic gaskets at interfaces with door jambs. Threshold closers at the bottom of the door or air seals will also help reduce sound transmission. In most cases, achieving the required sound rating will involve the use of gaskets and seals. Sliding doors should be avoided where optimum sound-control is desired.

3.1.4 Services

The location and detailing of services are two of the most important considerations in controlling sound transmission in residential buildings.

Generally, services and service penetrations should not be located on sound-insulated walls between SOUs but rather on internal walls or dedicated sound resisting service shafts. In all instances, service pipes should be located away from noise-sensitive parts of the dwelling, such as bedrooms (Figure 3.1).

3.1.5 External Walls

There are no NCC requirements for sound ratings of external walls, but in some parts of Australia there may be state planning regulations or local government requirements for external wall sound rating. For information on the sound performance of common timber-framed external walls, refer to *WoodSolutions Technical Design Guide #11 Timber-framed Systems for External Noise.*

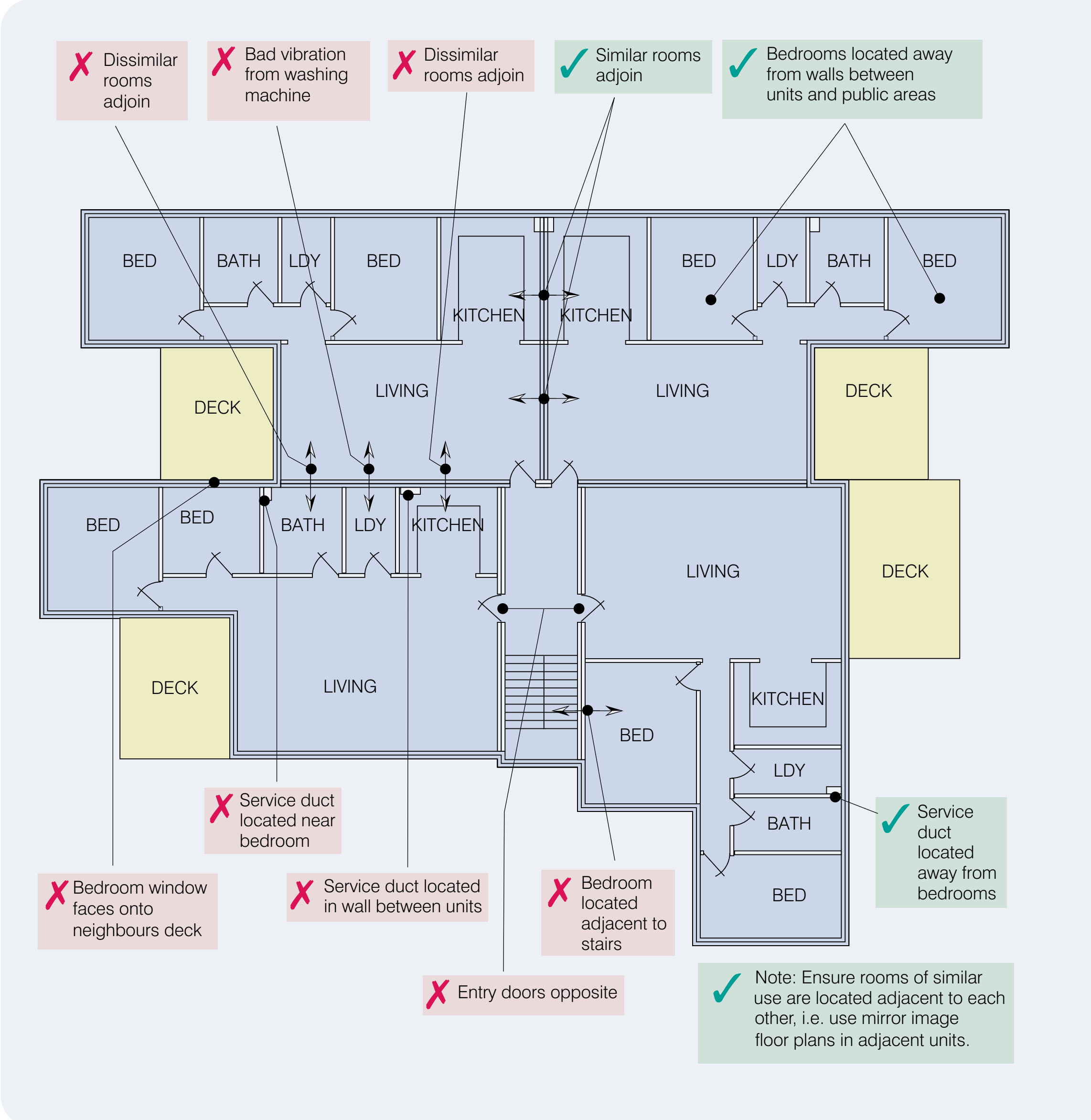


Figure 3.1: Good and bad sound design practices in building layout – plan view.

3.2 Addressing Flanking Noise

The ability to insulate against sound moving from one dwelling to the next depends not only on insulating individual wall and floor elements, but also on stopping noise from jumping or transferring from one building element to the next or, worse still, moving through the building in an uncontrolled way. As a result, the effectiveness of sound-insulated construction is concurrently dependent on addressing flanking noise. Flanking noise refers to sound passing around rather than through wall/ floor elements, causing sound to unexpectedly manifest itself in unwanted places.

The main flanking routes around wall and floor elements are shown in Figure 3.2. These routes particularly apply to walls and floors separating SOUs but may also apply to external walls and, in some instances, internal walls (within SOUs) as well.

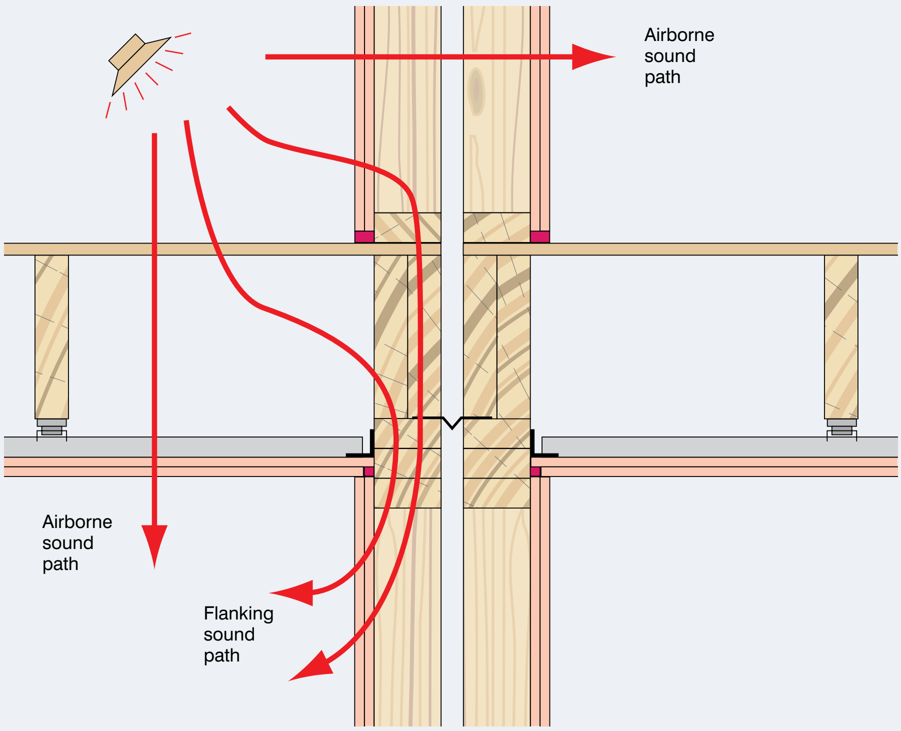


Figure 3.2: Flanking and airborne noise pathways – elevation view.

There are no minimum requirements addressing flanking noise in the NCC's Deemed-to-Satisfy Provisions, though there is an onus on designers and builders to address flanking noise in order to ensure that laboratory-tested wall and floor elements perform to their full potential in the field.

This Guide's approach is to consider reducing flanking noise paths wherever possible. The content is the result of careful thought, taking into account issues such as the limits on what could be achieved in reducing flanking because of their affect on fire and structural integrity. Even though direct reference to reducing flanking noise has not been made, many of the details incorporate elements within them.

An example of reducing flanking noise can be seen in the standard detail for floor joist and flooring over bounding walls where the joist and flooring are not continuous (Figure 3.3).

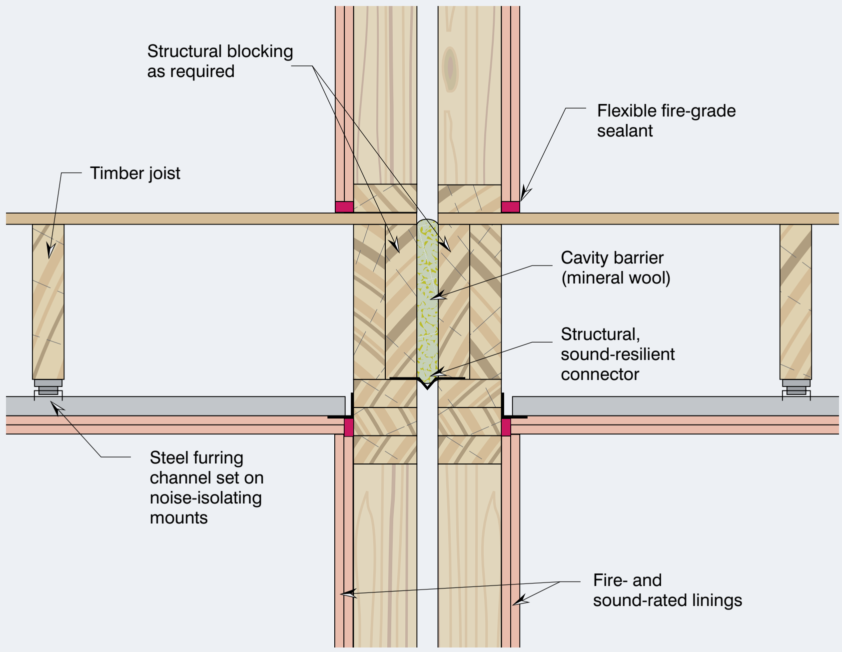


Figure 3.3: Discontinuous floor joist and floor sheeting – elevation view.

There are two main approaches used for addressing flanking noise in timber-framed buildings:

- Limit the ability of the noise to migrate from one element to another, e.g. dampening and isolation at junctions between elements (Figure 3.3).
- Limit the noise getting into wall/floor element, e.g. carpet, floating floors (Figure 3.4).

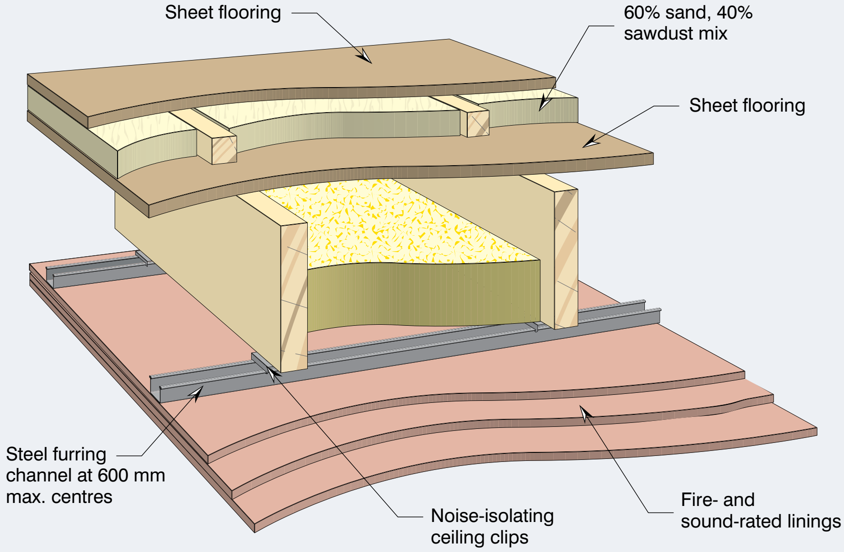


Figure 3.4: Acoustic isolating pad to reduce flanking noise.

In addition to these, timber-framed construction details orientated to improving flanking sound are provided in Section 3.3 and include:

- discontinuous elements at walls, floors and ceilings
- cavities within sound rated elements blocked or travel path increased to reduce noise
- introduced isolating elements, e.g resilient mats or brackets
- platform flooring discontinuous over double stud walls.

3.3 Strategies for Upgrading Sound Performance in Construction

Building occupants often desire higher sound performance than the NCC's minimum requirements. This is especially the case for impact sound and the related issue of vibration from footsteps, water movement through pipes, water hammer and sources such as washing machines, air conditioning units and dishwashers. Other scenarios not dealt with in the NCC include acoustic requirements for home entertainment areas, noise transfer within a dwelling and noise from outside the building (e.g. busy roads, trains, aircraft noise). Options for upgrading typical construction are provided below. Using a combination of options is more likely to give the best performance.

Isolating one side of a bounding construction from the other (e.g. using double stud cavity wall construction). This is also known as decoupling and can be useful in reducing both airborne and impact sound. Of note, it serves to limit noise vibration from one side of the element to the other.

Avoiding rigid connections between the opposing sides of isolated (decoupled) elements. This limits the occurrence of sound bridges that would otherwise allow sound to transmit from one side to the other. If required for structural stability, sound-resilient connectors should be used and should generally only be used at floor or ceiling level.

Using absorptive materials to fill wall and floor cavities (non-combustible glass fibre or mineral wool) can reduce airborne sound transmission.

Sealing sound leaks at the periphery of wall and floor elements or where penetrations are made for electrical and plumbing services.

For information for the upgrade of external walls refer to *WoodSolutions Technical Design Guide #11 Timber-framed Systems for External Noise.*

3.3.1 Walls

Extra mass on the walls – the addition of mass is a simple yet effective way to improve sound performance in timber construction. In its simplest form, it involves adding extra layers of material such as plasterboard to the outer layer of the sound-rated wall system.

Use a 90 mm rather than 70 mm wall studs – The wider the wall, the better its sound performance. This is particularly the case where trying to improve C_{tr} scores (being the modification factor for low frequency bass noise applied to R_w scores). The simplest way to do this is to use 90 mm wide studs instead of 70 mm wide studs in a double stud wall system.

Upgrade batts in the wall/floor – There are many types and grades of non-combustible insulation batts in the market place. Sound insulation specific batts are best and high-density materials tend to outperform low-density materials. Always refer to the supplier's documented recommendations; some systems require insulation or linings to affect different frequencies and therefore may have differing advice.

3.3.2 Floors

Extra mass on the ceilings – adding mass is a simple yet important way to improve sound performance in timber-framed construction. At its simplest manifestation, this involves adding extra layers of material such as plasterboard to the sound-rated ceiling system.

Extra mass on floors – the addition of mass on floors is an effective way to address impact noise (e.g. footsteps). The additional mass can be in the form of additional layers of sheet flooring.

3.4 The Next Step

The strategies and methods shown in this Step of the Guide may involve specialist proprietary systems that go beyond the scope of this publication. As a result, the next step is:

- Go to proprietary system suppliers and ask for advice on how to integrate their systems with those discussed in this Guide. As part of this, care must be taken to ensure that the fire and sound performance of systems in this Guide are not compromised in any way;
- Go to Step 4 to find out about fire-resisting construction requirements so that these requirements can be considered in tandem with sound requirements before selecting the appropriate timber construction system in Step 5.
- Go to Step 5 to select timber construction that will comply with minimum NCC sound and fire requirements.

4

Step 4 – Define NCC Fire Design Requirements (Design Development)

Designing fire-resisting construction involves a process of understanding how the NCC's Performance Requirements translate into the more objective and measurable Deemed-to-Satisfy Solutions for mid-rise timber buildings, prior to finalising the building layout and selecting timber construction systems that meet these requirements.

4.1 Utilising the Deemed-to-Satisfy Solutions for Fire Design

Section C of the NCC Volume One is concerned with safeguarding people if a building fire occurs. Specific attention is given to evacuating occupants, facilitating the activities of emergency services personnel, avoiding the spread of fire between buildings, and protecting other property from damage as a result of fire.

The NCC details Deemed-to-Satisfy (DTS) Solutions that satisfy the Performance Requirements under:

Part C1 – Fire-resistance and stability

Part C2 – Compartmentation and separation

Part C3 – Protection of openings

These Parts deal with a wide range of issues but it is primarily the fire-resistance of building elements and provisions that relate specifically to mid-rise timber buildings that are dealt with in this Guide. To this end, only relevant clauses from Parts C1, C2 and C3 are discussed in more detail below together with the following provisions that apply specifically to mid-rise timber buildings:

- protection of the building with an automatic fire sprinkler system complying with Specification E1.5 of the NCC
- fire-protected timber complying with Specification C1.13a of the NCC used for loadbearing internal walls, loadbearing fire walls and for elements of construction required to be non-combustible
- any insulation installed in the cavity of the timber building element required to have an FRL is non-combustible
- cavity-barriers provided in accordance with Specification C1.13 of the NCC.

The NCC Deemed-to-Satisfy Provisions that facilitate the construction of mid-rise timber buildings are shown in Figure 4.1.

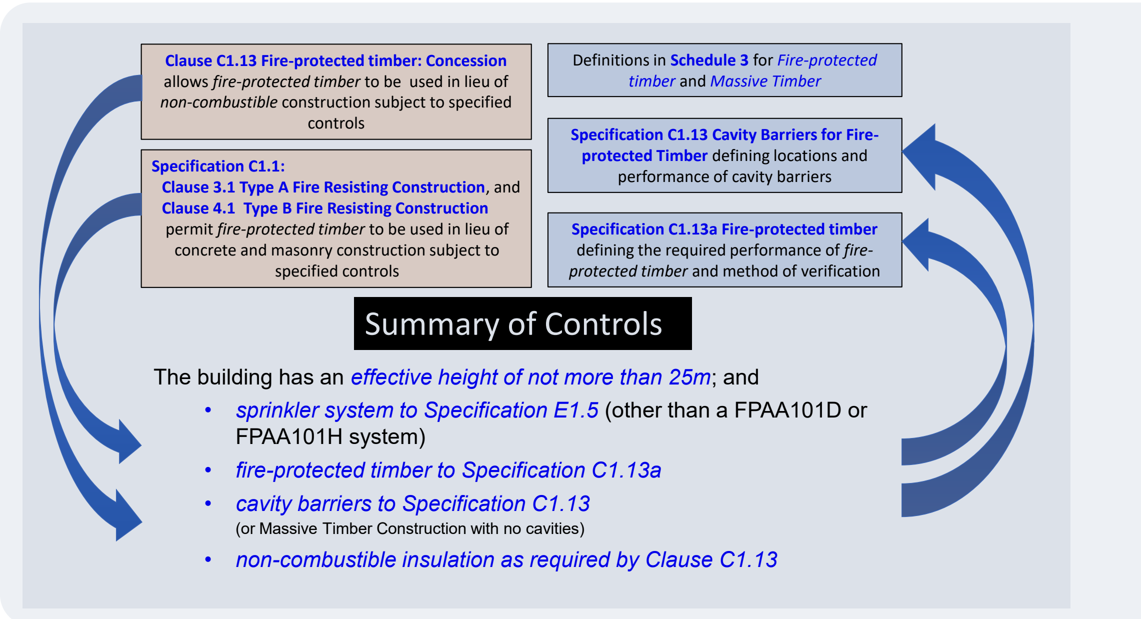


Figure 4.1: Mid-rise timber buildings overview of NCC DTS provisions.

4.2 Automatic Fire Sprinklers

Under Vic Spec E1.5.2 the sprinkler protection requirements are modified. Refer NCC Vic Spec E1.5.2 for projects constructed in accordance with the Victorian Acts and Regulations

A key fire safety feature for mid-rise timber buildings is the requirement to provide automatic fire sprinkler systems in accordance with NCC Specification E1.5 throughout the building, including any parts of the building that are not of timber construction. This requirement, in conjunction with other fire safety measures, is expected to reduce the risk from fires in mid-rise timber buildings below that in other forms of construction complying with the minimum NCC requirements that do not incorporate sprinkler systems.

4.2.1 Sprinkler Design Standards permitted by NCC Specification E1.5

Specification E1.5 allows sprinkler systems to be designed in accordance with:

- AS 2118.1: Automatic Fire Sprinkler Systems – General Requirements
- AS 2118.4: Automatic Fire Sprinkler Systems – Sprinkler protection for accommodation buildings not exceeding four storeys in height
- AS 2118.6: Combined sprinkler and hydrant systems in multi-storey buildings.

AS 2118.4 is limited to accommodation (residential) buildings not exceeding four storeys high. Therefore, most mid-rise timber building sprinkler systems will be designed to comply with AS 2118.1 or AS 2118.6.

Note: FPAA101D and FPAA101H systems are not currently permitted to be used in conjuction with fire-protected timber systems in accordance with the NCC DTS provisions. However, the use of the FPAA systems could be considered as part of a Performance Solution.

4.2.2 Designing Fire Sprinkler Systems to Improve Their Effectiveness

There are opportunities during the design process to incorporate features that can enhance the effectiveness of an automatic sprinkler system and simplify ongoing maintenance. A few examples are described below.

Residential heads in residential SOUs and associated corridors

Both AS 2118.1 and 2118.6 allow the use of appropriately listed residential heads in residential building SOUs and associated corridor areas. These heads have a more rapid response than standard heads and are more likely to suppress rather than control a fire thus reducing the risk to occupants within the SOU of fire origin. Therefore, where appropriate, residential heads should be specified.

Monitored valves

The reliability of fire sprinkler systems can be enhanced by providing monitored components, such as main stop valves and subsidiary stop valves. Monitored stop valves on each floor, for example, enables sprinkler protection to be maintained throughout the remainder of the building while work is undertaken on part of the sprinkler system. If the valve is left closed when the work is completed, the building owner/operator can be alerted to ensure the error is quickly corrected. This minimises the time periods and extent of areas where sprinkler protection is unavailable. The progressive installation of monitored valves during construction can be used as part of the strategy to address fires during construction by facilitating the progressive commissioning of the sprinkler system.

False ceilings

If sprinkler pipes are run above a ceiling system that is required to have Resistance to the Incipient Spread of Fire (RISF), the ceiling will need to be penetrated to accommodate sprinkler heads; potentially compromising the fire performance of the ceiling if the sprinkler system fails to operate successfully.

This can be avoided by providing a false ceiling and running the pipes below the RISF ceiling and the penetrations for the sprinkler heads need only penetrate the non-fire-resisting false ceiling.

This detail also provides flexibility for lighting systems, air-conditioning and other services.

Selection of materials and pipe connections

The use of materials and pipework connections that minimise the need for hot works on site and reduce the time the sprinkler system is not in operation during maintenance should be considered.

Protection of voids/concealed spaces

Concealed spaces within fire-protected timber elements greater than 200 mm deep generally require protection in accordance with AS 2118.1 and AS 2118.6. Where these voids include elements such as beams, the void depth is measured from the soffit of the beam.

Where open web beams (trusses) or similar elements are included in the cavity, consider providing sprinkler protection where the distance between a ceiling and the bottom chord is less than 200 mm because open webs will not obstruct the sprinkler discharge to the same extent as solid beams.

4.2.3 NCC Specification E1.5a Requirements and Concessions

Overview

NCC Specification E1.5a was introduced in the 2019 edition of the NCC and sets out additional requirements for Class 2 and 3 buildings not more than 25 m in *effective height* with a *rise in storeys* of 4 or more relating to:

- the design and installation of fire sprinkler systems
- detection and alarm systems
- fire orders.

If these additional requirements are implemented the following significant concessions are permitted to be applied:

- reduced FRLs for some fire doors and service penetrations and some non-loadbearing walls
- extended distances of travel in Class 2 and 3 buildings except for residential care buildings
- modifications to requirements for internal fire hydrants
- modifications to requirements for emergency warning and intercom systems (EWIS) in residential care buildings.

The application of Specification E1.5a to fire-protected timber buildings is explained below.

Sprinkler Systems complying with AS 2118.1 or AS 2118.4 as applicable are required to be provided in mid-rise fire protected buildings and therefore the requirements of Specification E1.5a 2 (a) for sprinkler protection are satisfied.

Note: Victorian variation Vic Spec E1.5a 2(a) applies more stringent requirements to sprinkler protection of covered balconies that must be adopted if compliance with the Victorian Building Acts and Regulations is required.

Spec E1.5a 2(b) requirements reflect good practice and are recommended to be applied even if the Spec E1.5a concessions are not adopted.

Specification E1.5a 2(b) Requirements

(i) the *automatic* fire sprinkler system is permanently connected to a fire alarm monitoring system connected to a fire station or fire station dispatch centre in accordance with Specification E2.2d if –

(A) the system has more than 100 sprinkler heads; or

(B) in the case of a *residential care building*, the building will accommodate more than 32 residents; and

(ii) the *automatic* fire sprinkler system is fitted with sprinklers complying with clauses 4.4, 4.5 and 5.5.2 of AS 2118.4 in bedrooms; and

(iii) an *automatic* smoke detection and alarm system is installed in accordance with Specification E2.2a except that it need not be connected to a fire alarm monitoring system connected to a fire station or fire station dispatch centre, and in the case of a *residential care building* it must be installed in accordance with –

(A) Specification E2.2a Clause 4; or

(B) both –

(aa) Specification E2.2a Clause 3, provided Specification E2.2a Clause 3(a)(ii) is applied as if the building was not protected with a sprinkler system; and

(bb) Specification E2.2d; and

(iv) in a *residential care building*, the *automatic* smoke detection and alarm system and the automatic fire sprinkler system are connected to a local fire indicator panel provided in accordance with Specification E2.2d; and

(v) fire orders are provided in a Class 3 building in accordance with G4.9 as for a building in an *alpine area*.

It is recommended that fire orders are provided in all Class 2 and 3 buildings to facilitate a prompt evacuation.

G4.9 Fire orders states:

Every Class 2, 3 or 9 building must display a notice clearly marked "FIRE ORDERS" in suitable locations near the main entrance and on each *storey*, explaining:

(a) the method of operation of the fire alarm system and the location of all call-points; and

(b) the location and methods of operation of all fire-fighting equipment; and

(c) the location of all *exits*; and

(d) the procedure for evacuation of the building.

Specification E1.5a 3(a) Concessions

(i) The FRL for *self-closing* fire doors, as *required* by C3.8 and C3.11, may be reduced to not less than -/30/30.

C3.8 applies to doorways that open to fire-isolated stairways, fire-isolated passageways or fire-isolated ramps, and are not doorways opening to a road or open space.

C3.11 applies to:

(a) doorways providing access from a sole-occupancy unit to:

- a public corridor, public lobby, or the like; or
- a room not within a sole-occupancy unit; or
- the landing of an internal non fire-isolated stairway that serves as a required exit; or
- another sole-occupancy unit.

(b) doorways providing access from a room not within a sole-occupancy unit to:

- a public corridor, public lobby, or the like; or
- the landing of an internal non-fire-isolated stairway that serves as a required exit.

(ii) The FRL for—

(A) service penetrations through non-*loadbearing internal walls* and *shafts* constructed of *fire-protected timber,* as *required* by C3.15, may be reduced to not less than -/60/15;

Notes:

The Resistance to Incipient Spread of Fire (RISF) and Modified Resistance to Incipient Spread of Fire (MRISF) requirements for service penetrations through fire-protected timber still apply.

The base non-loadbearing fire-protected timber wall system must be capable of achieving an FRL of at least -/60/60 in addition to satisfying the RISF or MRISF requirements of Specification C1.13a.

(B) all other non-*loadbearing internal walls*, as *required* by Specification C1.1, may be reduced to -/45/45 and the FRL for service penetrations through internal non-*loadbearing* walls and *shafts*, as *required* by C3.15, may be reduced to -/45/15

Note: A useful detail in buildings of predominantly fire-protected timber construction is to construct solid non-loadbearing service shafts from laminated non-combustible boards only since this form of construction will reduce the space required for service shafts. The form of construction will need to comply with all relevant NCC requirements including acoustics and impact resistance in addition to fire related properties.

(iii) The FRL for *fire-isolated stairways* enclosed with non-*loadbearing* construction, as required by D1.3, may be reduced to –/45/45.

Note: If fire-protected timber construction is adopted it is still necessary to comply with the Resistance to the Incipient Spread of Fire and Modified Resistance to the Incipient Spread of Fire criteria as appropriate. To satisfy these requirements it is expected that an FRL of at least –/60/60 would be achieved by the wall system.

The distance of travel concession facilitates the design of more efficient floor layouts

(iv) Except in a *residential care building*, the maximum distance of travel, as *required* by D1.4(a)(i)(A), may be increased from 6 m to 12 m.

(v) The maximum distance of travel from a single *exit* serving the *storey* at the level of egress to a road or *open space*, as *required* by D1.4(a)(i)(B), may be increased from 20 m to 30 m.

(vi) The maximum distance between alternative *exits*, as *required* by D1.5(c)(i), may be increased from 45 m to 60m.

Note: The relaxations to the distance of travel requirements facilitate the design of more efficient floor layouts

(vii) Internal fire hydrants in accordance with E1.3 are not *required* where—

(A) the building is served by external fire hydrants that provide compliant coverage installed in accordance with E1.3, except that in a *residential care building* the nozzle at the end of the length of hose need only reach the entry door of any *sole-occupancy unit* to be considered as covering the area within the *sole-occupancy unit*; or

(B) a dry fire hydrant system that otherwise complies with AS 2419.1 is installed in the building and—

(aa) each fire hydrant head is located in accordance with E1.3 and fitted with a blank end cap or plug; and

(bb) the pipework is installed in accordance with E1.3 (as for a *required* fire main) except that it need not be connected to a water supply; and

(cc) a hydrant booster inlet connection is provided in accordance with E1.3; and

(dd) an external street or feed hydrant capable of providing the *required* system flow is located within 60 m of the hydrant booster connection.

(viii) An emergency warning and intercom system need not be provided in a *residential care building* in accordance with E4.9 if a warning system with an override public address facility is installed in accordance with Specification E2.2d.

4.3 Fire-Protected Timber Requirements

Refer NCC Spec C1.13a for fire-protected timber requirements

The NCC defines fire-protected timber as fire-resisting timber building elements that comply with Specification C1.13a.

4.3.1 Fire-Protected Timber – General Requirements

Specification C1.13a applies the following General Requirements to fire-protected timber:

- the building element must be protected to achieve the required FRL
- a non-combustible fire-protective covering must be applied to the timber; it must achieve a Resistance to the Incipient Spread of Fire (RISF) of not less than 45 minutes when tested in accordance with AS1530.4.

Note: The NCC Clause C1.9(e) permits some materials, including plasterboard and fibre-reinforced cement sheeting, to be used wherever a non-combustible material is required.

To adequately specify or check Evidence of Suitability of a fire-protected timber element, three items of information are required:

Refer NCC Schedule 5 for FRL

Refer NCC A5.2 and AS 1530.1 for non- combustibility

Refer NCC A5.6 for RISF

- Fire-resistance Level (FRL) – determined from AS 1530.4 test or an equivalent or more severe test.
- Resistance to the Incipient Spread of Fire (RISF) – determined from AS 1530.4 test or an equivalent or more severe test.
- Results from a non-combustibility test in accordance with AS 1530.1 – for materials not deemed non-combustible by the NCC.

(i) FRL is the grading period in minutes for the following three criteria expressed in the order listed below separated by forward slashes (/).

- structural adequacy – ability of a loadbearing element to support an applied load
- integrity – ability of an element of construction to resist the passage of flames and hot gases from one space to another
- insulation – ability of the surface of an element of construction, on the non-fire side of the element, to maintain a temperature below the specified limits.

For example, if an FRL of 90/60/30 is specified the element would need to satisfy the structural adequacy criteria for 90 minutes, the integrity criteria for 60 minutes and the insulation criteria for 30 minutes. A dash means that there is no requirement for that criterion, i.e. an FRL of 90/–/– means that only the criterion of structural adequacy applies for 90 minutes.

(ii) The RISF in relation to a fire-protective covering means the covering's ability to insulate voids and the interfaces with timber elements so as to limit the temperature rise to a level that will not permit ignition of the timber and the rapid and general spread of fire throughout any concealed spaces. The performance is expressed as the period in minutes that the covering will maintain a temperature below the specified limits.

(iii) A material is classified as non-combustible if flaming is not observed and specified temperature rise limits are not exceeded when a sample of material is exposed to the heating conditions specified in AS 1530.1 or it is deemed non-combustible in accordance with NCC Clause C1.9(e).

To facilitate a consistent approach to specifying the performance of fire-protected timber the following format is recommended.

Fire-Protected Timber – FRL90/90/90:RISF45:NC

This means that the element must satisfy the structural adequacy, integrity and insulation requirements for 90 minutes; the RISF criteria for 45 minutes and the fire-protective covering must have been shown to be non-combustible when tested in accordance with AS 1530.1 or comply with the requirements of the NCC Clause C1.9(e).

While individual test/assessment reports from Accredited Testing Laboratories can be used as Evidence of Suitability, it may be more practical for Accredited Testing Laboratories to provide consolidated reports stating the performance in the above format.

Further information relating to the test procedures to determine the FRL and RISF are provided in Appendix A.

NCC Spec C1.13a includes some Deemed-to-Satisfy fire-protective covering systems based on fire-protective grade plasterboard

Cavities are permitted within fire-protected timber elements that, without adequate measures in place, can allow fire spread through concealed spaces. The risk of fire spread from enclosure fires to the cavities is substantially reduced by the requirement for an RISF45 applied to the fire-protective covering, among other things. There is a small residual risk of fire spread to the cavity from an enclosure fire or a fire start within a cavity due to hot works, for example. The risk of fire spread via concealed spaces is further reduced by the provisions for cavity barriers and requirements for wall/ceiling cavity insulation, if present, to be non-combustible.

Specification C1.13a deems two layers of 13 mm fire-protective grade plasterboard fixed in accordance with manufacturer's system requirements to achieve equivalent performance to an RISF45:NC fire-protective covering.

The timber-framed wall system in Figure 4.2 with two layers of 13 mm fire-protective grade plasterboard either side of a cavity between studs could be classified as fire-protected timber FRL90/90/90:RISF45:NC if Evidence of Suitability (as required by the NCC) is provided for the loadbearing wall system to verify that it achieves an FRL of 90/90/90 under similar or more severe load conditions.

This evidence would normally be an AS 1530.4 fire test report from an Accredited Testing Laboratory. The RISF45 for two layers of 13 mm thick fire-protective grade plasterboard does not require further verification since it is Deemed-to-Satisfy the 45 minute requirement and plasterboard is also deemed non-combustible by Clause C1.9(e) of the NCC.

If fire-protective coverings satisfy the NCC Deemed-to-Satisfy provisions for RISF and non-combustibility it is only necessary to provide Evidence of Suitability to verify the required FRL

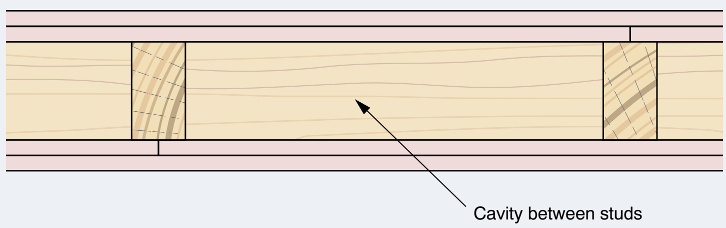


Figure 4.2: Horizontal section through typical FRL90/90/90:RISF45:NC timber stud wall showing allowable cavity.

Ensure the RISF is not compromised by service penetrations, doors and other openings and connections

The primary objective for the inclusion of the non-combustibility requirement for the fire-protective covering is so that the reaction of the fire-protected timber to external and enclosure fires is comparable to elements of construction that are non-combustible: such as reinforced concrete or steel protected with non-combustible materials.

The primary objective for the specification of RISF45 is to reduce the risk of the timber structural elements being ignited prior to burn-out of the contents or fire brigade intervention, in the unlikely event of the automatic fire sprinkler system failing. To achieve this, it is necessary that the RISF performance is not compromised by the presence of building service penetrations and openings for doors and windows. Refer to the relevant sections in this Step for further details on how the RISF performance can be maintained through appropriate penetration fire stopping systems, cavity barriers and lining of openings.

4.3.2 Massive Timber Panels

Subject to compliance with specific requirements, the RISF criteria can be 'relaxed' for massive timber panels in recognition of the higher inherent fire-resistance and mitigation of the risk of cavity fires

The NCC permits the General Requirements for fire-protected timber to be 'relaxed' if both the following additional criteria are satisfied:

- the minimum thickness of timber panels is not less than 75 mm
- there are no cavities between the surface of the timber and the fire-protective covering system or between timber members.

This 75 mm dimension relates to the minimum dimension of the dressed/finished timber member. In most instances, massive timber elements will have minimum dimensions much greater than 75 mm to meet the structural adequacy and integrity criteria of AS 1530.4.

Typical examples of massive timber installations satisfying the conditions are shown in Figure 4.3.

The rationale for allowing the 'concession' for massive timber is that it is reasonable to reduce the performance of the fire-protective covering, subject to maintaining the required FRL, because the consequences of ignition of timber structural members are significantly reduced:

- Timber with a large cross-section can achieve high fire-resistance levels due to its relatively high inherent fire resistance allowing it to continue to support an imposed load or maintain a fire separating function for significant periods. If there is an early failure of the fire-protective covering, the timber structure is likely to maintain its loadbearing capacity for a greater period than lightweight construction.
- By not permitting any concealed spaces between the timber and fire-protective coverings or between timber members, the risk of fire spread through concealed cavities is mitigated.

If the massive timber conditions are met, the following requirements can be adopted for fire-protected timber in lieu of the General Requirements:

- The building elements must be protected to achieve the required FRL and have a non-combustible fire-protective covering applied to the timber which achieves the Modified Resistance to the Incipient Spread of Fire (MRISF) of not less than the values stated in Table 4.1 when tested in accordance with AS 1530.4.
- The Modified Resistance to the Incipient Spread of Fire is determined in accordance with Clause 3 of NCC Specification C1.13a. Further information relating to the test procedures to determine the Fire Resistance and the MRISF are provided in Appendix A.

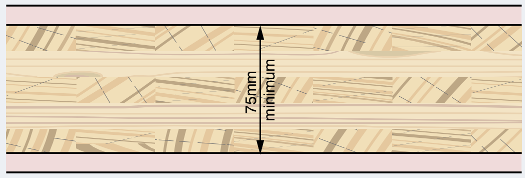
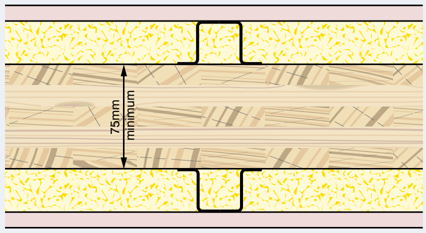
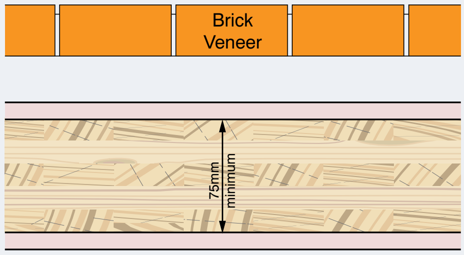
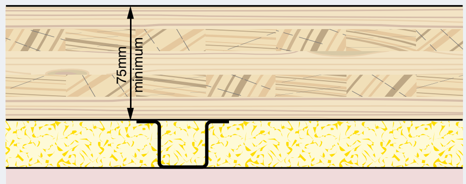
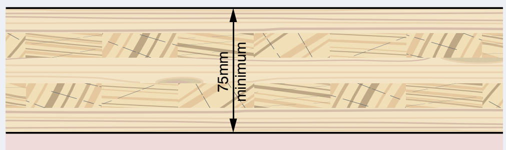
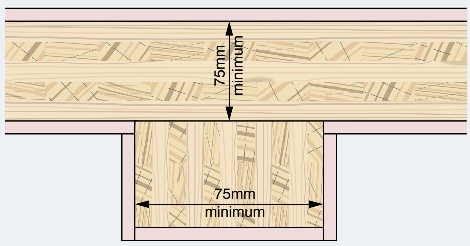
Description	Schematic section
Massive Timber Wall Panels	
Fire-protective covering direct fix to massive timber panel.	
Multi-layer fire-protective covering system direct fix to massive timber panel.	
External brick veneer wall – Note massive timber is faced on both sides with fire-protective coverings.	
Massive Timber Floor Panels	
Multi-layer fire-protective covering system direct fixed to the underside of the massive timber panel.	
Fire-protective covering direct fix to massive timber panel.	
Profiled ceiling fire-protective covering system follows the floor profile maintaining contact with massive timber element.	

Figure 4.3: Typical massive timber panel details for which the Modified Resistance to the Incipient Spread of Fire (MRISF) criteria may be applied.

To facilitate a consistent approach to specifying the performance of fire-protected massive timber the following format is recommended.

Fire-Protected Timber – FRL90/90/90:MRISF30:NC

This means that the element must satisfy:

- the structural adequacy, integrity and insulation requirements for 90 minutes
- the Modified Resistance to the Incipient Spread of Fire criteria for 30 minutes
- the fire-protective covering must have been shown to be non-combustible when tested in accordance with AS 1530.1 or comply with the requirements of the NCC Clause C1.9(e).

Table 4.1: Fire-protective covering requirements – Massive timber.

Application	Modified Resistance to the Incipient Spread of Fire (MRISF)	Minimum Deemed-to-Satisfy Fire-protective Grade Plasterboard
Inside a fire-isolated stairway or lift shaft	20 min	1 layer x 13 mm thick
External walls within 1 metres of an allotment boundary or 2 metres of a building on the same allotment	45 min	2 layers x 13 mm thick
All other applications	30 min	1 layer x 16 mm thick

Table 4.1 also includes Deemed-to-Satisfy fire-protective grade plasterboard minimum requirements if fixed in accordance with the manufacturer's system requirements in order to achieve the required FRL of the element for massive timber.

For example, if a non-loadbearing wall system is required to achieve an FRL of -/60/60, an appropriate specification for a massive timber element would be:

Fire-Protected Timber – FRL–/60/60:MRISF30:NC

If there is appropriate Evidence of Suitability to show a massive timber element can achieve an FRL of -/60/60 when protected by 16 mm fire-protective grade plasterboard, then no further evidence is required since the 16 mm thick plasterboard is Deemed-to-Satisfy the MRISF30 requirement and the plasterboard is also deemed to be non-combustible.

4.3.3 Fire-Protected Timber Element Requirements for Mid-Rise Class 2 and 3 Buildings of Timber Construction (General Requirements)

Mid-rise Class 2 and 3 (residential) buildings are typically more than 3 storeys high and are therefore required to be of Type A construction as designated by the NCC Volume One.

Having determined the Type of Construction for the building, it is possible to determine the fire-protected timber requirements for various wall, floor, ceiling and other building elements.

A typical mid-rise timber apartment building layout is shown in Figure 4.4 and Figure 4.5 with fire-protected timber elements. The FRLs and RISF requirements for these elements are summarised in Table 4.2.

Specification E1.5a allows significant concessions to be applied if supplementary requirements are satisfied as described in Section 4.2.3. Since the additional requirements are relatively minor and reflect good practice it is likely that in many applications the concessions will be adopted. Reductions in the FRLs of fire-protected timber constructions permitted by specification E1.5a are shown in brackets in Table 4.2.

For external walls refer to Section 4.6.

Refer NCC Volume One Specification C1.1 for required FRLs and Specification C1.13a for RISF requirements

Refer NCC Volume One Specification E1.5a for Concession option for sprinkler protected buildings

Table 4.2: FRL and RISF General Requirements for timber-framed construction in mid-rise Class 2 and 3 buildings.

Symbol	Description	FRL – Structural Adequacy /Integrity/ Insulation – min		Resistance to the Incipient Spread of Fire (min.)
		Loadbearing	Non-loadbearing[4]	
	Fire stair shaft	90/90/90	–/90/90 (–/60/60)	45
	Service Shaft	90/90/90	–/90/90 (–/60/60)	45
	Bounding walls – SOUs and public corridors etc	90/90/90	–/60/60	45
	Lift Shaft walls	90/90/90	–/90/90 (–/60/60)	45
	Door to fire Stair	Not applicable	–/60/30 (–/30/30)	Not applicable
	Fire Door to service shaft	Not applicable	–/60/30	Not applicable
	Door to SOU	Not applicable	–/60/30 (–/30/30)	Not applicable
	Lift door	Not applicable	–/60/–	Not applicable
	Fire doors to services risers[1]	Not applicable	–/60/30	Not applicable
	Non-loadbearing walls within an apartment	Not applicable	–/–/–	-
	Floors	90/90/90	Not applicable	45

Refer Specification C1.1 of NCC Volume One Cl 3.5 for the roof concession

Note 1: Riser doors may not require an FRL if service penetrations are fire stopped at floor level.

Note 2: Since the roof will have a non-combustible covering and mid-rise timber buildings are required to be sprinkler-protected throughout, the roof is not required to achieve an FRL.

In addition to the above requirements, the fire-protective coverings must also be non-combustible.

Note 3: Service penetrations through fire-protected timber elements permitted to achieve FRL of –/60/15 under the Specification E1.5a concession.

Note 4: Concessions for FRLs for non-loadbearing elements permitted by Specification E1.5a are shown in brackets.

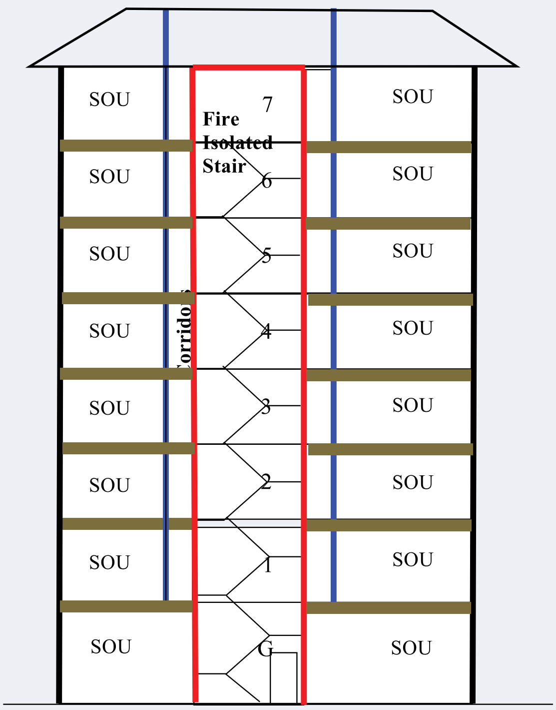


Figure 4.4: Typical section through a mid-rise apartment building.

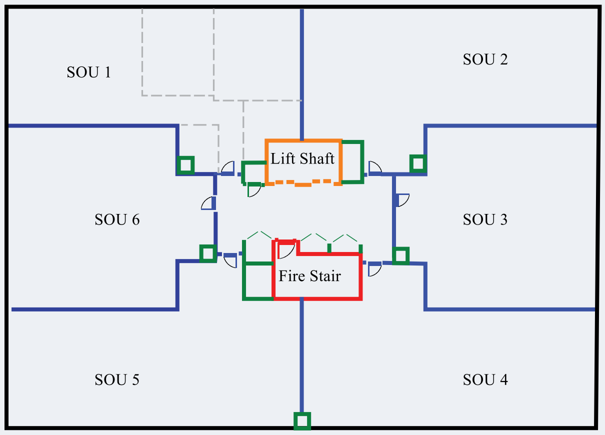


Figure 4.5: Plan of a typical apartment building floor.

4.3.4 Fire-Protected Timber Element Requirements for Mid-Rise Class 2 and 3 Buildings of Timber Construction using Massive Timber

Refer NCC Volume One Specification C1.1 for required FRLs and Specification C1.13a for MRISF requirements

The Massive Timber requirements, as summarised in Table 4.4, can only be applied if both the minimum element size and cavity restrictions are satisfied. If these conditions are not fully satisfied for an element, the General Requirements must be applied.

A typical mid-rise timber apartment building layout is shown in Figure 4.4 and Figure 4.5 with fire-protected timber elements. The FRLs and MRISF requirements for these elements are summarised in Table 4.3 for massive timber applications. For external walls refer to Section 4.6.

Table 4.3: FRL and MRISF requirements for massive timber construction in mid-rise Class 2 and 3 buildings.

Symbol	Description	FRL – Structural Adequacy /Integrity/ Insulation – min		Modified Resistance to the Incipient Spread of Fire (min.)
		Loadbearing	Non-Loadbearing[4]	
(red line)	**Fire stair shaft**	90/90/90	–/90/90 (–/60/60)	30 outside 20 inside
(green line)	**Service Shaft**	90/90/90	–/90/90 (–/60/60)	30
(blue line)	**Bounding walls – SOUs and public corridors etc**	90/90/90	–/60/60	30
(orange line)	**Lift Shaft walls**	90/90/90	–/90/90 (–/60/60)	30 outside 20 inside
(red door symbol)	**Door to fire Stair**	Not applicable	–/60/30 (–/30/30)	Not applicable
(green door symbol)	**Fire Door to service shaft**	Not applicable	–/60/30	Not applicable
(blue door symbol)	**Door to SOU**	Not applicable	–/60/30 (–/30/30)	Not applicable
(orange dashed line)	**Lift door**	Not applicable	–/60/–	Not applicable
(green chevron)	**Fire doors to services risers**[1]	Not applicable	–/60/30	Not applicable
(grey dashed line)	**Non Loadbearing walls within an apartment**	Not applicable	–/–/–	–
(brown line)	**Floors**	90/90/90	Not applicable	30

Note 1: Riser doors may not require an FRL if service penetrations are fire stopped at floor level.
Note 2: Since the roof will have a non-combustible covering and mid-rise timber buildings are required to be sprinkler-protected throughout, the roof is not required to achieve an FRL.

In addition to the above requirements, the fire-protective coverings must also be non-combustible.

Note 3: Service penetrations through fire-protected timber elements permitted to achieve FRL of –/60/15 under the Specification E1.5a concession.

Note 4: Concessions for FRLs for non-loadbearing elements permitted by Specification E1.5a are shown in brackets.

Refer NCC Volume One Clause C1.13(d) and Specification C1.1 Clause 3.1(d) and Clause 4.1(e)

4.4 Cavity Insulation Requirements

Combustible cavity insulation can facilitate ignition of cavity fires and the rapid spread of fire through cavities. Therefore, if cavity insulation is provided within fire-protected timber elements, it is required to be non-combustible.

Typical solutions include mineral fibre or glasswool insulation with very low organic binder contents. It is therefore important to check that Evidence of Suitability in the form of a current AS 1530.1 report from an Accredited Testing Laboratory is available for the specific products selected.

Cavity barriers are an essential component to mitigate the risk of fire spread through cavities

4.5 Cavity Barrier Requirements

Cavity barriers are barriers placed in a concealed space, formed within or around the perimeter of fire-protected timber building elements that comply with Specification C1.13.

They are required to be provided by the following clauses as part of a Deemed-to-Satisfy solution:

- Clause C1.13
- Clause 3.1d(iii) of Specification C1.1
- Clause 4.1e(iii) of Specification C1.1.

The spread of fire, smoke and hot gases to other parts of the building is limited by cavity barriers in conjunction with other measures such as the use of non-combustible cavity insulation.

The risk of fire spread via cavities and voids in designs that use massive timber is addressed by prohibiting designs that incorporate cavities and voids and hence the level of protection to the timber element can be reduced under certain circumstances.

4.5.1 Determining the Positions of Cavity Barriers

Cavity barriers are required at the following positions:

- junctions between fire-resisting floor/ceiling assemblies and fire-resisting walls
- junctions between fire-resisting floor/ceiling assemblies and fire-resisting external walls
- junctions between fire-resisting walls and external walls
- around the perimeters of door and window openings in fire-resisting construction.

Horizontal barriers must be provided at each floor level up to a maximum distance of 5 metre centres.

Vertical barriers must be provided in walls up to a maximum distance of 10 metre centres.

Typical positions of cavity barriers are shown for an apartment building in Figures 4.6 and 4.7. Table accompanying Figure 4.7 includes a key describing the position and types of interface being protected. Typical details are shown in Section 5.

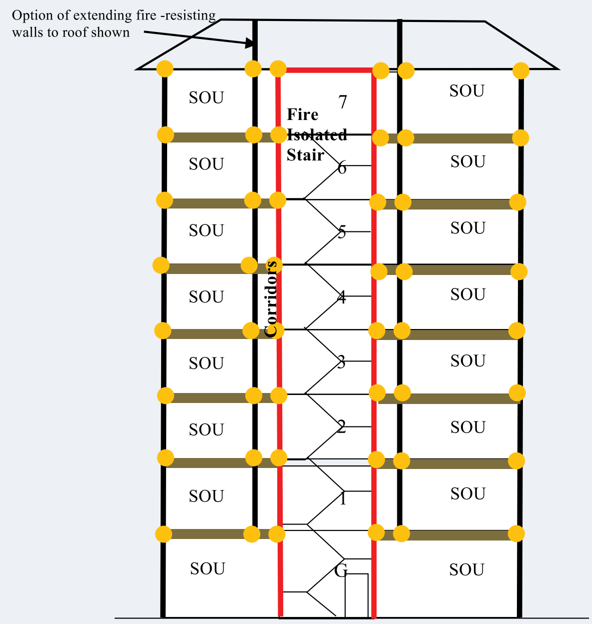


Figure 4.6: Vertical section of an apartment building showing typical cavity barrier positions.

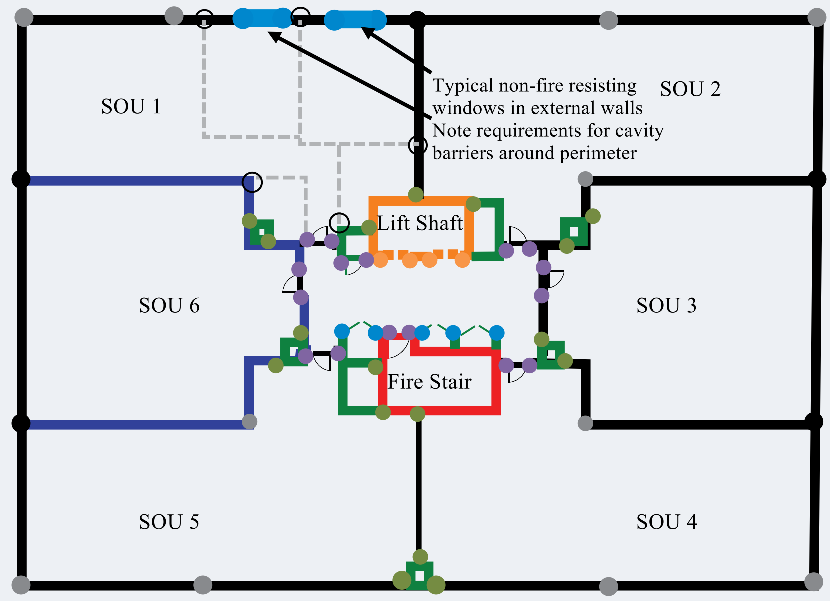


Figure 4.7: Floor plan section of an apartment building showing typical cavity barrier positions.

Symbol	Description	Comments
(yellow dot)	Horizontal cavity barriers around perimeter of floors	If the floor to floor height is greater than 5 m intermediate horizontal barriers in walls would be required
(grey dot)	Cavity barriers in fire-protected timber walls	Vertical cavity barriers are required at maximum 10 m centres
(blue dot)	Cavity barriers around perimeter of non-fire-resisting doors and windows	Required to prevent entry of fire into cavity when non-fire-resisting elements fail
(black dot)	Interface of fire-resisting walls with external walls	Can be incorporated as part of a standard detail
(green dot)	Interface of shafts with standard walls	Can be incorporated as part of a standard detail
(purple dot)	Interface with fire doors	Normally part of the standard detail for installation since the doorset is required to maintain the fire resistance of the wall
(orange dot)	Interface with lift doors	In some instances it may be more practical to interface with other forms of construction around lift doors
(open circle)	Interface between non-fire-resisting wall and fire-resisting walls	Continuity of the fire protective coverings should be maintained at the point of penetration

Note 1: Riser doors may not require an FRL if service penetrations are fire stopped at floor level.

4.5.2 Specifying Cavity Barrier Requirements for Building Elements

Essentially there are two levels of performance required for cavity barriers prescribed by the NCC.

- Cavity barriers with FRLs of -/45/45 for building elements with FRLs not exceeding 90/90/90.
- Cavity barriers with FRLs of -/60/60 for building elements with FRLs greater than 90/90/90

For each case, the NCC prescribes Deemed-to-Satisfy Provisions based on minimum thicknesses of timber or non-combustible mineral fibre in the direction of heat flow as summarised below in Table 4.4.

For Class 2 and 3 buildings most elements have FRLs of 90/90/90 or less. Higher FRLs may be required for multi-class buildings.

Table 4.4: NCC prescribed Deemed-to-Satisfy solutions for cavity barriers.

Prescribed solution options	Fire-protected timber FRL	
	90/90/90 or less	>90/90/90 to 240/240/240
FRL for cavity barrier	-/45/45	-/60/60
Timber required minimum thickness*	45 mm	60 mm
Mineral wool required minimum thickness*	45 mm	60 mm

* Minimum thickness measured in the direction of heat flow - refer Appendix B.

For fire-protected timber with large cavities, which may occur in floor and roof cavities for example, it may be more practical to construct cavity barriers from plasterboard supported from timber framing (refer Figure 5.49)

4.6 External Walls/Building Facades

In addition to maintaining loadbearing capacity when subjected to fires within a building, the external walls also need to address the risk of fire spread via the building facade under the following scenarios:

- Fire spread from adjacent buildings (or the fire source feature as defined in the NCC) to the subject building. Under the DTS Solution pathway for mid-rise timber buildings this is addressed by means of specification of minimum separation distances, fire-resisting construction and the requirement for external walls to be non-combustible or of fire-protected timber construction.
- Fire spread from the subject building (or the fire source feature as defined in the NCC) to adjacent buildings. Under the DTS Solution pathway for mid-rise timber buildings this is addressed by specifying minimum separation distances, fire-resisting construction and the requirement for external walls to be non-combustible or of fire-protected timber construction and by providing automatic fire sprinklers.
- Fire spread from an external fire source adjacent to the facade other than adjacent structures; including balcony fires. Under the DTS Solution pathway for mid-rise timber buildings, this is addressed by specifying fire-resisting construction and the requirement for external walls to be non-combustible or of fire-protected timber construction.
- Vertical fire spread between openings from a fully developed fire within the subject building. Under the DTS Solution pathway for mid-rise timber buildings, this is addressed by specifying fire-resisting construction and the requirement for external walls to be non-combustible or of fire-protected timber construction and by providing automatic fire sprinklers.

The measures described above are considered in more detail in the following Sections.

4.6.1 Fire-Protected Timber Requirements for External Walls

The FRLs required for external walls are nominated in NCC Specification C1.1 and are dependent on the building use (Class of Building), Type of Construction and proximity to the boundary (fire source feature) or other buildings. Mid-rise residential buildings (Class 2 and 3) are required to be of Type A construction.

The Resistance to the Incipient Spread of Fire (RISF) or, if massive timber is used, the Modified Resistance to the Incipient Spread of Fire (MRISF), requirements are nominated in NCC Specification C1.13a.

The requirements for Class 2 and 3 buildings of Type A construction are summarised in Table 4.5 and Table 4.6.

Table 4.5: FRL and RISF general requirements for timber-framed mid-rise residential building external walls (Type A construction).

Distance from fire source feature	FRL – Structural Adequacy /Integrity/Insulation – minutes		Resistance to the Incipient Spread of Fire (minutes)
	Class 2 and 3 (Residential)		
	Loadbearing	Non-Loadbearing	
≤1.0 m	90/90/90	–/90/90	45
<1.5 m	90/90/90	–/90/90	45
≥1.5 and <3 m	90/60/60	–/60/60	45
>3 m	90/60/30	–/–/–	45
External columns	90/–/–	–/–/–	45

Even though non-loadbearing external walls do not require an FRL if more than 3 metres from a fire-source feature, the fire-protective coverings must be applied and are required to achieve a RISF of 45 minutes since the external wall is required to be non-combustible. This is to address the risk of external fires on balconies or external areas adjacent to the building and the risk of vertical fire spread through openings if a fully developed fire occurs.

Table 4.6: FRL and MRISF requirements for timber mid-rise residential external walls for massive timber (Type A construction).

Distance from fire source feature	FRL – Structural Adequacy /Integrity/Insulation – minutes		Modified Resistance to the Incipient Spread of Fire (minutes)
	Class 2 and 3 (Residential)		
	Loadbearing	Non-Loadbearing	
≤1.0 m	90/90/90	–/90/90	45 external 30 internal
<1.5 m	90/90/90	–/90/90	30
≥1.5 and <3 m	90/60/60	–/60/60	30
>3 m	90/60/30	–/–/–	30
External Columns	90/–/–	–/–/–	30

Even though non-loadbearing external walls do not require an FRL if more than 3 metres from a fire-source feature, the fire protective coverings must be applied and are required to achieve a MRISF of 30 minutes.

For buildings within 1 metre of the boundary (or 2 m of an adjacent building on the same allotment), an MRISF of 45 minutes for the external surfaces is required to minimise the risk of ignition from fires in adjacent buildings but the internal face need only achieve a MRISF of 30 minutes.

Refer NCC Volume One Clause C2.6(b)(iii)

4.6.2 Vertical separation of openings in external walls

The NCC DTS Provisions for external walls requires vertical separation of openings to be addressed for Type A buildings to reduce the risk of fire spreading between floors if a fully developed fire occurs.

This can be achieved by providing spandrel panels or horizontal projections but the NCC waives these requirements if an automatic fire sprinkler system is provided in accordance with NCC Specification E1.5. This recognises that early suppression or control of an internal fire by an automatic fire sprinkler system is an effective means of minimising the risk of fire spread between floors via the facade provided fire-protected timber or non-combustible construction is adopted.

Overcoming the need to provide additional vertical separation by, for example, spandrel panels simplifies construction and provides greater design flexibility.

4.6.3 External Wall/Facade Systems

External walls form the building facade and the NCC requires them to serve a number of functions in addition to addressing fire safety, including:

- structural performance (for safety and serviceability)
- weather resistance (resistance to water penetration)
- light and ventilation (including condensation control)
- energy efficiency (thermal insulation)
- durability
- acoustic separation.

The external face of the wall may form part of the fire-protective covering (e.g. brick veneer construction) or may cover a fire-protective covering to prevent water penetration and serve other non-fire related functions (e.g. rain screen). In both cases, the NCC requires the external walls to be of non-combustible construction and therefore all these coverings must be non-combustible.

Refer Verification Methods CV1, CV2 CV3, AS 5113 and relevant State or Territory Regulations

Typical details of brick-veneer construction or fixing of non-fire-resistant coverings, such as rain screens, are shown in Section 5.

If the building design specifies combustible cladding systems, the performance pathway could be adopted subject to it being possible to demonstrate compliance of the wall system with the relevant NCC performance requirements.

NCC Verification Method CV3, in conjunction with Verification Methods CV1 and CV2, defines an appropriate method which requires, among other things:

- the external wall system to achieve the EW classification in accordance with AS5113.
- enhancements to automatic sprinkler protection.

Note: Some States and Territories may apply additional controls on the use of combustible cladding systems.

When designing lift shafts it is important to involve the lift supplier at an early stage to ensure the shaft will satisfy their design requirements and applicable regulations

4.7 Lift Shafts

Some designs of timber buildings adopt a hybrid approach and incorporate concrete or masonry shafts. Where this approach is adopted it is important that the potential for differential movement between the timber structure and shaft be taken into account when detailing connections and interfaces.

When designing lift shafts it is important to involve the lift supplier at an early stage to ensure the shaft will satisfy their design requirements and applicable regulations.

The remainder of this Section addresses the fire safety performance of lift shafts of fire-protected timber construction with respect to NCC compliance.

4.7.1 Timber-framed Lift Shaft Construction

Table 4.7 has been derived from Section 4.3 to show the NCC requirements that are applicable to timber-framed lift shafts in mid-rise residential timber buildings.

EWFA RIR 37401400 is available on the WoodSolutions website

Table 4.7: Requirements for fire-protected timber-framed lift shafts.

Criteria	Residential Buildings (Class 2 and 3)
FRL for loadbearing walls	90/90/90
FRL for non-loadbearing walls	–/90/90 (–/60/60)[2]
RISF for walls	45
Lift landing doors	–/60/–

Note1: The wall FRL and RISF requirements are applicable from both inside and outside the shaft.
Note 2: Concessions for FRLs for non-loadbearing elements permitted by Specification E1.5a are shown in brackets.

To minimise sound transmission to adjoining areas, double stud construction may be employed and/or an independent support structure provided within the shaft.

The fire-resistance of lift landing door assemblies should be determined by fire tests in a representative wall construction type. At the time of preparation of this Guide evidence of suitability for lift landing doors directly fixed to timber-framed wall assemblies was unable to be obtained.

A practical way to address this is to transition the shaft wall construction around the door opening to a form of non-combustible construction having FRLs with which the performance of the lift door has been verified.

An example of transitioning to a steel shaft wall system from a fire-protected timber wall shaft is shown in Figures 4.8 and 4.9 - refer to Section 4.10 and Section 5 for further details. These interface details have been assessed by an Accredited Testing Laboratory (EWFA Regulatory Information Report (RIR) 37401400), which determined that the interface details will not reduce the FRL, RISF or MRISF of the base wall system or the lift landing doors up to the lesser of 120/120/120 or the FRL of the element. Evidence of Suitability for the specific proprietary lift door, steel stud shaft wall and timber shaft wall, in accordance with Clause A5.2 and A5.4 to A5.6 as appropriate of the NCC, should be submitted to the relevant regulatory authority in addition to RIR 37401400.

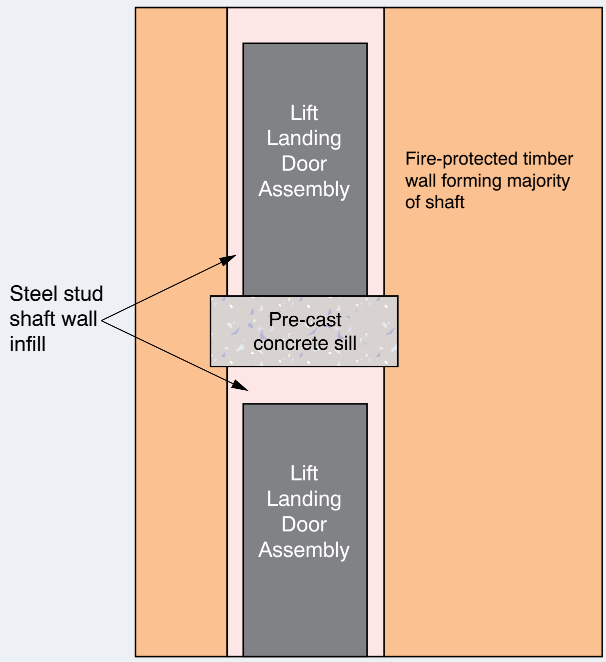


Figure 4.8: Elevation showing wall transition around lift landing doors.

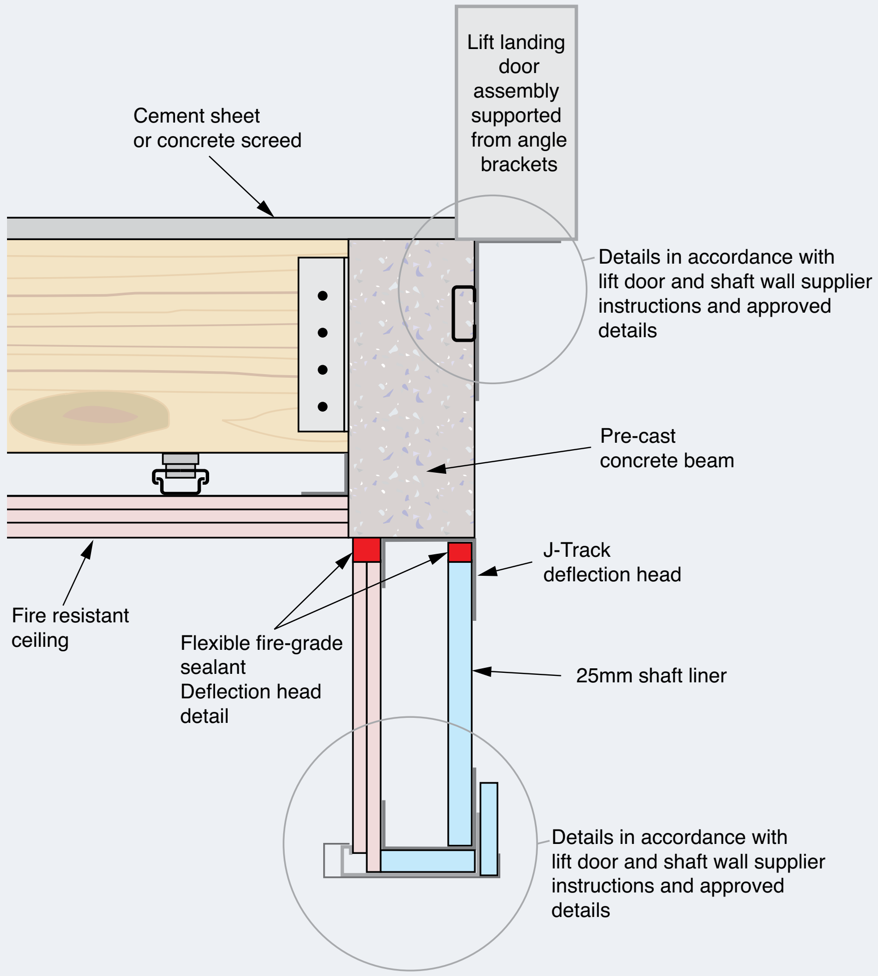


Figure 4.9: Generic detail for sill and head mounting.

4.7.2 Massive Timber Lift Shaft Construction

Table 4.8 has been derived from Section 4.3 to show the NCC requirements that are applicable to timber lift shafts in mid-rise timber buildings if using massive timber.

Table 4.8: Requirements for fire-protected timber lift shafts if using massive timber.

Criteria	Residential Buildings (Class 2 and 3)
FRL for loadbearing walls	90/90/90
FRL for non-loadbearing walls	–/90/90 (–/60/60)[2]
MRISF for walls	30 outside face 20 inner face
Lift landing doors	–/60/–

Note1: The wall FRL and MRISF requirements are applicable from both inside and outside the shaft unless otherwise indicated.
Note 2: Concessions for FRLs for non-loadbearing elements permitted by Specification E1.5a are shown in brackets.

If utilising massive timber construction, the MRISFs are reduced from 30 to 20 minutes within the lift shaft. This relaxation reflects the lower probabilities of severe fires occurring within these areas but a basic level of protection is retained to address the small potential of fires occurring within these areas, where fire may spread to evacuation paths which could be quickly compromised due to rapid fire spread in the early stages of a fire. The outer faces still require an MRISF of 30 minutes. This configuration is shown in Figure 4.10.

To minimise sound transmission to adjoining areas, double skin construction may be employed and/or an independent support structure provided within the shaft for a single skin option. If double skin construction is employed it should be noted that the NCC does not permit an unfilled cavity between the massive timber skins when using the massive timber provisions. If unfilled double-skin construction is preferred, there is still an option to use the General Requirements (timber-framed construction) rather than the massive timber requirements. The General Requirements require the inner and outer faces to achieve a RISF of 45 minutes. This can be achieved by applying two layers of 13 mm thick fire-protective grade plasterboard to both the inner and outer faces of the shaft.

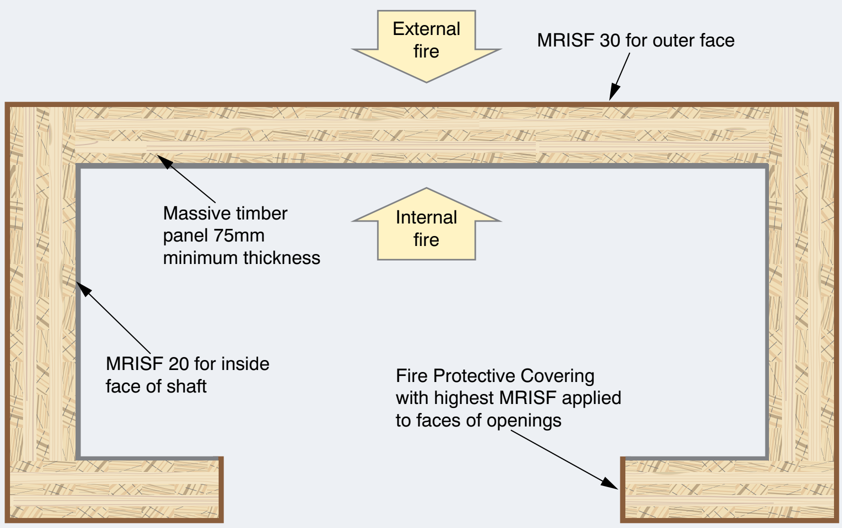


Figure 4.10: MRISF requirements for typical stair and lift shaft construction for single skin massive timber panel construction.

EWFA Regulatory Information Report (RIR) 37401400 is available on the WoodSolutions website

4.8 Fire Isolated Stairs and Passageways

The FRL, RISF or MRISF required for Fire-Isolated Stairs and Passageways are the same as those required for lift shafts described in Section 4.7 without the complication of lift landing doors.

Fire doors to fire-isolated stairs or passageways are required to achieve an FRL of –/60/30 or –/30/30 if the concessions of Specification E1.5a are applicable. Several proprietary fire door systems have been tested when mounted in timber construction. Installation details for fire doors capable of achieving the required FRLs should be obtained from the supplier as they may vary. Figure 4.11 shows a typical interface detail with a fire-protected timber wall. These interface details have been assessed by an Accredited Testing Laboratory (EWFA RIR 37401400) which determined that the interface details will not reduce the FRL, RISF or MRISF of the base wall system or the fire doors up to the lesser of 120/120/120 or the FRL of the element. Evidence of Suitability for the specific proprietary door, and timber shaft wall, in accordance with Specification A5.4 of the NCC, should be submitted to the relevant regulatory authority in addition to EWFA RIR 37401400.

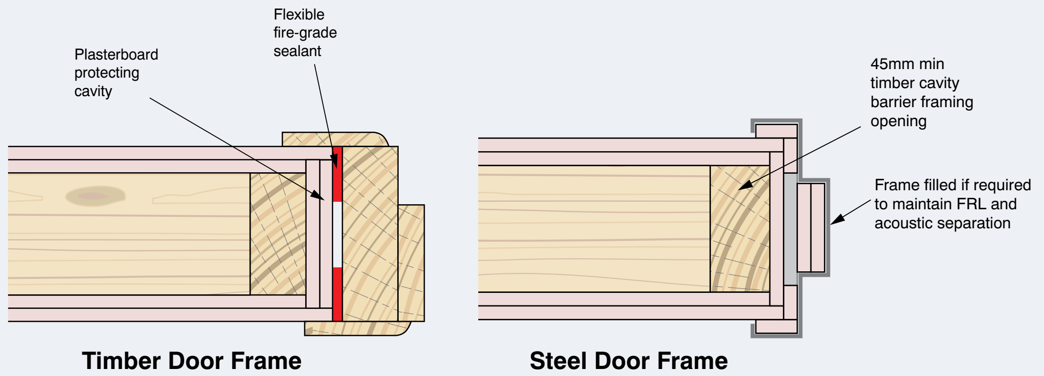


Figure 4.11: Typical fire door installation details.

4.8.1 Timber Stairways Concession

NCC Clause D2.25 provides a concession allowing timber treads, risers, landings and associated supporting framework to be used within a required fire-isolated stairway or fire-isolated passageway constructed from fire-protected timber in accordance with Specification C1.13a subject to:

- timber having a finished thickness of not less than 44 mm
- an average timber density of not less than 800 kg/m^3 at a moisture content of 12%
- the building being protected throughout by a sprinkler system complying with Specification E1.5, other than FPAA101D and FPAA101H systems, that is extended to provide coverage within the fire-isolated enclosure, and
- the underside of flights of stairs and landings at or near the level of egress or direct access to a car park being protected by a single layer of 13 mm fire-protective grade plasterboard fixed to the stringers with fixings at not greater than 150 mm centres.

Fires starting in fire-isolated stairs are rare. When they do occur, they generally involve stored or introduced materials and often the cause is malicious. Even though it is not permitted to store goods in fire-isolated stairs and passageways, areas under the lowest flight of stairs form a convenient dry area for temporary storage. These areas may also not be secured, further increasing the risk of malicious fire starts.

While it could be argued that the extension of the sprinkler system to fire-isolated stairs and passageways addresses this issue, as an additional precaution, the underside of the lower stairs where combustibles can be stored are required to be protected by a fire-protective covering of 13 mm fire-protective grade plasterboard.

Section 5 provides further details of the requirements for timber stairways.

4.9 Building Services

4.9.1 Selection of Building Services and Distribution Paths

Careful planning and design of building services and distribution paths at all stages of the design process can greatly simplify construction and subsequent maintenance

The building services and associated cable and pipe runs need to be selected and refined during the design process to ensure the installation of the services and associated fire protection is efficient and reliable, with access to ensure the systems can be maintained or expanded without compromising fire safety.

Key points for consideration with respect to fire safety and acoustics are:

The number of service penetrations through fire-protected timber construction and fire-resisting construction generally should be minimised as far as practicable. This can be achieved by measures such as self-contained air-conditioning systems serving each sole-occupancy unit (SOU), and false ceilings and wall facings allowing services to run behind the non-fire-rated facing without penetrating the fire-resisting elements.

Generally, services and connection details should not require hot works. For fire services, such as sprinkler systems, the time they will be unavailable during maintenance and modification should be minimised. In some instances these requirements may conflict. For example, the use of CPVC piping for sprinkler systems can reduce hot works but if the pipework is adjusted the system will be unavailable while the glue sets, potentially overnight. Another option to avoid hot works may be to use mechanical joiners for metal pipes.

If service penetrations through fire-resisting construction cannot be avoided, the services should penetrate shaft or service duct walls rather than fire-resisting walls or floors separating occupied areas. This reduces the acoustic impact as well as limiting the consequences if a penetration protection system fails; as smoke and fire spread will initially be limited to the service ducts.

Where practical, shafts, service risers and service ducts should be readily accessible from public parts of the building to facilitate maintenance and inspection but access hatches/panels or doors should normally be secured to prevent unauthorised access.

Where practical, service penetrations through fire-protected timber construction should be grouped together and penetrate framed out openings that are then fire stopped with proprietary systems such as non-combustible batts, board or pillow systems. This approach substantially reduces the risk of fire spread to cavities at a point of weakness and ignition if hot works are being undertaken on the services.

In residential buildings, each SOU is effectively a fire compartment and includes bathrooms and kitchens and, in many instances, it is impractical to consolidate services such as drain, waste and vent (DWV) pipes around the central core and therefore service shafts are distributed around the floor. For apartment buildings, the use of self-contained heating, ventilation and air-conditioning (HVAC) systems tends to be preferred; in hotels and the more institutional style buildings, centralised HVAC systems may be preferred requiring duct penetration of walls and floors to be addressed.

Typical details are provided in Section 5.

4.9.2 Service Shaft Construction

The requirements for fire-protected timber service shafts used for ventilation, pipes, garbage or similar purposes are summarised in Table 4.9.

Shafts must also be enclosed at the top and the bottom with a floor/ceiling system of the same Fire Resistance Levels and Resistance to the Incipient Spread of Fire ratings as the walls; except where the top of the shaft is extended beyond the roof, or the bottom of the shaft is of non-combustible construction laid directly on the ground.

The shaft is also required to be sound rated if it passes through more than one SOU and must have a R_w+C_{tr} of 40 if the adjacent room is habitable and R_w+C_{tr} of 25 if it is a kitchen or non-habitable room.

Table 4.9: Requirements for fire-protected service shafts in mid-rise timber buildings.

Criteria	Residential Buildings (Class 2 & 3)
FRL loadbearing elements	90/90/90
FRL non-loadbearing elements	-/90/90 (–/60/60)
RISF	45
MRISF (Massive Timber)	30

Note: Concessions for non-loadbearing elements permitted by Specification E1.5a are shown in brackets. These concessions also reduce requirements for the FRLs of service penetrations to -/60/15 through fire- protected non-loadbearing timber shafts.

In many instances it is more practical to construct non-loadbearing shafts from laminated board systems or steel shaft wall construction in lieu of fire-protected timber construction.

If the shaft wall is non-loadbearing and of non-combustible construction, and the Specification E1.5a concessions are applicable, the FRL of the shaft can be reduced to –/45/45 with service penetrations required to achieve an FRL of –/45/15.

Details on how to construct shafts in timber-framed construction and how to interface fire-protected timber walls with laminated board shafts or steel shaft wall construction are given in Section 5.

4.9.3 Protection of Service Penetrations

The NCC requires service penetration systems to comply with AS 4072.1 and AS 1530.4. For services penetrating fire-protected timber elements there is an added complication that the Resistance to the Incipient Spread of Fire (RISF) or Modified RISF criteria have also to be satisfied in addition to the integrity and insulation criteria applied to the non-fire side.

Further explanations of the test procedures are provided in Appendix A.

Typical solutions to address RISF performance criteria include:

- boxing out openings with plasterboard
- filling the area around the service penetration with non -combustible mineral fibre insulation
- transitioning to a different wall type where service penetrations are required.

If Specification E1.5a concessions apply the insulating criteria for service penetrations is reduced to 15 minutes.

Examples are provided in Section 5.

4.10 Interfacing With Other Forms of Construction

There can be advantages in adopting hybrid forms of construction in buildings. For example, ground floor and basement areas may be constructed from concrete to minimise the risk of water penetration, minimise potential damage in flood-prone areas or address the risk of termites.

The relatively lighter weight of timber structures also makes timber construction ideally suited to the upward extension of existing buildings facilitating infill developments and recycling existing buildings. For example, it may be possible to add apartments above existing retail buildings without having to undertake extensive foundation works.

4.10.1 Separation of Different Classes of Buildings

Refer NCC Volume One Clause C2.8 for further details

Refer NCC Volume One Clause C2.9 for further details

The NCC addresses the separation of classifications within a building in Clauses C2.8 and C2.9.

For different classifications on the same storey, parts having different classifications should be separated by a fire wall having the higher FRL of the two, in accordance with Specification C1.1.

For different classifications in different storeys in a Type A building (most mid-rise buildings), the floor between the adjoining parts must have an FRL not less than that prescribed by Specification C1.1 for the lower storey.

Refer NCC Clause C1.3 for determining the type of construction required for a multiple classification building

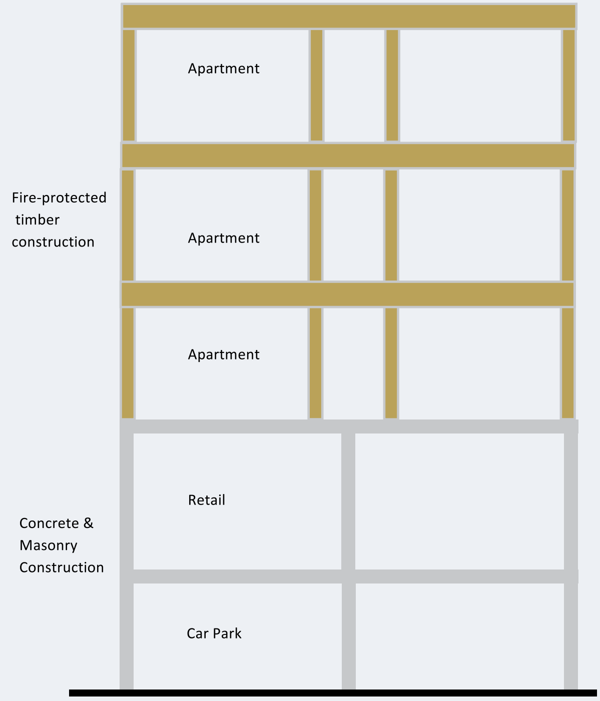


Figure 4.12: Example of multi-class building.

A typical building layout is shown in Figure 4.12 with a retail part of concrete framed construction below timber apartment levels. For the fire-protected timber concession to apply, the whole building must be sprinkler protected in accordance with NCC Specification E1.5 excluding FPAA101D and FPAA101H systems.

Retail use is assigned to Class 6 buildings. From Table 3 of Specification C1.1, the concrete slab separating the retail and apartment levels would require an FRL of 180/180/180.

4.11 Special Fire Issues

In constructing Class 2 and 3 mid-rise timber buildings, special issues arise as buildings become larger and more complicated. Although this Guide does not attempt to provide information to suit all circumstances, information is provided where there is relevance to timber construction practices.

Refer NCC Volume One Clause C1.13 for the Fire-protected timber Concession

4.11.1 Smoke-Proof Walls

For Class 2 and 3 buildings, the NCC requires that public corridors greater than 40 metres long be divided by smoke-proof walls at intervals of not more than 40 metres. These walls must be built from non-combustible materials and extend to the floor above, roof covering or Resistance to the Incipient Spread of Fire (RISF) ceiling.

Smoke-proof walls can be constructed from fire-protected timber if the RISF of 45 or MRISF of 30 (for massive timber construction) is achieved. Where the smoke-proof wall is also required to achieve an FRL (e.g. the wall is loadbearing) the fire-protected wall will need to meet the required FRL.

Where there is no requirement for an FRL, the Deemed-to-Satisfy plasterboard-based solutions can be adopted. For timber-framed construction, two layers of 13 mm fire-protective grade plasterboard should be applied to both sides of the framing; and if massive timber construction is used, the timber panel should be faced on both sides with one layer of 16 mm fire protective grade plasterboard.

4.11.2 Fire Precautions During Construction

Fires may occur on building construction sites due to the nature of the works. Typical causes include:

- hot works (cutting and welding)
- heating equipment
- smoking materials
- other accidental fires
- arson.

Timber construction covered with fire-protective linings is a safe and economical building system. The fire-protective coverings play an important role in providing this fire safety but, due to the construction sequencing, there may be a period where the timber is not protected. This is when timber buildings are at their highest risk from construction fires.

The NCC requires a suitable means of fire-fighting to be installed in a building under construction to allow initial fire attack by construction workers and for the fire brigade.

A building under construction that is less than 12 metres in effective height must have one fire extinguisher to suit Class A, B and C fires, as defined in AS 2444, and electrical fires provided at all times on each storey adjacent to each exit, or temporary stairway or exit.

After the building has reached an effective height of 12 metres, the following additional measures must be operational:

- the required fire hydrants and fire hose reels must be operational in at least every storey that is covered by the roof or the floor structure above, except the two uppermost storeys
- any required booster connections must be installed.

In this instance, 'required' means satisfying the NCC performance requirements in the complete building using either the performance or Deemed-to-Satisfy pathways.

As the scope of the NCC does not fully address Workplace Health and Safety (WHS) issues, and the NCC prescribes minimum levels of compliance, builders and building owners need to consider what is actually required for the building site. Typical matters that should be considered include:

- progressive installation of fire-fighting services
- progressive installation of fire-protective grade covering of timber members (i.e. installation of fire-protective coverings) and compartmentation of the building
- prefabrication and delivery to site with full or partial encapsulation of timber
- access for fire fighters and egress provisions for staff and visitors on the building site
- selection of materials and work methods that minimise the need for hot works.

WoodSolutions Technical Design Guide #20 Fire Precautions During Construction of Large Buildings provides additional information that can be applied to the design and planning stages as well as the actual construction phase.

4.11.3 Bushfire-prone Areas

The requirements for Class 2 and 3 buildings to address the risk of bushfires vary between States and Territories and may fall under different jurisdictions to standard building works. The need to consider bushfire exposures should be determined early in the design processes and addressed accordingly.

The NCC requires external walls to be of non-combustible construction in mid-rise buildings and the fire-protected timber provisions requires timber elements to be protected by non-combustible fire-protective coverings providing a good basis for the building to resist bushfire attack.

Further guidance is provided in ***Woodsolutions Technical Design Guide #4 Building with Timber in Bushfire-prone Areas,*** which includes design solutions for BAL levels from 12.5 to BAL-FZ. However, for mid-rise timber buildings, some modifications may be required to satisfy the fire-protected timber requirements

4.11.4 Lightweight Construction Structural Requirements – Specific Applications

The NCC requires elements that have Fire Resistance Levels (FRLs), or that form a lift, stair shaft, an external wall bounding a public corridor, non-fire-isolated stairway or ramp, to comply with Specification C1.8, if they are made out of lightweight materials such as timber-framing faced with plasterboard.

Specification C1.8 defines a structural test for lightweight construction and, in most parts, is directly related to the performance of the linings used. Appropriate Evidence of Suitability should be obtained from suppliers of lining materials used to verify compliance during the design phase.

4.11.5 Robust Structural Design

The NCC, under Part B1 Structural Provisions (BV2), provides a verification method for structural robustness as a means of verifying compliance with performance requirement BP1.1(a)(iii). The Verification Method states:

Compliance with BP1.1(a)(iii) is verified for structural robustness by -

(a) assessment of the structure such that upon the notional removal in isolation of -

(i) any supporting column; or

(ii) any beam supporting one or more columns; or

(iii) any segment of a loadbearing wall of length equal to the height of the wall, the building remains stable and the resulting collapse does not extend further than the immediately adjacent storeys; and

(b) demonstrating that if a supporting structural component is relied upon to carry more than 25% of the total structure a systematic risk assessment of the building is undertaken and critical high risk components are identified and designed to cope with the identified hazard or protective measures chosen to minimise the risk.

The structural design of mid-rise timber buildings should comply with these requirements and the design guidance provided in *WoodSolutions Design Guide #39 Robustness in Structures* to ensure the building is adequately robust in the event of localised failure of elements during a fire.

4.11.6 FRL Concessions that are not Applicable to Fire-protected Timber

The fire-protected timber provisions were based on the FRLs prescribed by Specification C1.1 without reductions in FRLs as permitted by the following concession:

- the residential aged care building concession specified in Clause 2.9 of Specification C1.1
- Vic H103.1 Fire safety in Class 2 and Class 3 buildings.

If a reduction in FRLs in accordance with the above concessions is being considered, the Performance Solution pathway must be adopted.

5

Step 5 Integrate Architectural, Structural and Building Services Designs (Detailed Design)

This step brings together the content of the previous Sections to develop an integrated design. A residential building with retail at ground level and basement car parking is used to demonstrate the process including interfacing Class 2 and 3 parts of a fire-protected timber building with other forms of construction and parts of a building with a different Class.

A key focus of this Step is coordinating the various design disciplines so that:

- Timber elements and protection systems are optimised to satisfy the NCC requirements in a practical and cost-effective manner by focusing on the synergies between elements designed to satisfy the following criteria:
  - fire-protected timber
  - sound transmission and insulation
  - thermal resistance
  - weatherproofing
  - structural tests for lightweight construction.
- Interfaces between building services and the structure, fire-protected timber elements and acoustic barriers are designed:
  - to minimise building service penetrations through fire-protected timber elements and acoustic barriers as far as practical
  - such that where services have to penetrate fire-protected timber elements the fire safety performance of the element is not compromised and fire separation is maintained
  - so that if services have to penetrate acoustic barriers the positions are selected to minimise negative impacts on amenity
  - so that service penetration systems can accommodate any differential movement between elements
  - to allow for maintenance and additions/modifications to the building services.
- Structural design is efficient and robust.
- Other fire safety principles for mid-rise buildings are satisfactorily implemented including:
  - cavity barriers
  - automatic fire sprinkler systems.
- Other design requirements are addressed such as termite management and resistance to ground water/moisture penetration.

5.1 Optimising the Performance of Elements of Construction

Elements of construction in a modern buildings may have to serve a number of functions including:

- restricting fire spread
- limiting sound transmission from adjacent enclosures (and in some instances external noise)
- limiting heat loss and/or heat gain through external elements
- weather resistance of external facades and roofs
- impact resistance to reduce the risk of damage to lightweight construction.

The elements also need to achieve levels of durability appropriate for the application. Further advice on durability is provided in: *WoodSolutions Timber Design Guide #5 Timber service life design – Design guide for durability.*

Efficient designs can be achieved by selecting combinations of materials and configurations that work together to satisfy the design objectives summarised in the following Sections.

Typical examples include:

- Cavity barriers required by the NCC Deemed-to-Satisfy for mid-rise timber buildings to reduce the risk of fire spread through concealed spaces can also be used to minimise flanking noise transmission around the perimeters of elements of construction and reduce heat loss via leakage through the structure.
- Non-combustible cavity insulation will:
  - reduce the risk of fire spread through cavities
  - reduce sound transmission through elements of construction
  - reduce heat loss and/or gain through external walls.

5.1.1 Fire-protected Timber

Fire-protected timber has timber structural members protected by non-combustible fire-protective coverings. The fire-protective coverings:

- prevent or delay the ignition of the timber members so that the response to an enclosure fire will be similar to non-combustible elements such as masonry or concrete during the growth period and prior to fire brigade intervention
- ensure the fire-protected timber element achieves the Fire Resistance Level (FRL) prescribed for the particular element.

Any insulating materials provided within cavities must be non-combustible to reduce the risk of fire spread through cavities and voids.

The NCC contains some Deemed-to-Satisfy Solutions for fire-protective grade plasterboard coverings but there are many opportunities for the use of optimised proprietary systems. For example, combinations of high-performance non-combustible fire-resisting claddings and mineral fibre insulation could provide lighter weight, more cost-effective options.

The NCC DTS solutions recognise that massive timber panels have a relatively high inherent fire resistance and, if there are no concealed cavities or voids, the risk of fire spread through concealed spaces will be substantially reduced or removed. Therefore, provided the minimum dimensions prescribed for massive timber panels are satisfied and there are no internal cavities and voids, the NCC allows some relaxations to the requirements for fire-protective coverings (refer Section 4.3).

Note: The use of timber blocks and other combustible fire protection systems such as intumescent paints in lieu of non-combustible fire-protective coverings is not permitted under the NCC DTS solutions for mid-rise timber buildings due to the potential increase in risk of fire spread to the structural element as the combustible materials are consumed.

5.1.2 Cavity Barriers

The primary objective of cavity barriers is to prevent uncontrolled spread of fire through cavities in the low probability the protective covering fails or fire starts within the cavity.

The NCC provides Deemed-to-Satisfy solutions using solid timber or mineral fibre but also specifies FRLs for cavity barriers encouraging the development of proprietary systems optimised for specific applications.

Careful detailing can provide opportunities for efficient design.

Typical examples include:

- in a single leaf, timber-framed stud wall, the top and bottom plates can be dimensioned such that they can act as cavity barriers
- if a cavity is filled with non-combustible mineral fibre insulation to achieve a nominated R-value or enhanced acoustic separation, the mineral fibre may also satisfy the requirements for a cavity barrier.

5.1.3 Sound Transmission and Insulation

Battening wet areas protects fire- and sound-rated walls from compromise due to bath and shower installation and can also be used to reduce service penetrations through fire-protected timber elements

In timber construction, airborne and impact sound requirements are primarily achieved using one or more of the following principles:

- **Increasing mass (e.g. increasing the thickness of wall linings).** This can be particularly useful in reducing airborne sound transmission. For instance, like fire-grade linings, the greater the number of layers, the greater the increase in R_w (Note: extra factors are involved in increasing R_w+C_{tr}).
- **Isolating one side of a wall from the other** (e.g. using double stud cavity wall construction). This is also known as decoupling (discontinuous construction) and can reduce both airborne and impact sound. Of note, it serves to limit noise vibration from one side of the element to the other.
- **Avoiding rigid connections between the opposing sides of isolated (decoupled) elements.** This limits the occurrence of sound bridges that would otherwise allow sound to transmit from one side to the other. If required for structural stability, sound-resilient connectors should be used and should generally only be used at changes in floor level (Figure 5.2).
- **Using absorptive materials to fill wall and floor cavities** (glass fibre or mineral wall) can reduce airborne sound transmission. The NCC requires absorptive material to be non-combustible.
- **Sealing sound leaks** at the periphery of wall and floor elements or where penetrations are made for electrical and plumbing services.

There are also simple techniques that can be incorporated into the building design that can dramatically improve the sound performance of timber wall and floor/ceiling systems. The following systems provide examples that can be used to enhance sound performance of walls and floors.

Wall Systems

Batten out walls in wet area. In wet area construction, fire/sound rated walls can be compromised where bath and shower base units need to be recessed into the wall. A simple means of achieving this is to batten out the wall (after fire/sound resisting linings have been applied) and then provide an additional lining over the top (Figure 5.1). The bath can then be installed into the batten space without affecting the fire- and sound-rated wall. In such instances, it is best to have at least 35 mm batten space and to place insulation into the cavity. This arrangement also substantially reduces the risk of compartmentation being compromised during refurbishment activities. For example, if the additional lining boards are removed or replaced, the fire-protective covering can be left in place, maintaining the required fire separation.

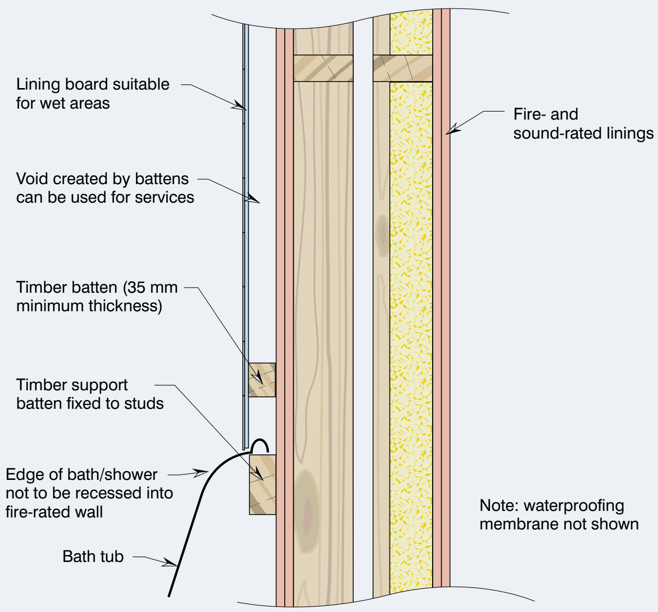


Figure 5.1: Batten detail for wet area walls – elevation view.

Floor Systems

Floor joists parallel to sound rated wall. By running floor joists parallel rather than perpendicular to the sound rated wall, the ability of impact sound from the floor being transferred across the wall to the adjoining SOU is lessened (Figure 5.2).

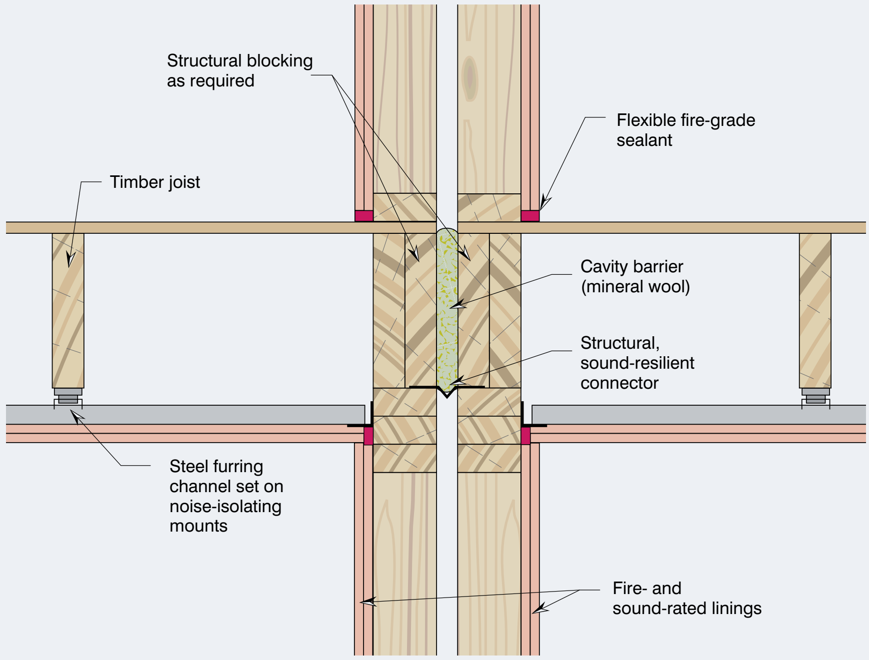


Figure 5.2: Joists running parallel to bounding wall – elevation view.

Upgrade sound-resilient ceiling mounts. Ceiling mounts are commonly used to prevent noise that gets into the floor from coming out through the ceiling below. They help reduce sound transfer between the bottom of the floor joist and the ceiling lining. To improve performance, some ceiling mounts now provide an isolating and damping effect (Figure 5.3). They typically force the sound energy through a rubber component that deforms slightly under load as the sound passes from the joist to ceiling sheet. Therefore, sound-resilient mounts are not all the same and different systems have different performance.

Time spent choosing the right sound-resistant ceiling mount can pay dividends.

Evidence of suitability must be provided to show that the required FRL of a ceiling system can be achieved using the acoustic resiliant mounts.

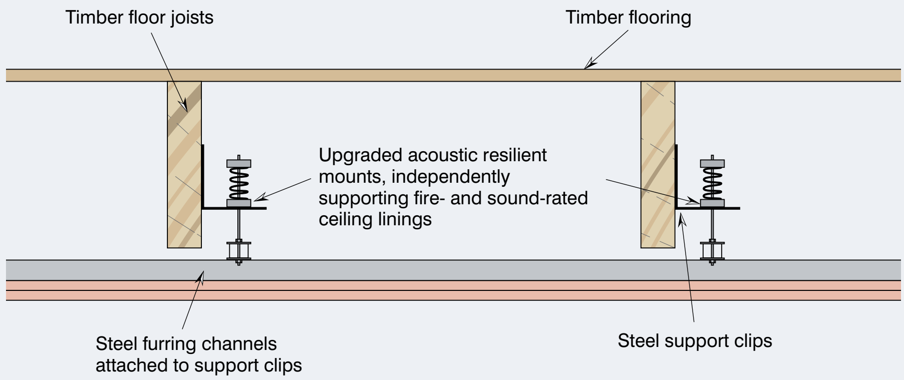


Figure 5.3: Upgraded sound-resilient ceiling mounts – elevation view.

Increase mass of the top layer of floor systems. Increasing the mass of the top surface of the acoustic floor system is one of the best ways to improve acoustic performance. There are three common ways – concrete topping, sand or additional floor sheets.

Quantifying the improvement is difficult as the acoustic performance is aimed at improving the low frequency performance of the floor, a phenomena not measured by tested systems. It is suggested that the base floor system be designed to comply with the NCC's sound requirements, and the additional floor mass provides enhanced performance unless evidence of suitability is available to quantify the improvement.

When height is added to a floor, consideration of the effect this has in other areas (such as wet areas, corridors, stairs, doors and windows) is needed at the planning stage.

Sand used to increase mass in timber floors. This increases the mass of the upper layer of the floor element. The air spaces between the sand particles help reduce the vibration and energy created by impact sound from footfalls. Typically, this is achieved by placing 45 mm battens directly over a normal acoustic floor system at typical 450 or 600 mm centres (dependent on floor sheet spanning capacity). A dry sand layer, or dry sand mixed with sawdust is placed between the battens and levelled just below the surface of the final floor sheet. The final floor sheet is fixed in the normal manner, and desired floor covering placed on this (Figure 5.4).

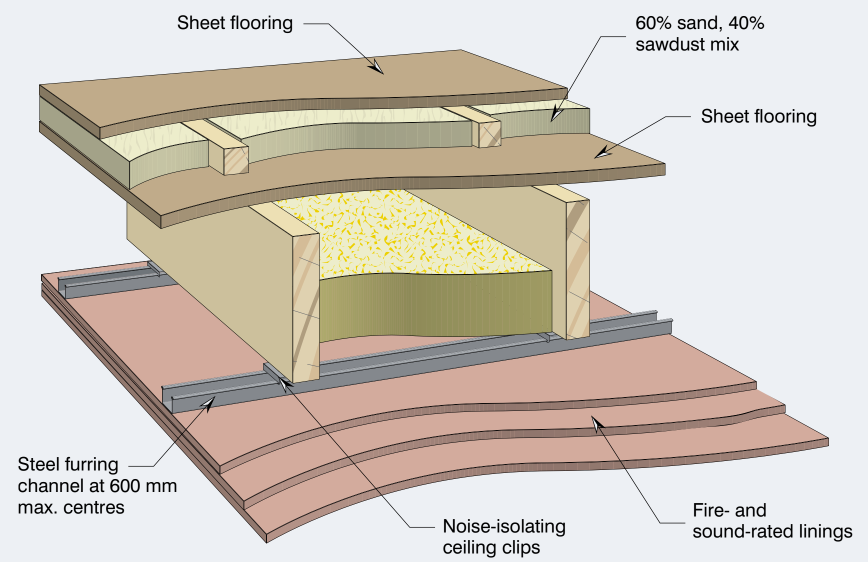


Figure 5.4: Adding mass to floor system through the use of sand top layer.

Concrete topping. This increases the sound performance of the floor system, and typically can be achieved with a 35 to 45 mm thick layer of concrete placed over an isolating acoustic mat. Care is required to turn the isolating acoustic mat up at the perimeter of the topping adjacent to the wall, otherwise the effect of the topping is negated (Figure 5.5).

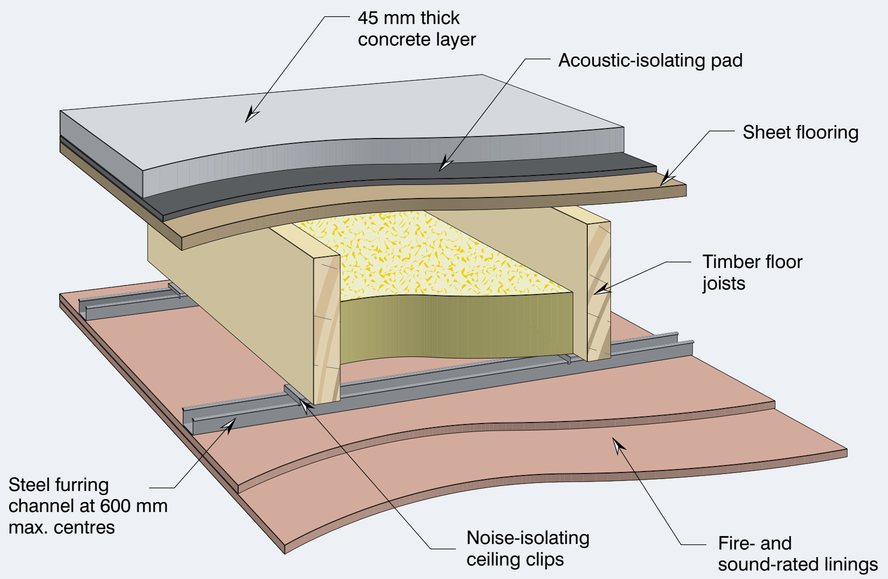


Figure 5.5: Adding mass to floor system through the use of concrete topping.

Extra sheet flooring. This method utilises standard sheet flooring on an isolating mat. This system does not perform as well as the higher mass products, sand or concrete (Figure 5.6).

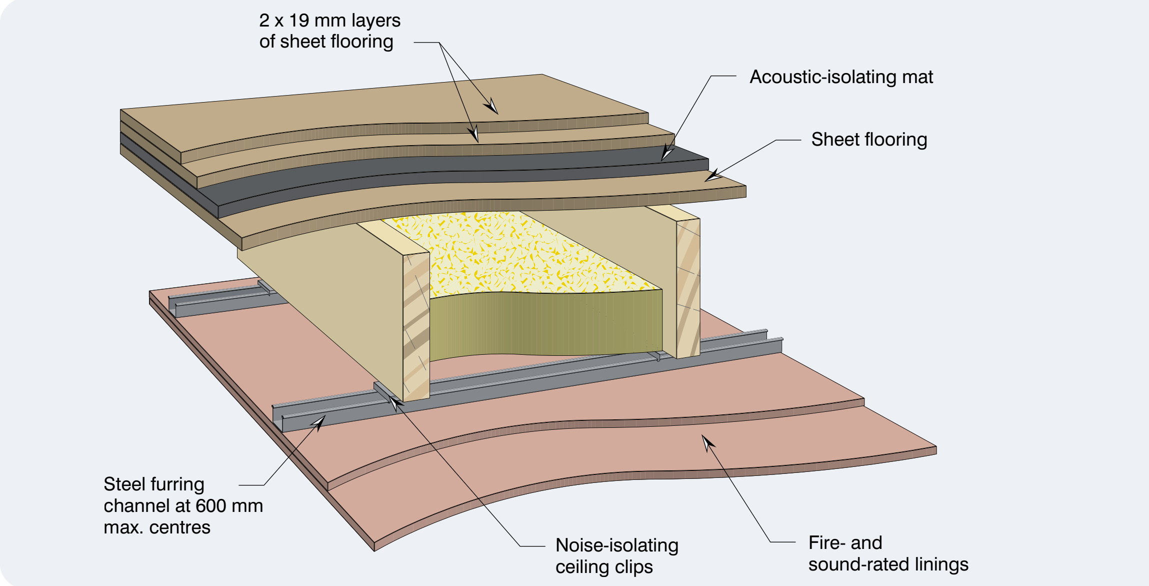


Figure 5.6: Adding mass to floor system through the use of additional floor sheets.

Separate floor and ceiling frame. By having two sets of joists (separate floor and ceiling joists) that are nested between but not touching each other, it is possible to isolate the two structures, thereby minimising the transference of impact sound through the structure. Care must be taken with this approach to prevent flanking noise running along the floor joists and into the walls below. This can be improved by sitting the ceiling joists onto strips of acoustic isolating mat (Figure 5.7).

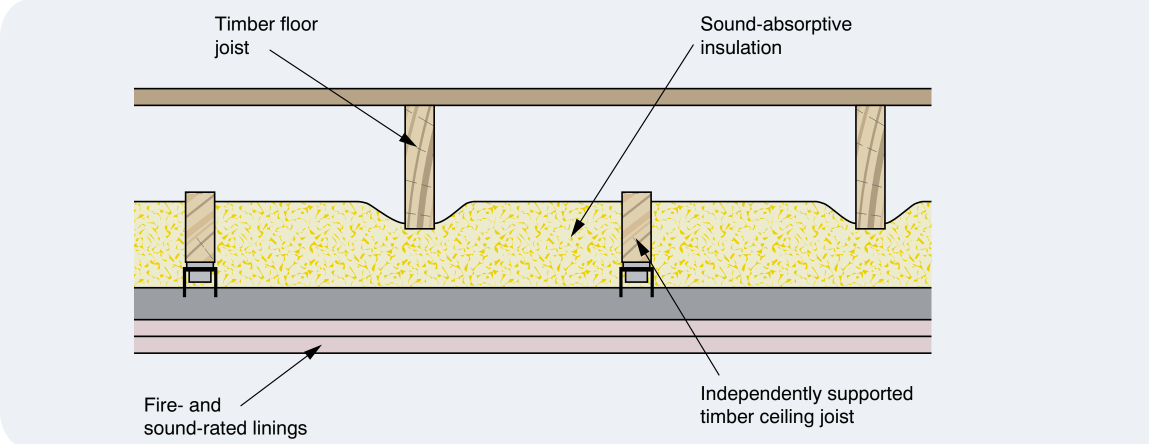


Figure 5.7: Separate ceiling and floor joist structures.

5.2 Establish Architectural Layout

The basic architectural layout of a building is determined by considering a large number of variables; the relative importance of which will vary from project to project. Typically these include:

- the project brief
- site conditions
- sustainable construction
- aesthetics
- economics
- planning, building and other regulations.

The design should then be refined with input from the various disciplines involved in the design team.

This process is demonstrated for a mid-rise timber residential building with basement car parking and ground level retail as shown in Figure 5.8.

A typical residential floor plan is shown in Figure 5.9.

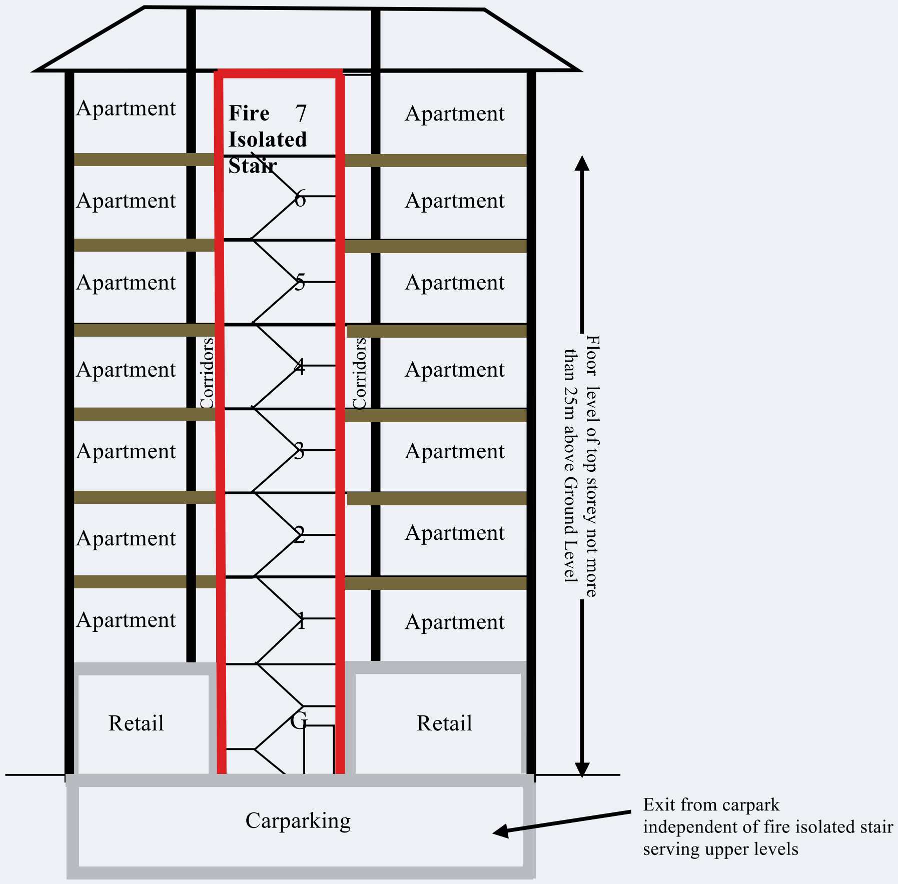


Figure 5.8: Section through a mid-rise residential building.

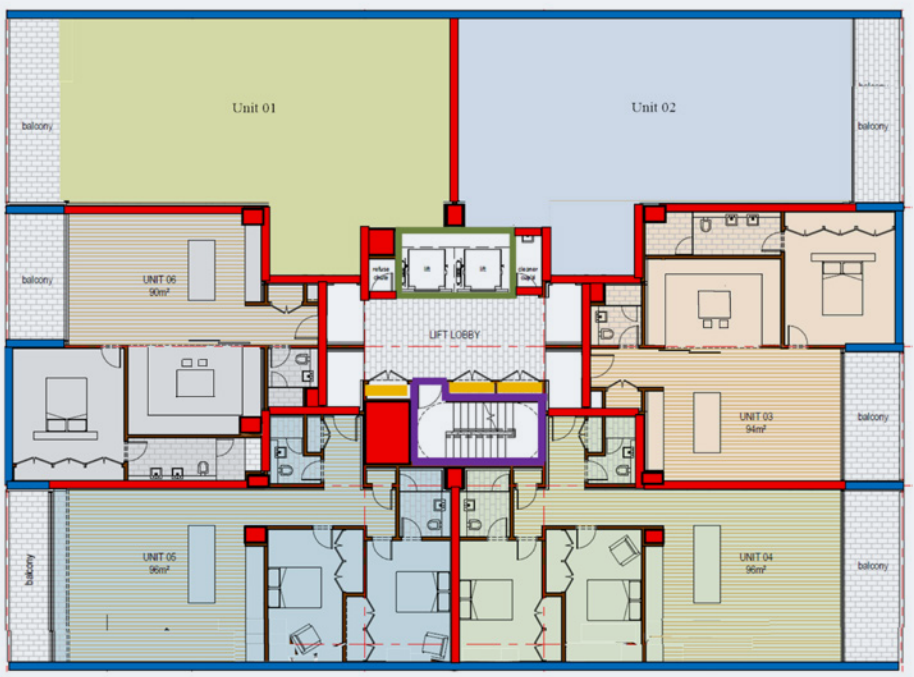


Figure 5.9: Plan of typical residential floor.

5.2.1 Optimising Building Layout - NCC DTS Distance of Travel Requirements

To address the evacuation of occupants during a fire emergency, among other things, the NCC DTS provisions prescribe maximum distances of travel from an entrance doorway of any SOU to an exit or a point from which travel in different directions to two exits is available.

These requirements for Class 2 and 3 buildings are provided in Clause D1.4 (a) of the NCC 2019 which states:

(i) The entrance doorway of any sole-occupancy unit must be not more than –

(A) 6 m from an exit or from a point from which travel in different directions to two exits is available; or

(B) 20 m from a single exit serving the storey at the level of egress to a road or open space; and

(ii) no point on the floor of a room which is not in a sole-occupancy unit must be more than 20 m from an exit or from a point at which travel in different directions to two exits is available.

Where travel to alternate exits is required, additional constraints apply to the distance between alternative exits.

These requirements are provided in Clause D1.5 and the requirements applicable to Class 2 and 3 buildings state:

Exits that are required as alternative means of egress must be—

(a) distributed as uniformly as practicable within or around the storey served and in positions where unobstructed access to at least two exits is readily available from all points on the floor including lift lobby areas; and

(b) not less than 9 m apart; and

(c) not more than—

(i) in a Class 2 or 3 building – 45 m apart; or ……..

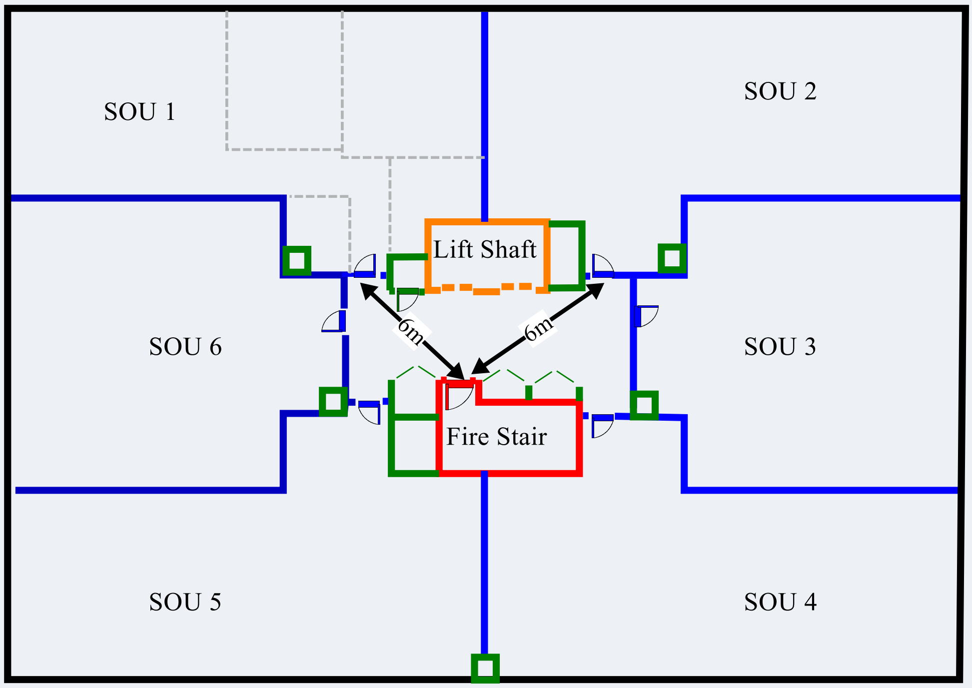
(d) located so that alternative paths of travel do not converge such that they become less than 6 m apart.

These requirements tend to dictate the architectural layout of Class 2 and 3 buildings. For example, a typical layout for a building with a single fire-isolated stair can accommodate six SOUs per floor to comply with the distance of travel requirements as shown in Figure 5.10(a);

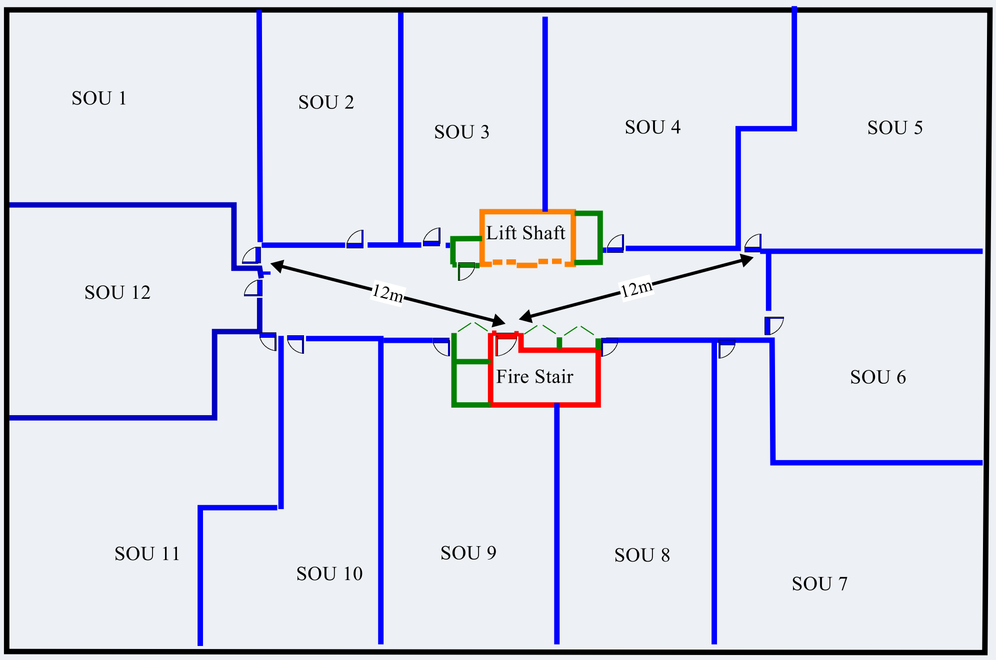
The distance of travel concession facilitates the design of more efficient floor layouts

If the requirements of NCC Specification E1.5a are satisfied (refer Section 4.2.3) a number of concessions can be applied including the following relating to distances of travel –

- Except in a residential care building, the maximum distance of travel, as required by D1.4(a)(i)(A), may be increased from 6 m to 12 m.
- The maximum distance of travel from a single exit serving the storey at the level of egress to a road or open space, as required by D1.4(a)(i)(B), may be increased from 20 m to 30 m.
- The maximum distance between alternative exits, as required by D1.5(c)(i), may be increased from 45 m to 60 m.
- These concessions facilitate greater flexibility under the DTS provisions for fire-protected timber mid-rise buildings. For example, a typical layout for a building with a single fire-isolated stair can accommodate 12 SOUs per floor to comply with the distance of travel requirements permitted in the Specification E1.5a concession as shown in Figure 5.10(b).



(a) Layout with 6 m maximum distance of travel to an exit



(b) Layout with 12 m maximum distance to an exit (refer Specification E1.5a)

Figure 5.10: Comparison of layout with different maximum travel distance to exits

5.3 Select Structural Form

For this example, the preferred structural material is timber for the Class 2 parts, which may have been selected for many reasons including:

- lightweight construction (useful if ground conditions are difficult)
- speed of construction
- sustainable construction
- prefabrication of elements.

This does not preclude the use of hybrid forms of construction.

Reinforced concrete construction was selected for the basement car park and ground floor retail areas to address ground water penetration and used as part of the termite management system.

5.3.1 Building Classes Other Than 2 or 3

The example building includes Class 6 (Retail) and Class 7 (Carpark) parts. The NCC 2019 Deemed-to-Satisfy Provisions allow the use of fire-protected timber in all building Classes or parts of buildings with an effective height not greater than 25 m:

The Class 6 and 7 parts should be fire-separated from the Class 2 part of the building in accordance with Clause C2.9 (or Clause C2.8 if different classes share the same floor) and comply with the Deemed-to-Satisfy solutions for the Class 6 and 7 parts.

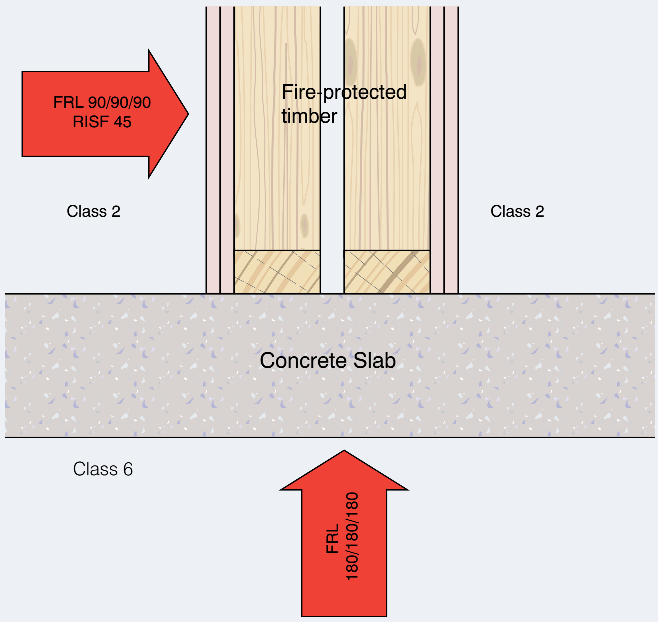


Figure 5.11: FRL requirements for fire separation between Class 6 and Class 2 parts of a building.

For the example building, the reinforced concrete slab fire separating the retail part of the building from the residential part would require an FRL of 180/180/180 if the DTS pathway is adopted while the bounding construction around apartments in the residential part typically require an FRL of 90/90/90 and an RISF of 45 minutes.

5.3.2 Select Basement and Ground Level Structural Form

Generally, reinforced concrete is selected for below ground works such as foundations and basements in conjunction with waterproofing membranes to address issues such as water penetration.

One way to manage termite risk is to extend concrete construction above ground so that termite entry can be readily detected.

Since the ground level of the example building is used for retail (Class 6), the most practical solution is to extend the concrete structure to floor level for Level 1 of the apartment building and comply with the Deemed-to-Satisfy Provisions for the basement and ground floor levels using concrete or masonry construction (Figure 5.8).

5.3.3 Select Upper Level Structural Form

All the upper levels are for residential occupancies and fire-protected timber construction has been selected as the preferred option using a DTS solution.

The mostly likely forms of construction would be timber-framed (lightweight) or massive timber panel systems such as Laminated Veneer Lumber (LVL) and Cross-Laminated Timber (CLT). While subsequent sections consider both options, the proprietary nature of massive timber panels limits the number of generic details that can be included in this Guide.

5.3.4 Select Lift and Fire Stair Shaft Construction

Lift and fire stair shafts in mid-rise timber buildings can be of timber, masonry or concrete construction. The choice will depend on the structural design of the building and numerous other factors.

If concrete or masonry shaft construction are adopted, it is important that the detailing can accommodate the possibility of differential movement between the timber structure and masonry/concrete shafts. Further information relating to masonry and concrete shaft construction lies outside the scope of this Guide.

Fire-protected timber shafts can be timber-framed construction or massive timber panel systems. Both options will be considered in subsequent sections.

An independent structural frame can be provided within the shaft as part of the lift installation, effectively isolating the lift system from the shaft walls and providing adequate acoustic separation.

If an independent steel frame is used within a fire-protected timber shaft, the possibility of differential movement between the timber and steel frame will need to be addressed. Typically, this can be addressed if the lift system can be recalibrated for differences in floor levels.

5.3.5 Structural Design

Issues that should be taken into account in the structural design of Class 2 and 3 buildings include:

- The design of mid-rise timber buildings must comply with the relevant NCC requirements including design to sustain local damage, with the structural system as a whole remaining stable and not being damaged to an extent disproportionate to the original local damage – refer NCC Clause BP1.1 (a)(iii) (structural robustness). A first principles performance pathway can also be adopted that addresses both fire and structural performance. Further guidance is provided in *WoodSolutions Technical Design Guide #39 Robustness in Structures*.
- The lighter mass of timber to that of masonry/concrete construction – greater attention needs to be given to resistance against overturning.
- The greater effect from wind loads than expected on smaller structures. This is due to a greater height-to-width ratio, resulting in a need for attention to resistance to overturning.
- Potential for movement (and differential shrinkage in buildings of hybrid construction) in taller timber buildings. Movement can be minimised by:
  - using seasoned timber or engineered timber
  - constructing bearers and joists in the same plane
  - detailing to avoid differential shrinkage between dissimilar materials, e.g. steel to timber; timber to masonry or allowing articulation to absorb the differential movement
  - allowing for differential movement with respect to plumbing and other services.

Refer NCC Volume One C2.12 and C2.13 for FRLs of construction separating equipment areas. Required FRLs may be at least 120/120/120

Avoid using cavities within fire-protected timber elements where practical

A professional structural engineer with appropriate skills will be needed to ensure the above issues and structural performance in general are adequately addressed.

The following standards should be called on:

- AS 1170.0 – Structural design actions – General Principles.
- AS 1170.1 – Structural design actions – permanent, imposed and other actions provides the basis for determination of appropriate dead, live design loads and loads combinations
- AS 1170.2 – Structural design actions – wind actions – which provides the basis for wind loads.
- AS 1170.4 – Structural design actions – Earthquake actions in Australia – which provides guidance and design procedures for earthquake forces.
- AS 1720.1 – Timber structures – Design methods.
- AS 1720.5 – Timber structures – Nailplated timber roof trusses

In addition:

- Select details that minimise the effects of shrinkage (especially since differential shrinkage may have an adverse impact on the function of fire-resisting wall and floor elements).
- Check that double stud walls bounding Sole Occupancy Units are capable of supporting multi-storey load paths from above. Enlist internal fire-resisting walls if required.
- Check that any elements supporting loads (including bracing elements) are treated as fire-resisting construction and designed accordingly. This usually includes all external walls.

5.4 Establish Service Plant Areas, Service Runs, Risers and Shafts

5.4.1 Service Plant Areas

Service plant rooms are generally located away from public areas, either in basements or on roof tops, depending on the building design

Clauses C2.12 'Separation of Equipment' and C2.13 'Electricity Supply System' generally require certain types of equipment to be fire separated from the rest of the building by construction having an FRL of 120/120/120 with doorways protected by self-closing fire doors with an FRL not less than -/120/30.

For Class 2 and 3 buildings designed to the NCC Deemed-to-Satisfy Provisions this means that some service plant areas may require to be enclosed in construction having an FRL of 120/120/120 rather than the FRL of 90/90/90 that generally applies to the rest of the structure. For applications similar to the example apartment building, the most practical solution may be to locate these service areas in the basement or ground floor where FRLs of 120/120/120 or greater are required.

Instead of using centralised plant for air-conditioning in apartment buildings, a common solution is to use self-contained units within each SOU to reduce the services that need to be distributed around the building.

5.4.2 Service Runs

In fire-protected mid-rise timber buildings, the timber elements are protected by fire-protective coverings and services tend to be concealed in a similar manner to conventional building designs using service risers, ducts and fitting cabling and pipes behind false wall and ceiling linings.

While the use of cavities within fire-protected timber construction to run cables and pipes can appear to be a simple solution, this choice presents a number of issues including:

- difficulty in maintaining the RISF or MRISF ratings of the elements at points of service penetrations
- risk of acoustic separation being compormised
- risk of fire protection systems not being correctly installed after modifications or additions to existing installations
- risk of disruption of concealed cavity barriers during modifications or additions.

A more reliable option is to plan the layout of required services and potential future services carefully utilising service risers, service shafts and ducts, and additional (false) linings to conceal services minimising penetrations through fire-protected timber elements as far as practicable. This approach is described in the following Sections.

Adding/modifying services is simplified if services are protected at each floor level by framing out the opening and using a multi-service penetration system

The face of openings cut in fire-protected timber members needs to be protected so that no timber is exposed. The required RISF or MRISF and the FRL of the fire-protected timber must also be maintained. Continuing fire-protective coverings around the opening is a typical solution

5.4.3 Service Risers and Horizontal Distribution of Services

Services such as electricity, water and telecommunications/data systems are normally distributed between floors through service risers that are commonly located close to the structural core (lift and stair shafts) as shown in Figure 5.12.

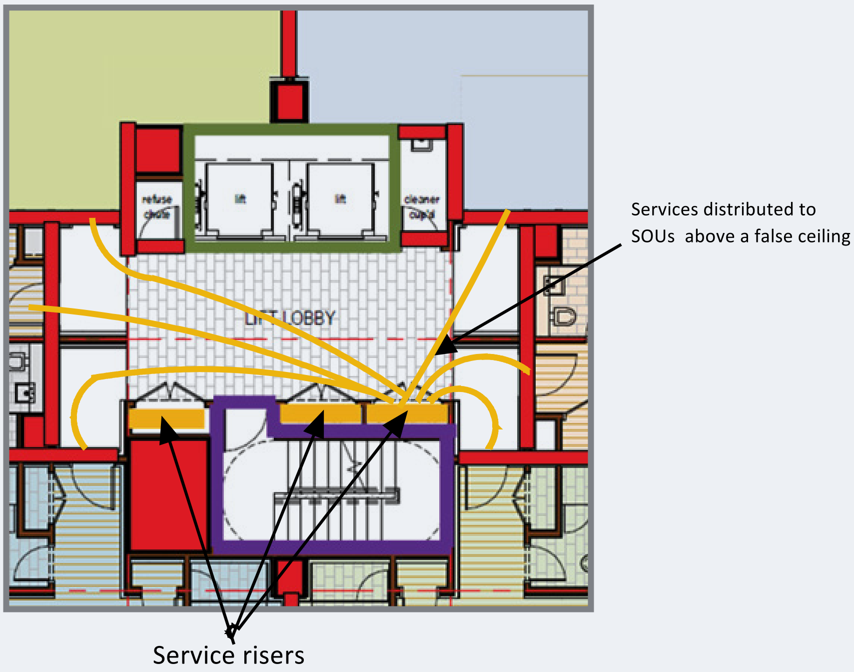


Figure 5.12: Typical position of service risers in the example apartment building.

Fire compartmentation can be maintained by protecting the service penetrations at each floor level or using fire-resisting construction for the risers (shafts), fitting fire doors or fire-rated access panels to the risers and fire protecting each service where it penetrates the riser wall.

Generally, the option of protecting the service penetrations at each floor level is the most practical solution. This can be achieved by forming an opening in the floor such that no timber is exposed, the FRL and RISF or MRISF is not compromised and services can be run through the opening. The opening can be protected by a multi-service penetration system such as a pillow, mineral fibre batt or other proprietary fire protection system that can be readily reinstated if additional services need to be run. A typical example is shown in Figure 5.13.

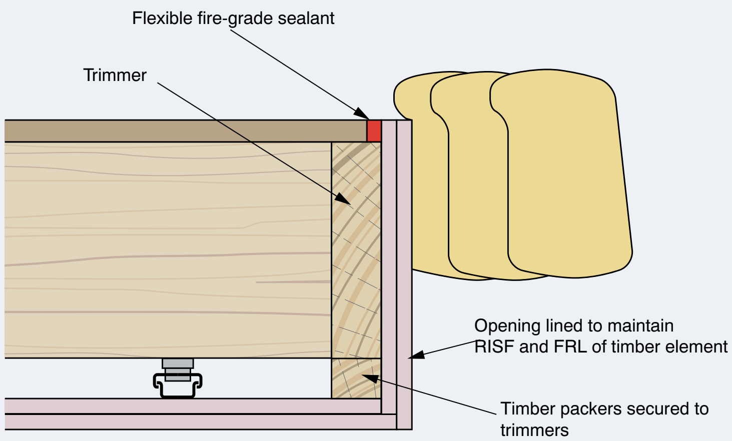


Figure 5.13: Typical riser penetration detail through a fire-protected timber floor.

Using a framed opening also avoids the need to expose cavities and timber members if additional services need to be run substantially reducing the risk of cavity fires and premature ignition of timber members. Refer to Section 5.14 for further details on the selection of service penetration systems.

For horizontal distribution of services, ducts may be created or more commonly the services can be run above a false ceiling fitted below a fire-protected timber floor/ceiling system in the lift lobby and corridors. For the apartment building example, the services could be distributed to the individual apartments from the risers as shown schematically in Figure 5.12 and Figure 5.14.

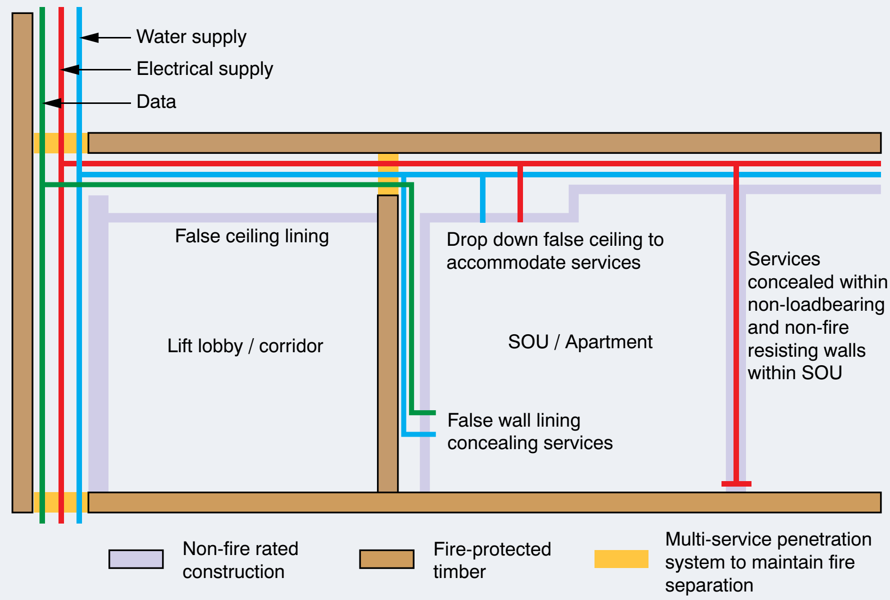


Figure 5.14: Typical distribution of services for apartment level.

The use of false ceiling and false wall linings within SOUs to conceal services can provide a number of advantages including a significant improvement in the reliability of fire-protection systems by:

- avoiding large numbers of individual service penetrations within fire-protected timber members for services such as power outlets, lighting, plumbing services including fire sprinklers
- concealing pipework and cable runs
- allowing reconfiguration of services within an SOU without disrupting fire-protected timber elements
- reducing the risk of cavity fires during maintenance activities and the risk of fire spread to cavities if the fire protection of services is not reinstated after reconfiguration or repair to services
- enabling services to be grouped together and protected by a single multi-service penetration system fitted above the false ceiling (access panels can be provided to facilitate access for inspection and/or adding or modifying existing services).

The use of the false wall and ceiling linings can have additional benefits, such as reducing sound transmission and improving energy efficiency by reducing leakage/flanking paths and providing an additional layer of protection.

Services can be run through internal walls within an SOU without the need for protection provided the wall is not required to be of fire-resisting construction. Note: Loadbearing members are required to achieve an FRL even if they are not part of the SOU boundary.

Planning service runs carefully within SOUs and the use of false ceiling and wall linings can substantially reduce the number of service penetrations through fire-protected timber.

Internal walls within SOUs that are not required to achieve an FRL can be a practical option for the location of services such as power outlets.

5.4.4 Service shafts

The use of centralised service risers is not a practical solution for some services including:

- soil and waste pipes requiring a minimum fall to avoid blockages
- waste chutes
- ventilation, exhaust and pressurisation systems.

Generally, these services require fire-resisting shafts that may be distributed across the floor plate where it is impractical to run services back to a central shaft.

The distribution of service shafts across a typical apartment floor in the example building is shown in Figure 5.15. The service shaft positions within the SOUs serve the kitchen areas and bathrooms and are generally located close to these areas to minimise penetrations through fire-resisting construction and the height required for the fall on pipes. The shaft positions should also be selected to minimise the impact of sound transmission to adjacent SOUs.

The use of false walls to conceal the service runs to the shafts is recommended as an alternative to running services through fire-protected timber walls and protecting the penetrations at the point of entry and exit.

Refer to Sections 5.8 and 5.10 for examples of appropriate shaft constructions.

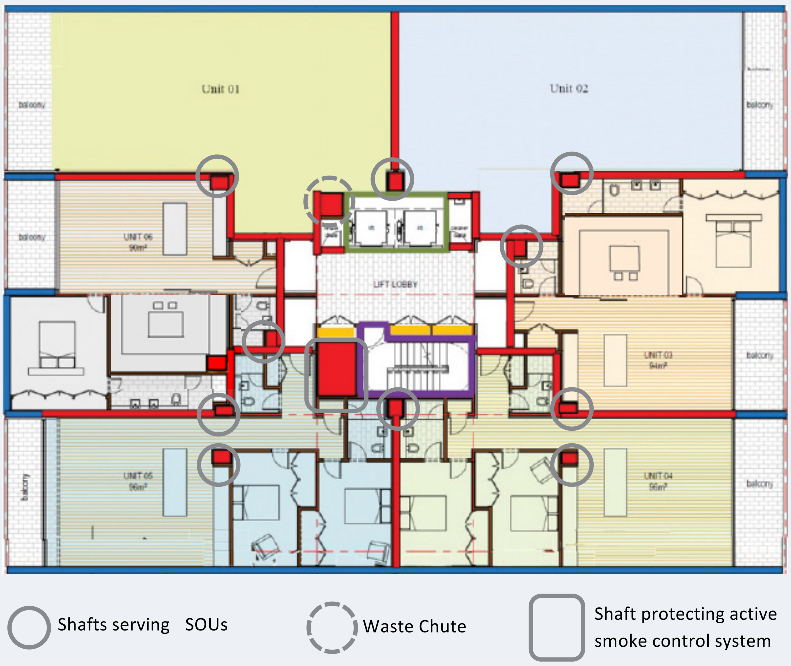


Figure 5.15: Typical shaft locations.

Shafts are generally required to have a sound rating. Where they are also required to have a Fire Resistance Level, it is best to treat the shaft like an independent compartment (Figure 5.16). Care is needed to ensure the sound rating is achieved, as many wall systems are not adequate on their own.

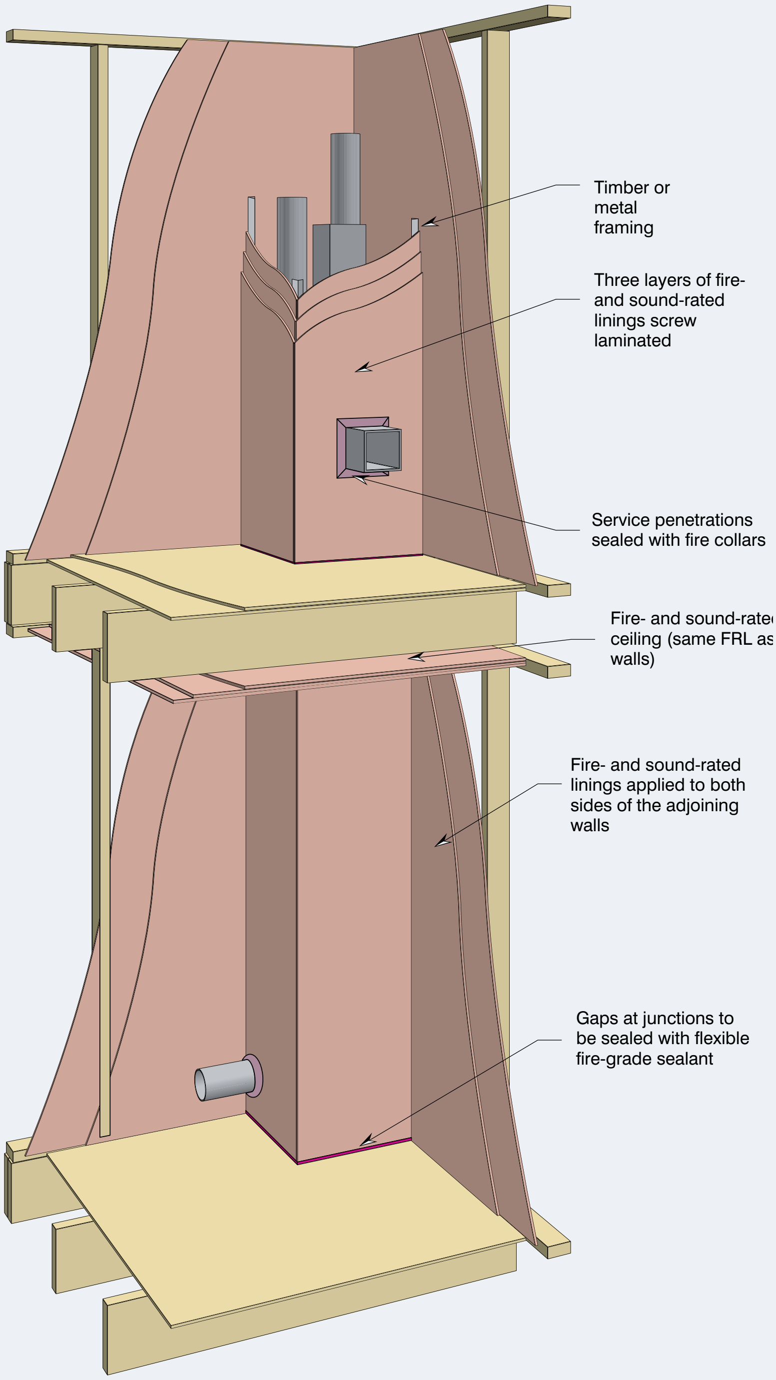


Figure 5.16: Fire-rated service duct.

Where timber framing is used to support the shaft linings it must be sheeted with fire/sound-grade linings on both sides of the shaft, including the part of the shaft that is the bounding wall of the SOU.

An alternative to using timber framing is to use laminated plasterboard or a shaft wall systems. These systems are proprietary, developed by lining manufacturers, and reference to their details is required. Refer to Figure 5.17 for an illustration of a typical fire-grade plasterboard system.

The number of layers, type and thickness of plasterboard and fixing methods selected depend on the required FRL and Evidence of Suitability that is available. Generally, for Class 2 and 3 buildings, an FRL of –/90/90 is required for non-loadbearing service shaft walls but this is reduced to –/60/60 for non-loadbearing fire-protected timber shaft walls or –/45/45 for non-combustible shaft walls if the concessions in NCC Specification E1.5a apply.

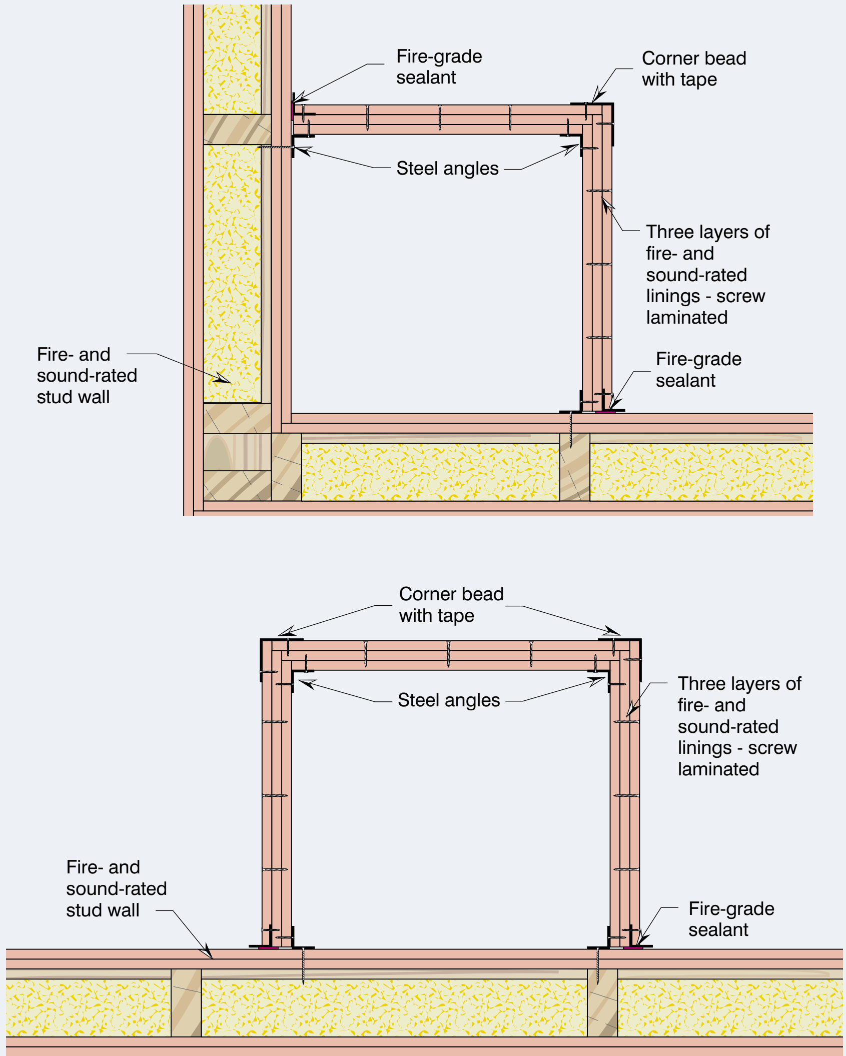


Figure 5.17: Laminated fire-grade plasterboard used to create shafts.

5.5 Fire-Protected Timber External Walls

External walls must be designed to satisfy a range of criteria including:

- fire performance
- structural performance (for safety and serviceability)
- weather resistance (resistance to water penetration)
- light and ventilation (including condensation control)
- energy efficiency (thermal insulation)
- durability
- acoustic separation (the control of transmission of sound from external sources is not required by the NCC but may be part of a design brief or planning control).

5.5.1 Fire Performance of External Walls

The external face of the wall may form the fire-protective covering of a fire-protected timber element, e.g. brick veneer construction as shown in Figure 5.18. If this option is used the specification will need to address the installation of cavity barriers to ensure correct placement and that moisture is not transported from the internal brickwork face to the timber frame through the cavity barrier.

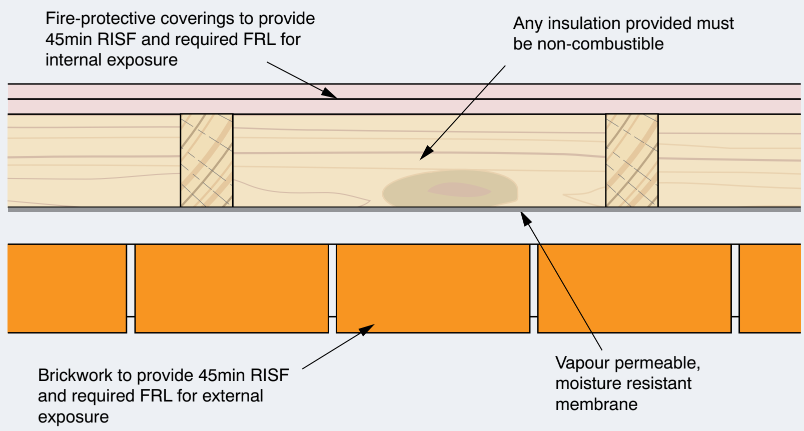


Figure 5.18: Fire-protected timber brick veneer external wall.

Alternatively, a cladding system may be fixed to a fire-protected timber element to prevent water penetration and serve other non-fire related functions. The cladding system could be a direct fix system or ventilated systems as shown schematically in Figures 5.19 and 5.20 for lightweight timber-frame and massive timber construction, respectively. These figures may not show all components that form part of proprietary systems.

Evidence of Suitability in accordance with NCC requirements should be obtained from the product suppliers. Further details of the evidence required are provided in Appendix C.

Many massive timber panels are proprietary products. Fire (and other) properties depend on the adhesives used and manufacturing processes, which are currently not fully standardised. Evidence of Suitability for massive timber external wall systems will tend to be product specific in most instances and configurations will tend to vary to satisfy the relevant NCC and other design requirements.

Fixings for the cladding system must be detailed so that the performance of the fire-protective coverings is not compromised.

The NCC DTS provisions require the external walls to be of non-combustible construction. Therefore any cladding systems applied to fire-protected timber external walls in mid-rise buildings must be non-combustible to comply with the NCC DTS provisions.

EWFA RIR 37401400 available from the WoodSolutions website determines that non-combustible external cladding systems can be fitted to fire-protected timber walls without compromising the FRL, RISF or MRISF.

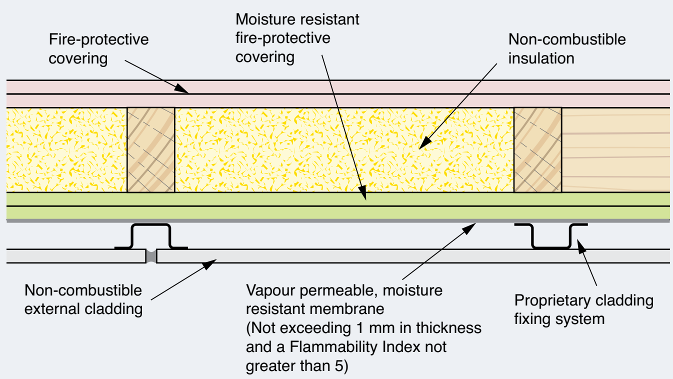


Figure 5.19: Fire-protected timber frame external walls with lightweight cladding.

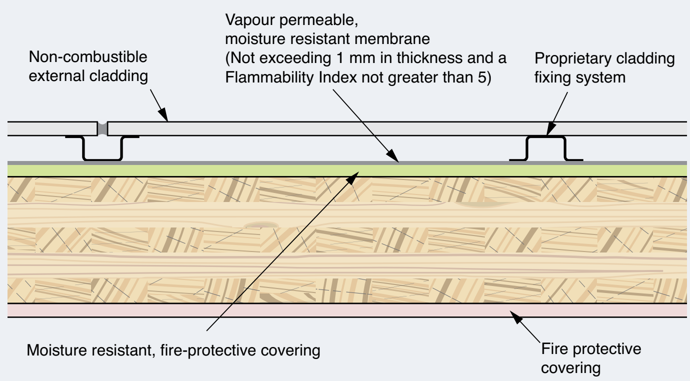


Figure 5.20: Fire-protected massive timber external wall with external lightweight cladding.

If combustible cladding systems are to be used, the performance pathway has to be adopted to demonstrate compliance of the external wall system with the relevant NCC performance requirements. Verification method CV3, in conjuction with verification methods CV1 and CV2, and the classification standard AS 5113 define an appropriate method for demonstrating compliance in most States and Territories. Further guidance is provided in Section 4.6.3.

Figure 5.21 shows the external walls, along with other wall elements, in the example Class 2 building and Table 5.1 summarises the required FRLs and RISF or MRISF based on the distance from the boundary.

While there are significant reductions in the required FRLs for non-loadbearing elements as the distance from the fire source feature increases, the design of the external walls will not vary significantly because the required RISF or the MRISF, in combination with the minimum thickness requirement of 75 mm for massive timber, will become the dominant design factors.

If the subject building is of massive timber construction and is not more than 1 metre from a fire source feature, the required MRISF is increased to 45 minutes externally to minimise the risk of fire spread from adjacent structures.

Table 5.1: Fire-resistance requirements for external walls in the example Class 2 building of Type A construction.

Distance from fire source feature	FRL – Structural Adequacy /Integrity/ Insulation – minutes		General Timber	Massive Timber
	Load bearing	Non Load bearing	RISF (minutes)	MRISF (minutes)
≤1.0 m	90/90/90	-/90/90	45	45 external 30 internal
<1.5 m	90/90/90	-/90/90	45	30
≥1.5 and <3 m	90/60/60	-/60/60	45	30
≥3 m	90/60/30	-/-/-	45	30
External Columns	90/-/-	-/-/-	45	30

5.5.2 External Noise

Currently, there are no NCC requirements to provide external noise attenuation for buildings. However, Government authorities have regulatory or legislative powers to require control of noise entering buildings; particularly residential buildings. These requirements vary around Australia and designers and specifiers should make enquiries in relation to their design/development.

The *WoodSolutions Technical Design Guide #11 Timber-framed Systems for External Noise* provides examples of lightweight external wall systems that can be used as guidance.

5.5.3 Weatherproofing

There are currently no Deemed-to-Satisfy Provisions in the NCC in relation to the weatherproofing of external walls and so suppliers of waterproofing products/membranes are relied on to demonstrate compliance with the NCC Performance Requirement (FP1.4). A weatherproofing Verification Method (FV1.1) is described in the NCC to enable compliance with FP1.4 via a tested prototype. It is important that installed waterproofing membranes/systems for timber construction are vapour permeable (i.e. allowing timber building components to breathe) but do not permit water to penetrate through to the structural timber building elements (moisture resistant).

5.6 Internal Walls Bounding SOUs and corridors

Internal walls bounding the SOUs are shown as red walls in Figure 5.21, must be designed to satisfy a range of criteria including:

- fire performance
- structural performance (for safety and serviceability)
- durability
- acoustic separation.

Figure 5.21: Example Class 2 building highlighting fire-protected timber walls.

For lightweight timber-framed construction, double stud partition systems are commonly adopted in order to achieve the required acoustic separation.

For massive timber elements it may be necessary to install a multi-layered, fire-protective covering made of non-combustible, fire-protective grade plasterboard and insulation (Figure 5.23) to improve acoustic performance.

5.6.1 Fire Performance of Walls Bounding SOUs

Figures 5.22 and 5.23 show typical lightweight timber frame wall systems and massive timber wall systems satisfying the NCC Deemed-to-Satisfy fire requirements for bounding construction in the example Class 2 building. While the double stud arrangement provides good acoustic separation, the central cavity will need to be protected by cavity barriers to limit the risk of fire spread through concealed spaces. Acoustic separation is not as good with a single stud system but if 90 x 45 mm studs or larger are used the timber framing members can act as in situ cavity barriers without the need for additional dedicated cavity barriers to be fitted within the wall system.

EWFA report 22567A -01 issued to FWPA assesses the FRL of some typical double stud wall systems

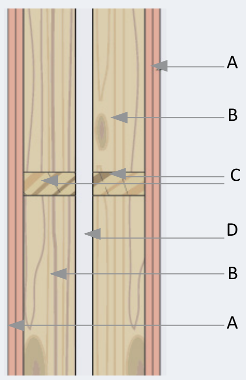
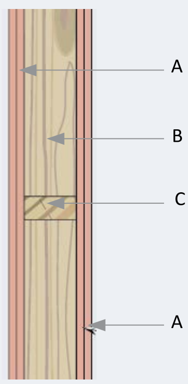
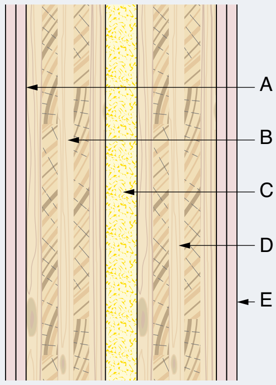
Double Stud	**Single Stud**
	
Construction **A** linings 2 x 13 mm fire-protective grade plasterboard **B** timber studs typically 90 x 45 **C** Noggings at mid-height **D** Cavity min 20mm Note Non Combustible Cavity Insulation may be added	
Performance FRL 90/90/90 obtain Evidence of Suitability from supplier[21] RISF 45 mins (NCC Spec C1.13a DTS)	**Performance** FRL 90/90/90 obtain Evidence of Suitability from supplier RISF 45 mins (NCC Spec C1.13a DTS)

Figure 5.22: Typical fire-rated lightweight timber-framed wall systems for Class 2 mid-rise buildings.

Evidence of Suitability in accordance with NCC requirements should be obtained from the product suppliers



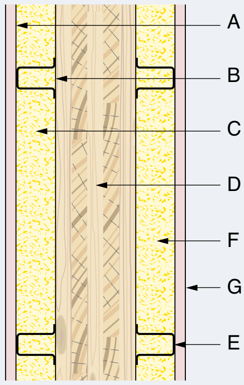
Construction

A – 2 x 13 mm fire-protective grade plasterboard
B – 95 mm CLT
C – 60 sound absorbing insulation
D – 95 mm CLT
E – 2 x 13 mm plasterboard

Performance

Fire resistance – 90/90/90
MRISF – 45 minutes

Note: Performance stated is based on 1 x 13 mm thick fire-protective grade plasterboard lining but 2 x 13 mm thick fire-protective grade plasterboard linings are required due to the 'cavity' between CLT panels, therefore the NCC General Requirements apply.



Construction

A – 16 mm fire-protective grade plasterboard
B – 60 metal batten (nominal)
C – 60 mm glasswool insulation
D – 95 mm CLT
E – 60 metal batten (nominal)
F – 60 mm glasswool insulation
G –16 mm fire-protective grade plasterboard

Performance

Fire resistance – 90/90/90
MRISF – 30 minutes

Note: Performance stated is based on 1 x 13 mm thick fire-protective grade plasterboard lining but 1 x 16 mm thick fire-protective grade plasterboard lining is required to achieve a MRISF of 30 minutes.

Figure 5.23: Typical fire-rated massive timber proprietary wall systems for mid-rise Class 2 buildings.
Note: Confirm the system performance with CLT supplier

The design of the massive timber walls tend to be largely influenced by acoustic considerations and there may be opportunities to refine the above design to optimise both acoustic and fire performance.

5.6.2 Sound Performance of Walls Bounding SOUs

Using the lightweight timber frame wall systems and massive timber wall systems satisfying the NCC Deemed-to-Satisfy fire requirements for bounding construction in the example Class 2 building, the typical acoustic performance of timber-framed systems is shown in Figure 5.24.

The double stud arrangement is typically used as it provides good acoustic separation as internal wall systems separating SOUs with the central cavity protected by cavity barriers to limit the risk of fire spread through concealed spaces. Acoustic separation is not as good with a single stud system but if 90 x 45 mm studs or larger are used the timber framing members can act as in situ cavity barriers without the need for additional dedicated cavity barriers to be fitted within the wall system.

Evidence of Suitability in accordance with NCC requirements should be obtained from the product suppliers

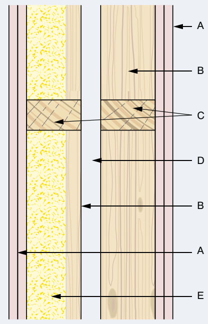
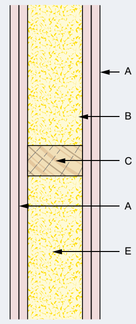
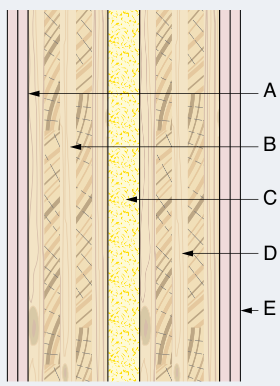
Double Stud	Single Stud
	
Construction **A** Linings 2 x 13 mm fire-protective grade plasterboard **B** Timber studs typically 90 x 45 **C** Noggings at mid-height **D** Cavity min 20 mm **E** 75 mm mineral wool insulation	**Construction** **A** Linings 2 x 13 mm fire-protective grade plasterboard **B** Timber studs typically 90 x 45 **C** Noggings at mid-height **D** Cavity 15 mm (max.) **E** 75 mm mineral wool insulation
Performance FRL 90/90/90 obtain Evidence of Suitability from supplier RISF 45 mins (NCC Spec C1.13a DTS) **Acoustics:** $R_w+C_{tr} \geq 50$	**Performance** FRL 90/90/90 obtain Evidence of Suitability from supplier RISF 45 mins (NCC Spec C1.13a DTS) **Acoustics**: $R_w < 50$ ($R_w+C_{tr} \geq 50$) can be achieved when using 120 x 35 timber studs suitable for use as bounding wall construction between SOUs and public corridors, stairways, etc – refer Section 2.2)

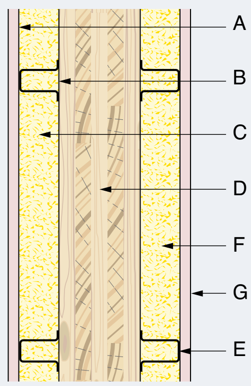
Figure 5.24: Typical acoustic-rated lightweight timber framed wall systems for Class 2 mid-rise buildings.

The design of the massive timber walls tend to be largely influenced by acoustic considerations and performance many vary depending on the manufacturing of the product. The acoustic performance of various tested CLT wall configurations can be found in the WoodSolutions Technical Design Guide *#44 CLT Acoustic Performance.*



Construction
A – 2 x 13 mm fire-protective grade plasterboard
B – 95 mm CLT
C – 60 sound absorbing insulation
D – 95 mm CLT
E – 2 x 13 mm plasterboard
Performance
Fire resistance – 90/90/90
MRISF – 45 minutes
Acoustic - Rw ≥ 50

Note: Performance stated is based on 1 x 13 mm thick fire-protective grade plasterboard lining but 2 x 13 mm thick fire-protective grade plasterboard linings are required due to the 'cavity' between CLT panels, therefore the NCC General Requirements apply.



Construction
A – 16 mm fire-protective grade plasterboard
B – 60 metal batten (nominal)
C – 60 mm glasswool insulation
D – 95 mm CLT
E – 60 metal batten (nominal)
F – 60 mm glasswool insulation
G –16 mm fire-protective grade plasterboard
Performance
Fire resistance – 90/90/90
MRISF – 30 minutes
Acoustic - Rw ≥ 50

Note: Performance stated is based on 1 x 13 mm thick fire-protective grade plasterboard lining but 1 x 16 mm thick fire-protective grade plasterboard lining is required to achieve a MRISF of 30 minutes.

Figure 5.25: Typical acoustic-rated massive timber proprietary wall systems for mid-rise Class 2 buildings.

Note: Confirm the system performance with CLT supplier

5.7 Fire-protected Timber Floors

Floor systems must be designed to satisfy a range of criteria including:

- structural performance (for safety and serviceability)
- fire performance
- acoustic separation
- durability.

Common structural elements used for timber floors include:

- solid timber beams
- LVL beams
- I-section beams with OSB or plywood webs
- parallel chord steel web trusses
- parallel chord timber web truss
- I-section with Steel Web
- massive timber panel systems (e.g. CLT or LVL).

These structural members can be used with a range of flooring systems, internal insulation systems and soffit/ceiling lining systems in keeping with the building finishes and to achieve the required fire and acoustic performance.

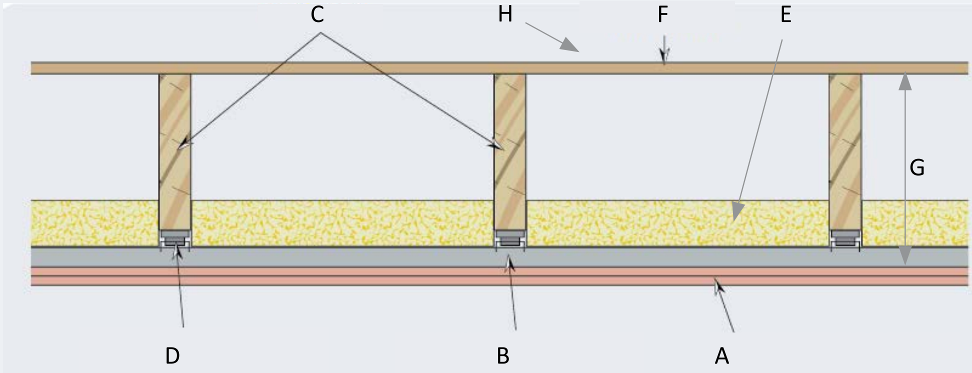
EWFA RIR 37401400 can be found on the WoodSolutions website that assesses the FRL and RISF of commonly available floor joist products

5.7.1 Fire Performance of Flooring Systems Protected by Typical Ceiling Systems

Typical floor systems that may satisfy the fire-related NCC Deemed-to-Satisfy fire requirements for fire-protected timber in the example Class 2 building are shown in Figures 5.26 and 5.27.

These particular systems incorporate a ceiling system comprising two layers of 16 mm thick fire-protective grade plasterboard secured to steel furring channels supported from the structural element. Since the ceiling provides the largest contribution to the FRL of the floor/ceiling systems, and the performance will be largely independent of the structural members prior to structural failure, the results can be applied to a large range of combinations of structural element, cavity insulation and flooring systems to which additional finishes may be applied, provided compliance with other all NCC requirements is not compromised.

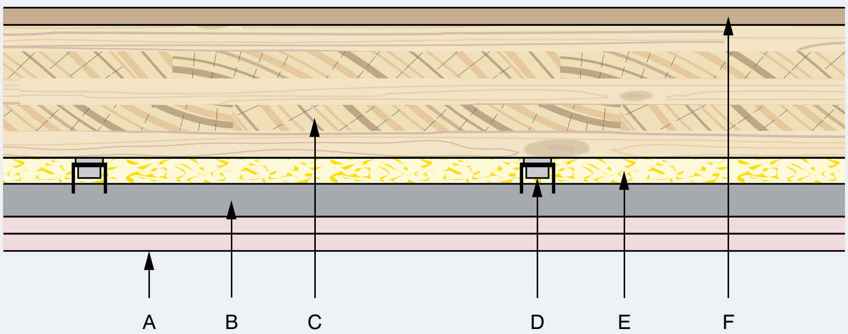
EWFA RIR 37401400 can be found on the WoodSolutions website that assesses the FRL and RISF of the floor system shown in Figure 5.26



Construction
A Linings 2 x 16 mm fire-protective grade plasterboard
B Steel furring channels at 600 mm max centres
C Timber Beams
Solid timber joists
LVL beams
I-section beams with OSB or LVL webs
I-section with steel web
Parallel chord steel web trusses
Parallel chord timber web truss
D Furring Channel Fixings
Direct fixing clips
Acoustic (resilient) mounts
Suspended ceiling (hanger support)
Suspended ceiling (acoustic hanger)
E Non-combustible cavity insulation may be added
F Flooring (minimum thickness)
Plywood – 15 mm
Cement sheet – 15 mm
Particle board – 18 mm
T& G flooring – 15 mm
Engineered flooring – 15 mm
Concrete applied over plywood
AAC – 50 mm
Calcium silicate sheets – 15 mm
G Minimum Cavity Depth – 288 mm from fire protective grade plasterboard.
H Floor finishes such as carpet, acoustic treatments may be added

Performance
FRL 90/90/90 (verify with supplier and/or EWFA report RIR 37401400)
RISF 60 mins (verify with supplier and/or EWFA report RIR 37401400) or RISF 45 mins (NCC Spec C1.13a DTS)

Figure 5.26: Typical timber-framed floor.



Construction
A Ceiling linings 2 x 16 mm fire-protective grade plasterboard
B Steel furring channels at 600 mm max centres
C Massive Timber Panel (min 75 mm thick)
D Furring Channel Fixings
Direct fixing clips
Acoustic (resilient) mounts
Suspended ceiling (hanger support)
Suspended ceiling (acoustic hanger)
E Cavity minimum 40 mm (must be filled with non combustible insulation if massive timber 'concession' applied otherwise may be unfilled)
F Floor finishes such as carpet, acoustic treatments may be added

Performance
FRL 90/90/90 (verify with supplier). Note higher FRLs may be achieved depending upon massive timber element design
MRISF/RISF 60 mins (verify with supplier) or MRISF/RISF> 45 mins (NCC Spec C1.13a DTS)

Figure 5.27: Typical massive timber panel floor.

For timber-framed floor systems, in particular, the required thickness of the fire-protective coverings tend to be dominated by the FRL criteria (90/90/90 or above) rather than the RISF criteria of 45 minutes.

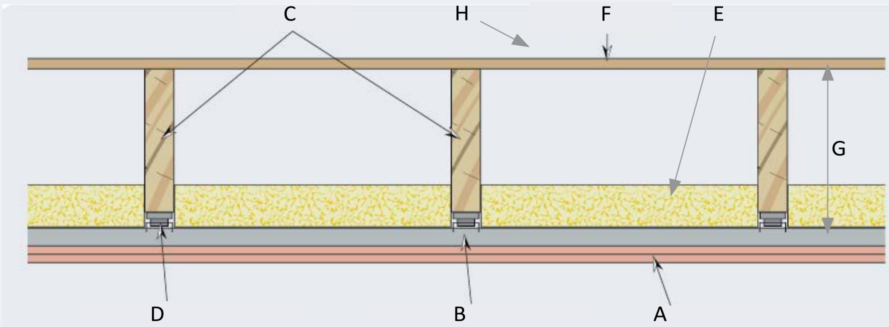
For massive timber panel floor systems, where thicknesses of 150 mm or more may be required to achieve adequate structural performance, the required thickness of fire-protective coverings will tend to be dominated by the MRISF or RISF criteria or acoustic considerations rather than FRL criteria because of the high inherent fire resistance of the massive timber panels.

In many situations, fire-protective coverings based on a single layer of 16 mm fire-protective grade plasterboard may be suitable for massive timber panel floor systems. However, the fire performance of these systems depends on many factors, including adhesives, number of layers and thicknesses of lamella, manufacturing process, timber species and grade, and applied loads. These factors are not fully standardised and vary between manufacturers therefore Evidence of Suitability in the form of fire-resistance test reports from Accredited Testing Laboratories should be sought from the suppliers of the specific CLT system to confirm the FRL of fire-protected timber members.

5.7.2 Sound

The sound performance of a floor/ceiling system depends on a number of elements including: the density of the floor covering (tile, timber, carpet), isolation from the structure (acoustic underlay), ceiling insulation (density), ceiling installation (acoustic mounts) and layers and thicknesses of ceiling plasterboard. The objective is to minimise both airborne (R_w+C_{tr}) and impact sound ($L_{n,w}$) transmission through the floor/ceiling system and the performance of the floor/ceiling system should be verified with the plasterboard supplier for DTS Solutions.

There are a range of flooring products (e.g. timber overlay, carpet) that can be used and achieve the minimum NCC acoustic requirements. The use of a hard flooring surface will influence the impact performance ($L_{n,w}$) of the floor/ceiling system. The following is provided for guidance.



Construction
A Linings 2 x 16 mm fire-protective grade plasterboard
B Steel furring channels at 600 mm max centres
C Timber Beams
Solid timber joists
LVL beams
I-section beams with OSB or LVL webs
I-section with steel web
Parallel chord steel web trusses
Parallel chord timber web truss
D Furring Channel Fixings
Direct fixing clips
Acoustic (resilient) mounts
Suspended ceiling (hanger support)
Suspended ceiling (acoustic hanger)
E Non-combustible cavity insulation may be added
F Flooring (minimum thickness)
Plywood – 15 mm thick
Cement sheet – 15 mm
Particle board – 18 mm
T& G flooring – thickness 15 mm
Engineered flooring – 15 mm
Concrete applied over plywood
AAC – 50 mm
Calcium silicate sheets – 15 mm
G Minimum Cavity Depth – 288 mm from fire protective grade plasterboard.
H Floor finishes such as carpet, acoustic treatments may be added

Performance
FRL 90/90/90 (verify with supplier)[xxv]
RISF 60 mins (verify with supplier)
or RISF 45 mins (NCC Spec C1.13a DTS)
Acoustics (Verify with supplier):
Above system incorporates: 10 mm overlay solid strip flooring, 4.5 mm acoustic underlay on top of flooring products (F), R2.5 ceiling insulation (E), Acoustic (resilient) mounts (D).
$R_w+C_{tr} \geq 50$
$L_{n,w} \leq 62$ (bare floor)
$L_{n,w} \leq 50$ (carpet and underlay)

Evidence of Suitability in accordance with NCC requirements should be obtained from the product suppliers.

Figure 5.28: Sound performance of typical timber-framed floor/ceiling system.

The acoustic performance of various tested CLT floor/ceiling system configurations can be found in the *WoodSolutions Technical Design Guide #44 CLT Acoustic Performance.*

5.8 Service Shafts

While service shafts can be constructed from fire-protected timber walls, in many instances there are substantial advantages in using either steel stud shaft wall or laminated shaft wall construction particularly if the shafts are in locations where sound transmission is not a significant consideration.

The advantages include:

- ease of construction
- smaller footprint (more usable space)
- simplification of treatment of service penetrations
- greater selection of proprietary fire protection systems for service penetrations that already have Evidence of Suitability to demonstrate the FRLs of the systems.

EWFA report RIR 37401400 available form the WoodSolutions website assesses the impact of the interface details in Figure 5.29 on the FRL, RISF and MRISF of the systems

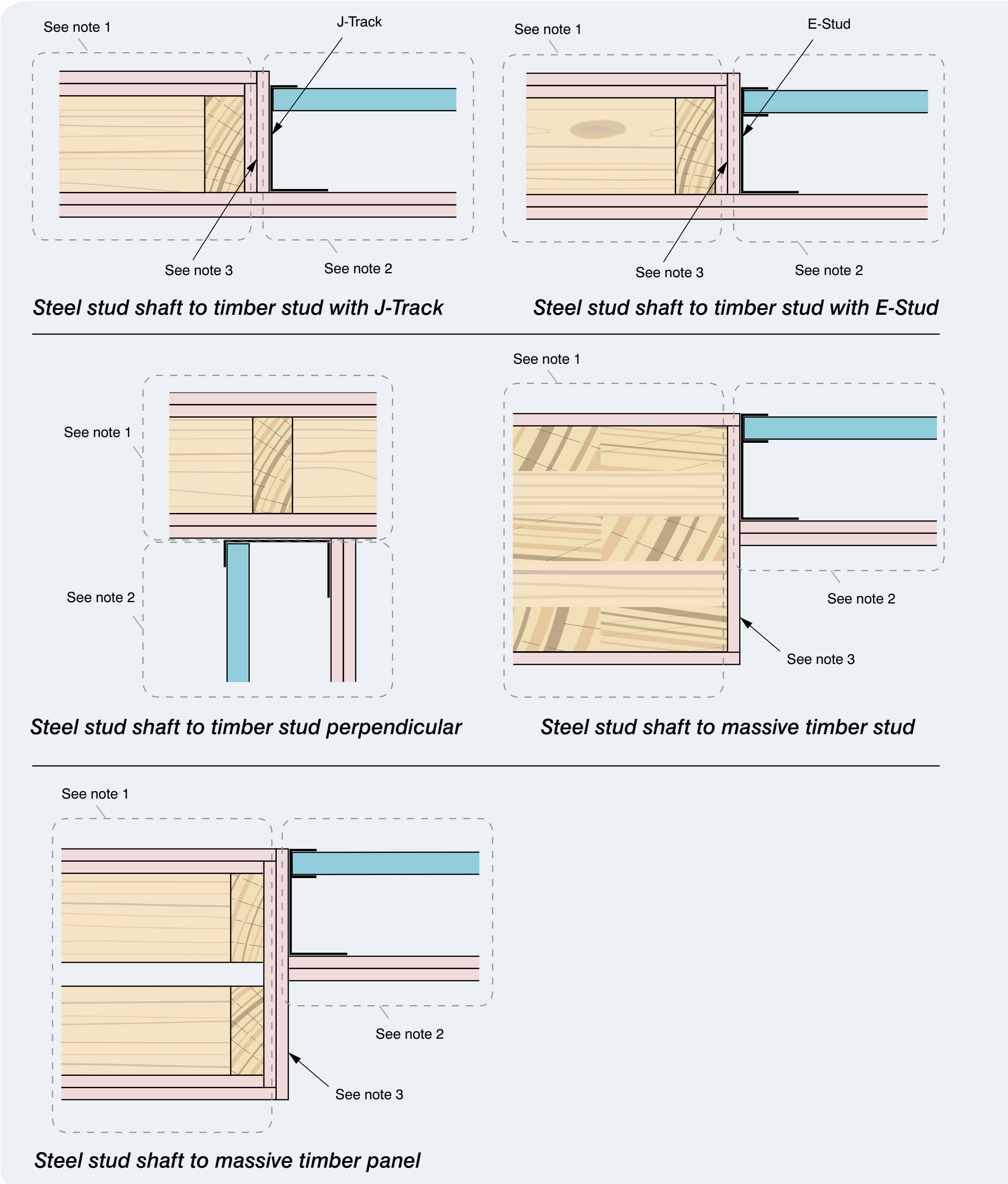


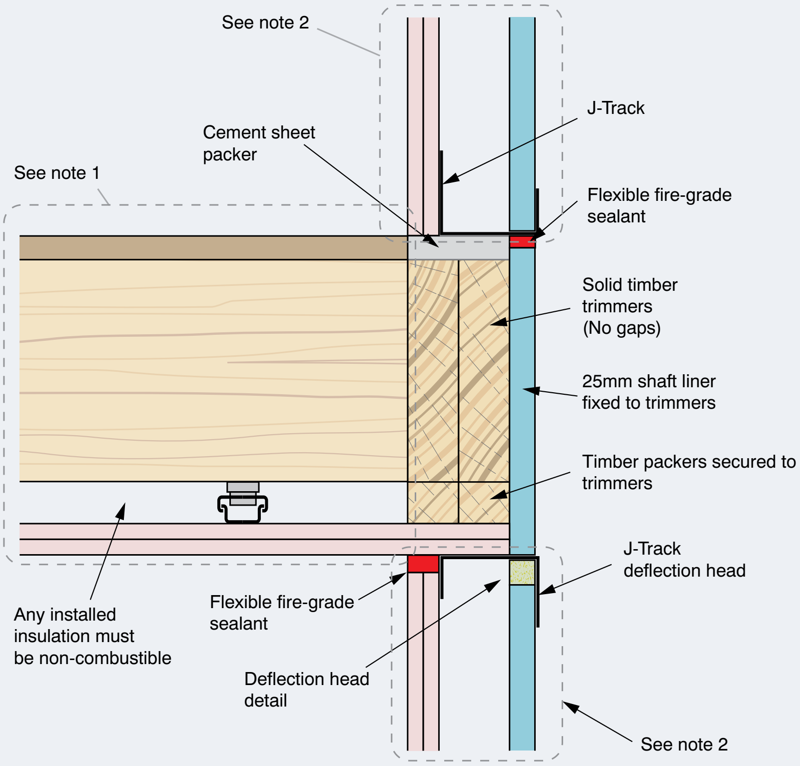
*Figure 5.29: Interfaces between fire-protected timber and steel stud shafts **(continued next page)***

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

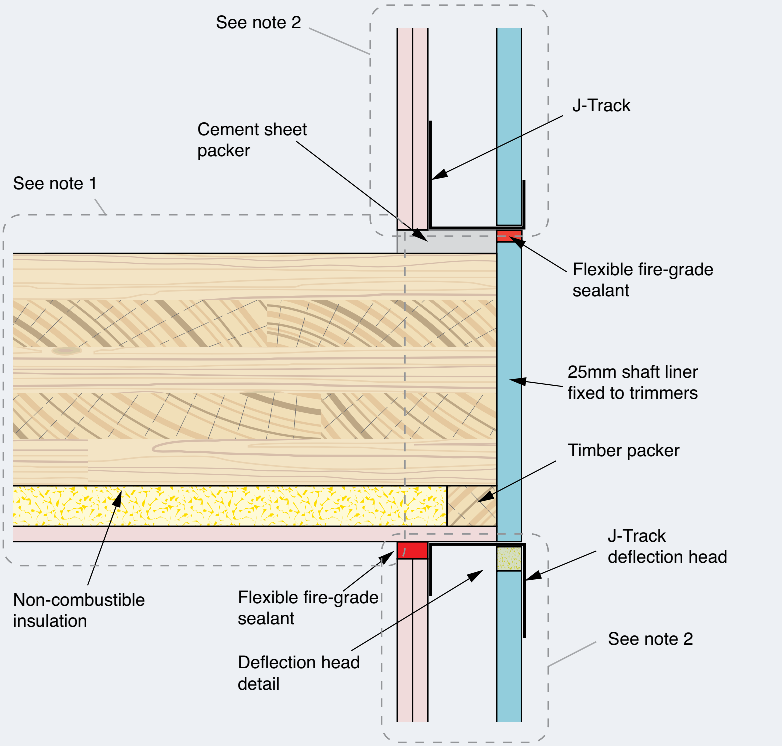
Note 2: Shaft wall construction having the required FRL.

Note 3: Interface protected with the same fire protective coverings that are applied to the fire-protected timber element face. Shaft wall tracks are to be screw fixed to timber elements at 300 mm maximum centres with 62 mm long screws.

EWFA RIR 37401400 available form the WoodSolutions website assesses the impact of the interface details in Figure 5.30 on the FRL RISF and MRISF of the systems



Shaft continuity at timber framed floor



Shaft continuity at massive timber panel floor

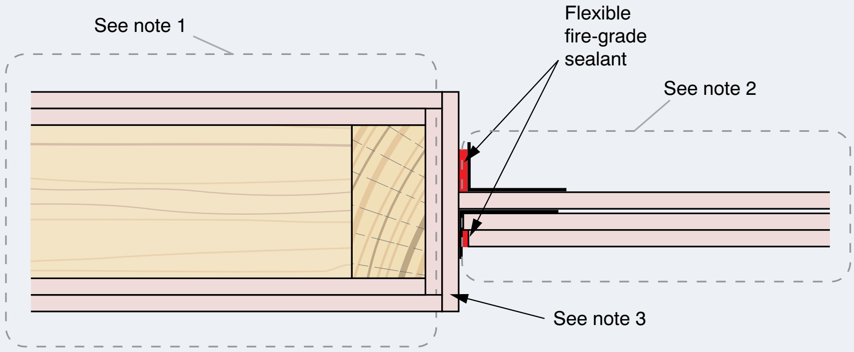
Figure 5.30: Interfaces between fire-protected timber and steel stud shafts (continued from previous page)

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

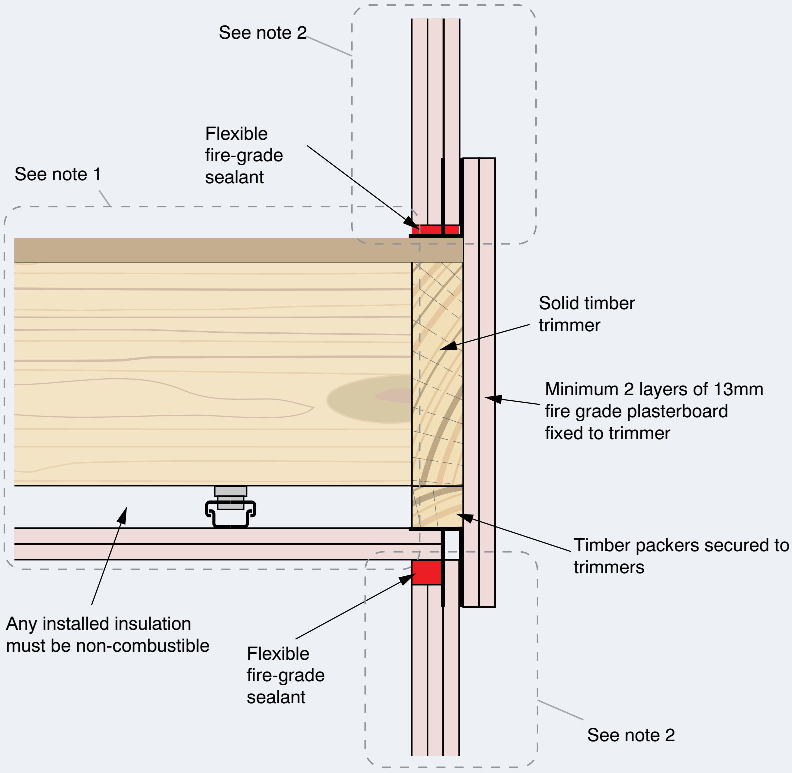
Note 2: Shaft wall construction having the required FRL.

It is important that the fire performance is not compromised at the interfaces between the shaft and fire-protected timber walls and floors. Figure 5.30 shows typical interface details for steel framed shaft construction and Figure 5.31 shows typical interface details for laminated shaft construction. These interface details have been assessed by an Accredited Testing Laboratory (EWFA report reference RIR 37401400) and found not to compromise the performance of the wall or shaft systems.

EWFA RIR 37401400 assesses the impact of the interface details on the FRL of the systems



Laminated shaft to timber stud wall



Shaft continuity at timber framed floor opening. (Massive timber detail similar)

Figure 5.31: Interfaces between fire-protected timber and laminated board shafts.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

Note 2: Shaft wall construction having the required FRL.

Note 3: Interface protected with the same fire protective coverings that are applied to the fire-protected timber element face. Shaft wall tracks are to be screw fixed to timber elements at 300 mm maximum centres with 62 mm long screws.

5.9 Fire Doors in Fire-protected Timber Walls

Fire door assemblies are required to comply with AS 1905.1 as appropriate in addition to achieving the required FRL. Generally, fire doors are required to be tested when mounted in a wall of representative construction. Evidence of Suitability should therefore be provided from the supplier that relates to the performance of their fire doors when mounted in representative timber elements of construction.

In addition, the fire doors must not compromise the RISF or MRISF performance of the wall. The frame fixing details shown in Figure 5.32 have been assessed by an Accredited Testing Laboratory to determine that the details will not reduce the RISF or MRISF to below 45 minutes for the timber-frame systems and 30 minutes for the massive timber panel systems (Refer EWFA report reference RIR 37401400). Other details may be adopted if appropriate Evidence of Suitability to demonstrate compliance with the NCC requirements for fire doors and fire-protected timber elements is provided.

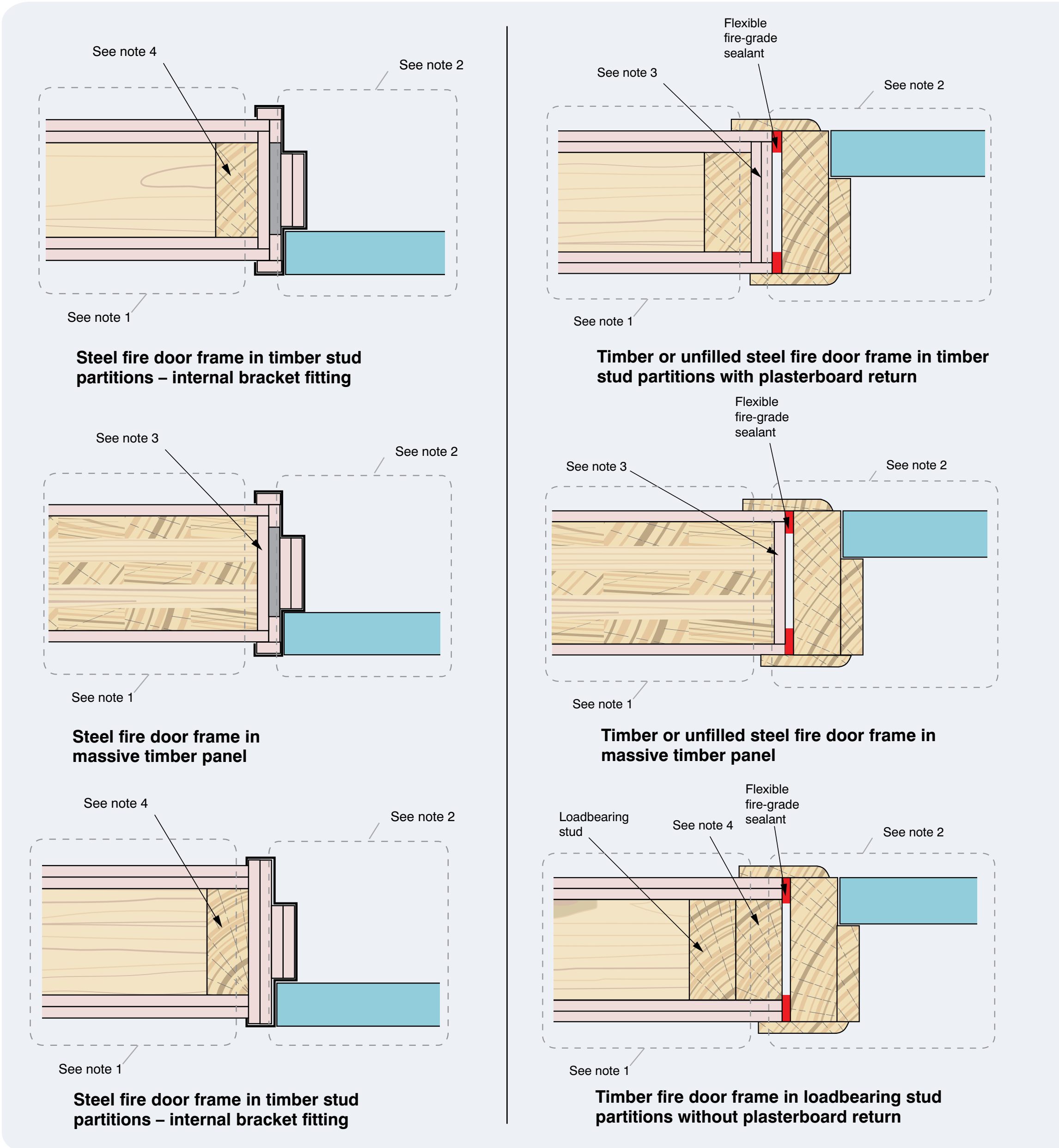


Figure 5.32: Fire door interface details.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity Insulation must be non-combustible.

Note 2: Fire Door Assembly with the required FRL determined in accordance with AS 1530.4 and AS 1905.1 as appropriate.

Note 3: Interface protected with the same fire protective coverings that are applied to the fire-protected timber element face.

Note 4: Minimum of 45 mm thick non-loadbearing solid timber cavity barrier framing the cavity opening around the door.

5.10 Construction for Fire-Isolated Stair Shafts

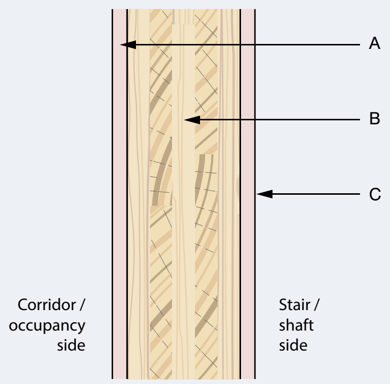
Evidence of Suitability in accordance with NCC requirements should be obtained from the product suppliers

Fire-isolated stair shafts can be constructed from fire-protected timber, concrete masonry and other non-combustible non-loadbearing materials or a hybrid construction may be adopted. The selection will depend on the structural design of the building, construction programming, and other factors.

Where concrete or masonry shafts are used the design will need to account for differential movement between the shaft and timber structure.

For timber-framed construction, walls similar to those shown in Figure 5.22 could be adopted for the example building.

A further concession is provided for massive timber panels in that the fire-protective covering for the internal face of the shaft is permitted to achieve a MRISF of 20 minutes compared to the 30 minutes required for the outer face as shown in Figure 5.33 and Figure 5.34. The fire protective coverings around the face of openings for doors and access panels should be the greater of that required for the external facing or to achieve the required FRL.



Construction
A Linings min 1 x 16 mm fire-protective grade plasterboard (corridor/occupancy side)
B Massive timber min 75 mm thick ***(note greater thickness may be required to achieve required FRL unless additional fire protective coverings applied)***
C Linings min 1 x 13 mm fire-protective grade plasterboard (internal shaft side)

Performance
FRL 90/90/90 obtain Evidence of Suitability from supplier
MRISF 30 mins (1 x 16 mm fire-protective grade plasterboard) – NCC Spec C1.13a DTS
MRISF 20 mins (1 x 13 mm fire-protective grade plasterboard) – NCC Spec C1.13a DTS

Figure 5.33: Typical stair and lift shaft construction for single skin massive timber panel construction.

Although a minimum panel thickness of 75 mm is permitted, in most instances substantially greater thicknesses will be required as part of the structural design and/or to achieve the required FRLs. The FRL should be checked to ensure the load levels during the test were comparable to the loads that will be applied under fire conditions.

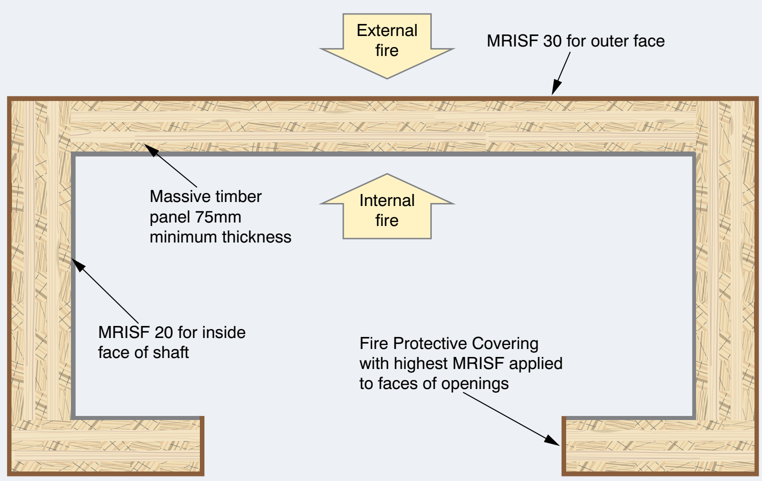


Figure 5.34: MRISF requirements for typical stair and lift shaft construction for single skin massive timber panel construction.

5.11 Construction for Stairways within Fire-isolated Stairs

NCC Clause D2.25 provides a concession allowing timber treads, risers, landings and associated supporting framework to be used within a required fire-isolated stairway or fire-isolated passageway provided the timber used:

- has a finished thickness of not less than 44 mm with an average timber density of not less than 800 kg/m^3 (at 12% moisture content).
- the building is protected throughout by a sprinkler system complying with Specification E1.5 (other than a FPAA101D or FPAA101H system) that is extended to provide coverage within the fire-isolated enclosure
- the underside of flights of stairs directly above landings providing access to ground level or car parking levels being protected by a single layer of 13 mm fire-protective grade plasterboard fixed to the stringers with fixings at not greater than 150 mm centres (Figure 5.35).

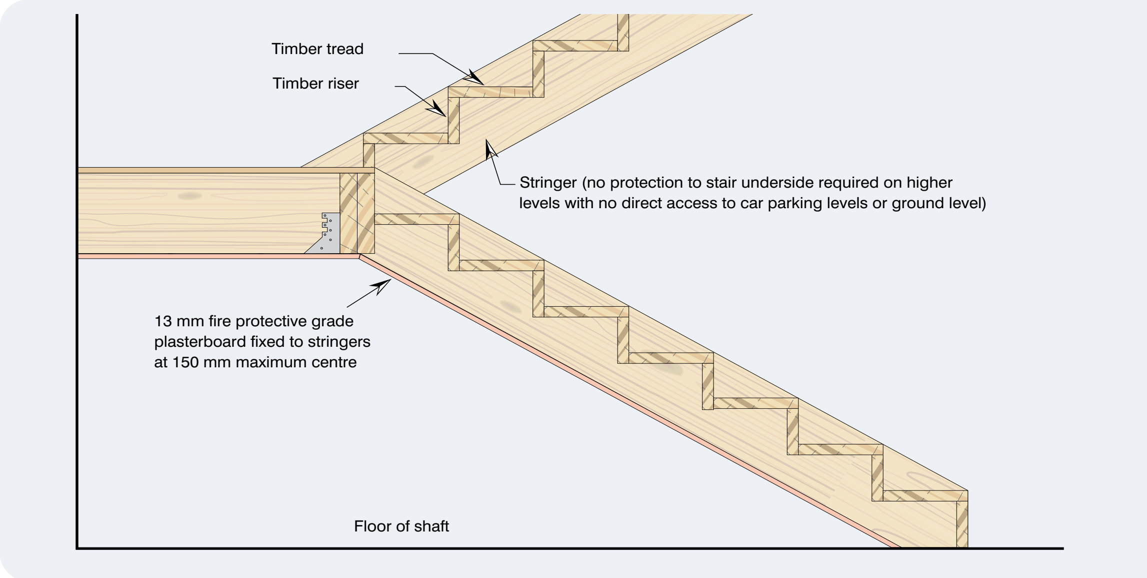


Figure 5.35: Stairway fire protection.

Refer to Section 5.15 for further information about sprinkler installations.

Impact sound from stair usage may vibrate the stair shaft walls, creating a pathway for sound transmission. A practical way to prevent this is by isolating the support for the stair structure by using stringers to support the stairs (top and bottom) rather than the wall adjoining areas requiring sound isolation (Figure 5.36). In some instances, newel posts to support the stringers may be necessary.

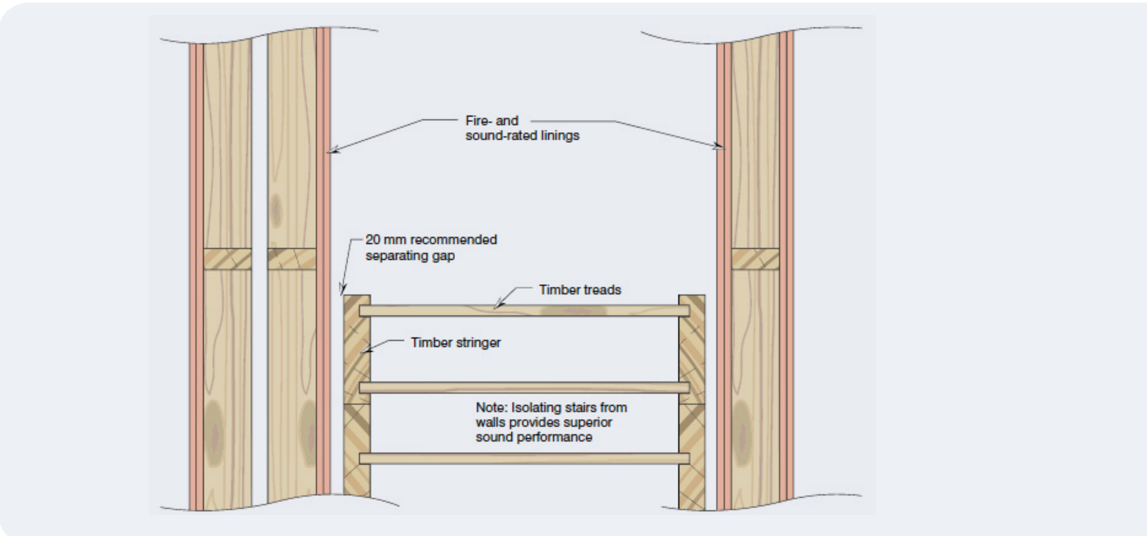


Figure 5.36: Sound isolation of stairway.

If a non-combustible stair (e.g. steel) is installed within the fire-protective timber stair shaft, the sprinkler system does not require extending to provide coverage in a fire-isolated stair.

5.12 Construction for Lift shafts

Lift shafts can be constructed in a similar manner to stair shafts as described in Section 5.10.

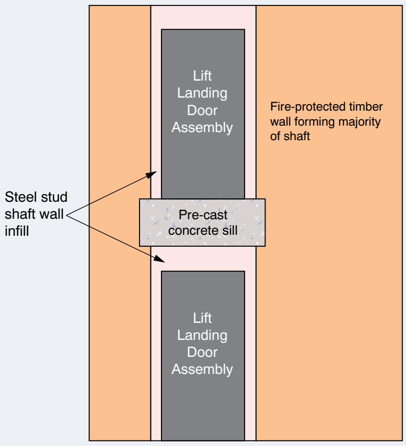
Care is needed to ensure that the lift shaft is compatible with the selected lift system. Compatibility issues should be resolved early in the design process and early liaison with the lift supplier is strongly recommended.

In the short term, most lift landing door assemblies will have been fire tested in masonry/concrete or steel stud shaft wall systems. The following details provide an interface between fire-protected timber and a pre-cast concrete sill and steel shaft wall systems. This can enable lift doors to be installed within sections of the wall of steel stud /plasterboard shaft wall and concrete construction to which existing lift landing door fire-resistance test results can be applied.

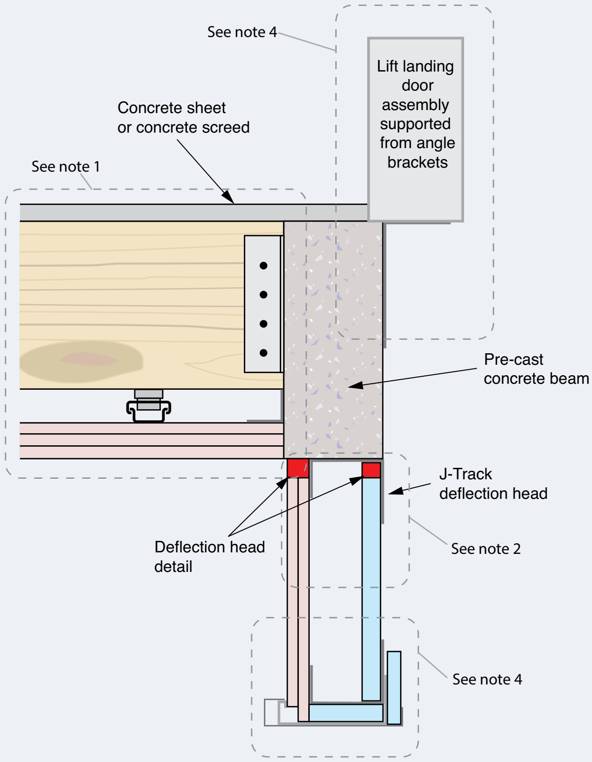
In the longer term, a larger range of lift landing doors is expected to be fire tested in fire-protected timber construction, providing simpler installation details.

The interface details in Figure 5.37 have been assessed by an Accredited Testing Laboratory (refer EWFA report RIR 37401400). The applicability of the Evidence of Suitability to a particular application should be checked with the authority having jurisdiction.

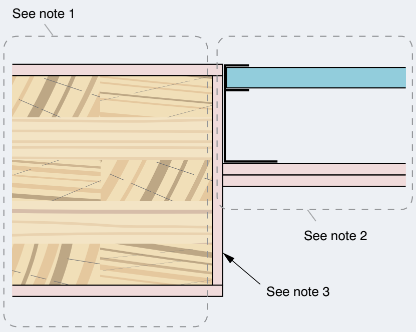
Impact sound from lift use may vibrate the lift shaft walls, creating a pathway for sound transmission. While this can be addressed to some extent using double stud wall assemblies or twin-skin massive timber panel construction utilising two layers of 13 mm plasterboard, there are other options, such as the construction of a framework within the lift shaft that supports the lift assembly independently of the shaft walls.



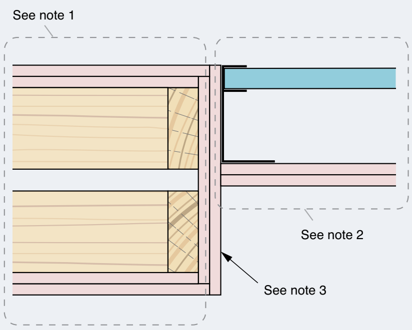
Elevation of lift doors in shaft



Head and sill detail for interfaces with shaft wall and concrete sill (timber-frame)



Side interface between shaft-wall and double timber stud shaft



Side interface between shaft-wall and massive timber panel

Figure 5.37: Typical details for shaft wall conversion for lift-landing door installation.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

Note 2: Shaft wall construction having the required FRL.

Note 3: Interface protected with the same fire protective coverings that are applied to the fire-protected timber element face.

Note 4: Lift landing door assembly having the required FRL installed in accordance with the lift door and shaft wall supplier instructions and evidence of compliance confirming the FRL.

5.13 Cavity Barriers and Junction Details

5.13.1 Typical Junction Details at Intersection of Fire-Protected Timber Walls and Floors

Cavity barriers are required at the junctions between fire-protected timber floor assemblies and fire-protected timber walls in framed construction. In many instances the Deemed-to-Satisfy solutions permitting the use of solid timber and/or mineral fibre enable integration of cavity barriers with typical wall and floor junction details.

The key design parameters are to achieve, as a minimum, the required seal thickness in the direction of potential fire spread through the cavity and ensure the seals are continuous.

Typical details for double stud walls and external walls for the example Class 2 building are shown in Figures 5.38-5.41. These details are based on a 'ring beam' design concept which can be useful in the management of the risk of disproportionate collapse. This form of construction is also compatible with the prefabrication of floor cassettes. Prefabrication can provide a number of advantages including:

- acceleration of the construction program
- improved quality control
- improved safety.

The timber blocking can act as cavity barriers between the floor/ceiling cavity and wall cavity but it is still necessary to include horizontal cavity barriers to prevent spread via the wall cavities at each floor level and at 5 metre centres if the floor to floor height is greater than 5 metres. A practical solution is to provide mineral fibre cavity barriers as shown in Figures 5.38-5.40.

Although the mineral fibre cavity barrier is only required to be 45 mm thick in the potential direction of fire spread, where practical, installation of cavity barriers the full floor depth provides a more robust solution since any joins in the ring beam/blocks will also be backed by the mineral fibre.

For single stud internal walls the detail is simplified because the top and bottom plates of the wall frame close off the cavities within the wall as shown in Figure 5.41.

Massive timber panel designs are required to avoid cavities and therefore the main consideration with the design of junctions is to maintain continuity of the fire-protective coverings.

Figures 5.38 to 5.41 include typical examples of joint seals to allow for movement and maintain acoustic and fire separations. The joint sealing details may vary depending upon the installation order of wall and ceiling fire-protective grade coverings amongst other things. Reference should be made to the plasterboard and / or sealant suppliers for Evidence of Suitability if alternative configurations are adopted.

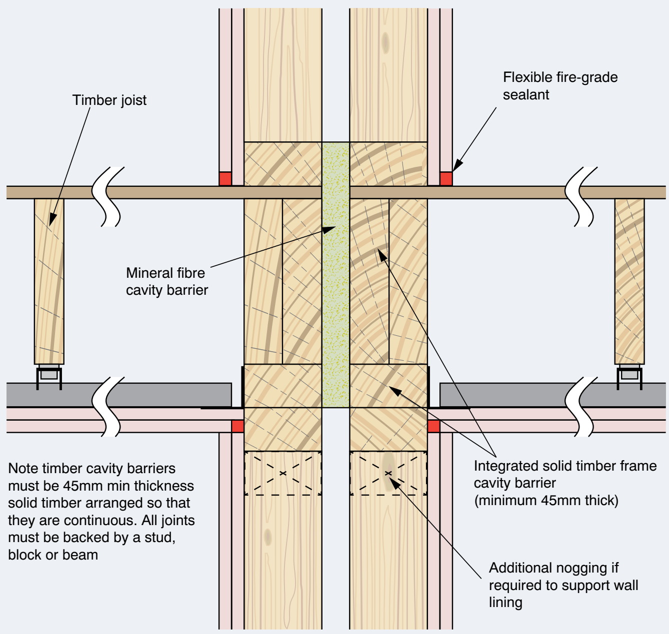


Figure 5.38: Fire-protected timber frame wall/floor junction with integral cavity barriers – beams parallel to wall Class 2 building.

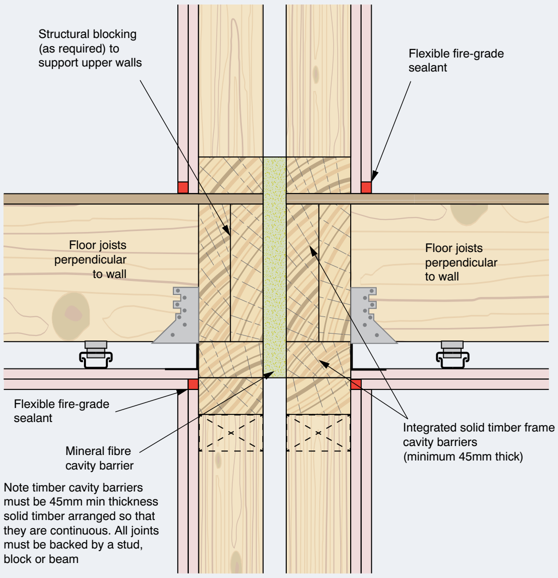


Figure 5.39: Fire-protected timber frame wall /floor junction with integral cavity barriers – beams perpendicular to wall Class 2 building.

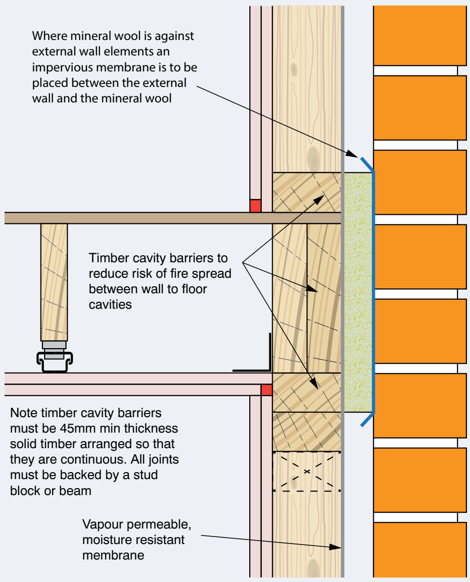


Figure 5.40: Fire-protected timber frame wall /floor junction with integral cavity barriers – beams parallel to wall Class 2 building.

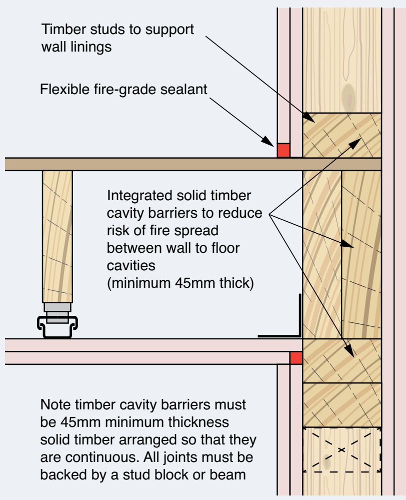


Figure 5.41: Fire-protected single stud timber frame wall /floor junction with integral cavity barriers – beams parallel to wall Class 2 building.

5.13.2 Vertical Cavity Barriers

Vertical cavity barriers are required at the intersection of walls and at 10 metres maximum horizontal centres. Typical details for double stud walls and external walls for the example Class 2 building are shown in Figures 5.42-5.44. Single stud details adopt a similar approach.

For double stud walls separate cavity barriers can be provided for each skin as shown in Figure 5.43 but in most instances a more practical solution is to fit a wider section spanning the full width of the intersecting wall, as shown in Figures 5.42 and 5.44.

Massive timber panel designs are required to avoid cavities and therefore the main consideration with the design of junctions is to maintain continuity of the fire-protective coverings.

Where external cladding or veneer systems form part of the fire-protective coverings (e.g. brick veneer) at cavity barrier positions an impervious membrane must be placed between the mineral fibre and cladding or veneer surface to control moisture transfer from the cladding or veneer.

An alternative approach for external walls that may avoid the risk of bridging at cavity barrier positions is to apply the fire-protective coverings to the outer face of the timber elements as well as the inner face and then fit a non-combustible external cladding system that satisfies the NCC DTS requirements. Typical examples are shown in Figures 5.19 and 5.20.

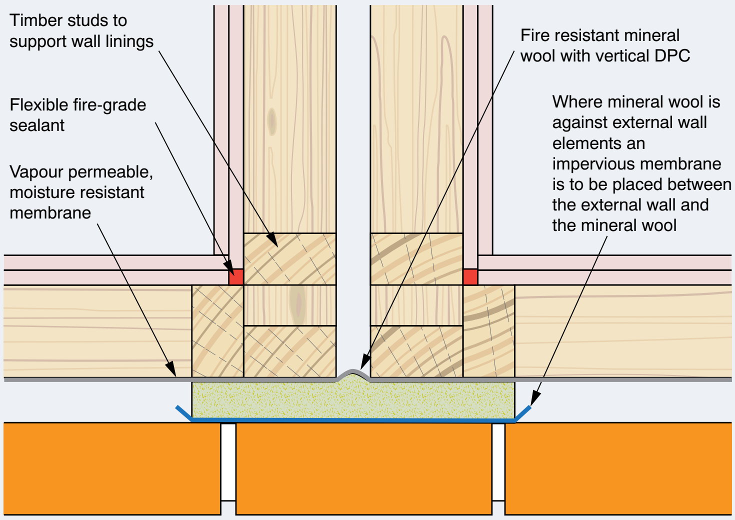


Figure 5.42: Double stud fire-protected timber internal wall intersecting a brick veneer wall.

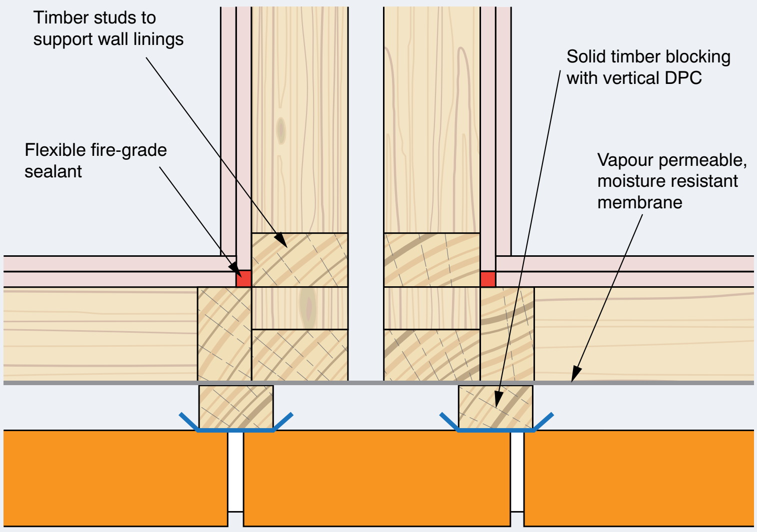


Figure 5.43: Double stud fire-protected timber internal wall intersecting a brick veneer wall with split cavity barrier system.

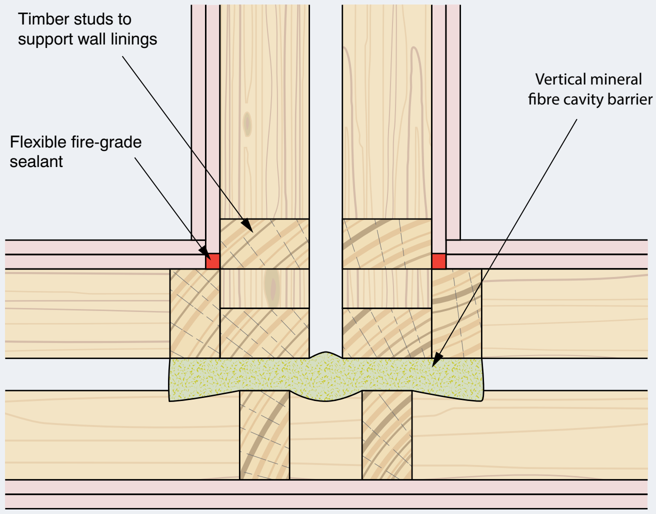


Figure 5.44: Double stud fire-protected timber internal wall intersection.

Provided the timber studs are a minimum of 45 mm thick, intermediate cavity barriers (at maximum 10 metres centres) can be fitted at a stud position as shown in Figure 5.45.

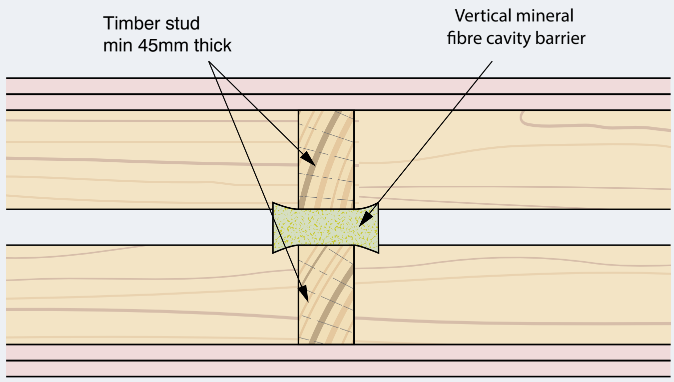


Figure 5.45: Intermediate vertical cavity barrier in double stud wall.

5.13.3 Unprotected Openings in External Walls

Cavity barriers are required around the perimeter of openings, such as unprotected windows in external walls, to prevent premature entry into the fire-protected timber cavities at these positions. A typical example is shown in Figure 5.46.

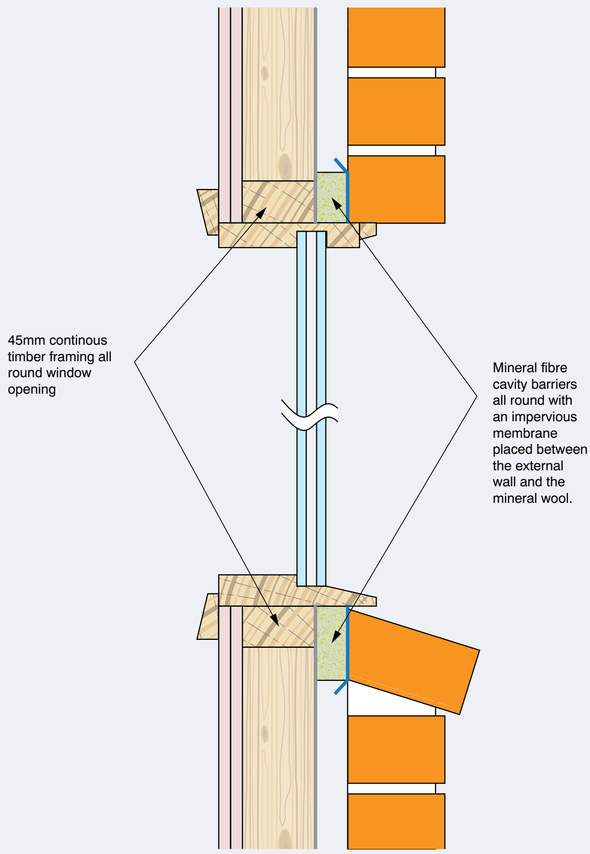


Figure 5.46: Cavity barrier around window in external wall.

5.13.4 Intersection of Non-Fire-Resisting Walls with Fire-Protected Timber Elements

Fire-protective coverings of fire-protected timber elements should not be interrupted at the point of intersection with non-fire-resisting walls to ensure the FRLs and RISF or MRISF are not compromised. Typical examples are shown in Figures 5.47 and 5.48.

Where the non-fire-resisting element is fixed to the fire-protected element additional framing may be required to avoid the risk of failure of the non-fire-resisting element compromising that of the fire-protected element. A typical detail for additional framing is shown in Figure 5.48.

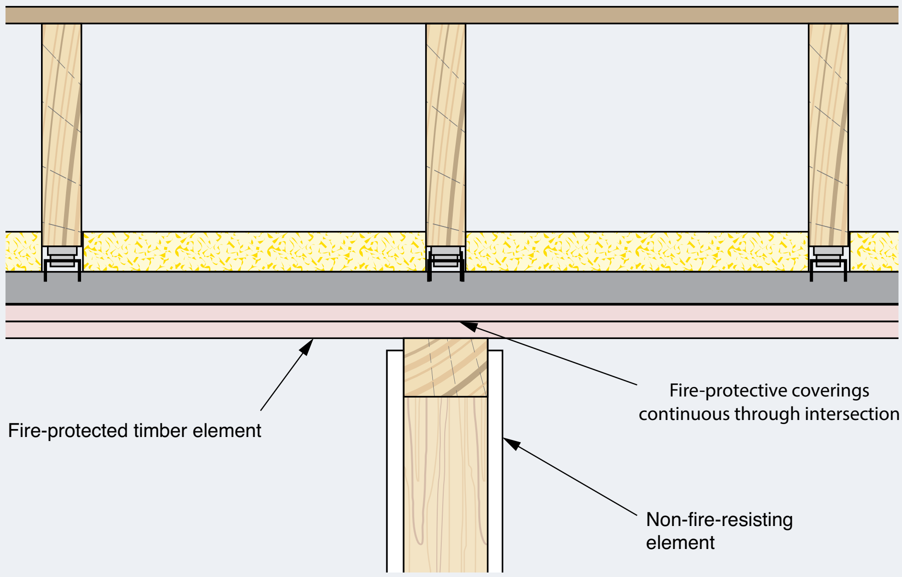


Figure 5.47: Junction of non-fire-resistant wall and fire-protected timber floor.

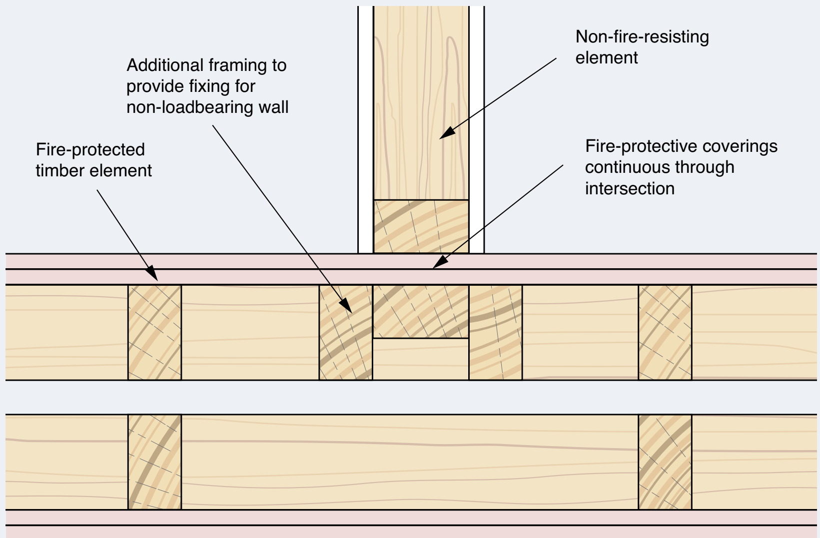


Figure 5.48: Junction of non-fire-resistant wall with fire-protected timber wall including additional framing detail.

With massive timber, the fixing point is less likely to require additional stiffening.

5.13.5 Roof Space Cavity Barriers or Fire-protected Timber Wall Extension

Special attention needs to be given to the design of roof spaces to address the risk of uncontrolled fire spread. There are generally two approaches that can be adopted:

Option 1: Extend SOU bounding fire-protected timber walls to roof level

The bounding construction around SOUs is continued to roof level (Figure 5.49). This has the advantage that the ceilings to the top floor do not need to be fire-resisting because the wall extension can provide the necessary fire and sound separation.

It is critical that the seal against the underside of the roof is capable of achieving the required FRL, RISF or MRISF and that the fire separation is not interrupted or bypassed at vulnerable positions such as the eaves or where framing members intersect extension of the SOU boundary walls.

If this option is adopted a horizontal cavity barrier should be provided for timber-framed construction at ceiling level as shown in Figure 5.49.

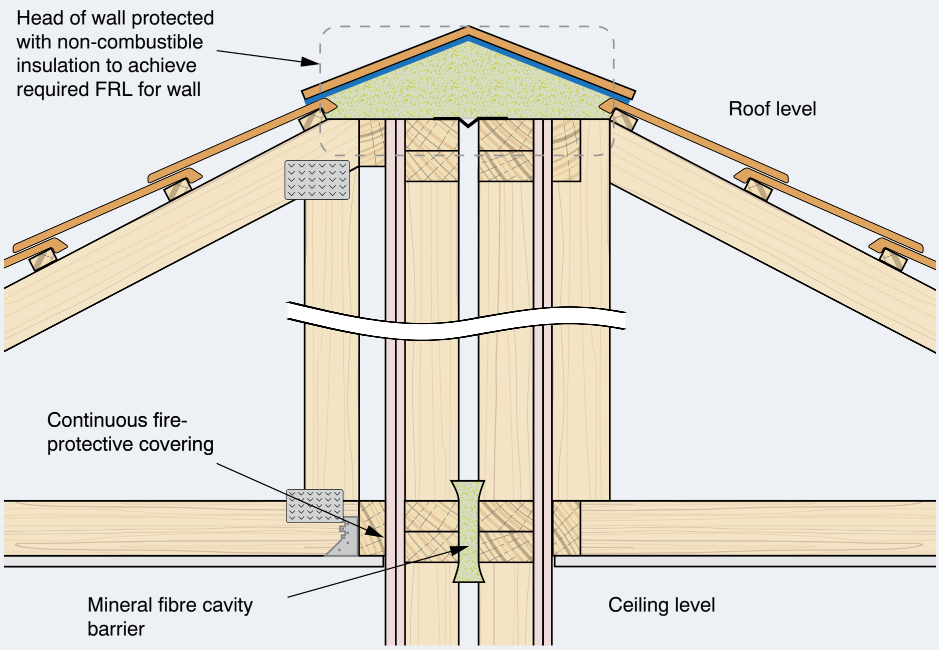


Figure 5.49: Roof space option 1 extending SOU bounding fire-protected timber walls to roof level.

Good practice principles for service penetrations:

1 If practicable avoid service penetrations through fire-protected timber elements.

2 If fire-protected timber elements have to be penetrated by services, group the services and run them through lined openings protected by multi-penetration systems.

3 Ensure the FRLs and the RISF or MRISF levels are maintained at service penetrations.

Option 2: Provide fire-protected timber ceiling and cavity barriers within roof space

If Option 2 is applied to the Class 2 example building, assuming timber-framed construction, the ceiling would require an FRL of 90/90/90 and a RISF of 45 minutes and the roof spaces would need to be divided by cavity barriers above each of the SOU bounding walls. Where the roof void is relatively deep it may be impractical to apply the Deemed-to-Satisfy solutions of solid timber or mineral fibre and a plasterboard partition achieving the required FRL of 45 minutes for a cavity barrier may provide a more practical solution as shown in Figure 5.50.

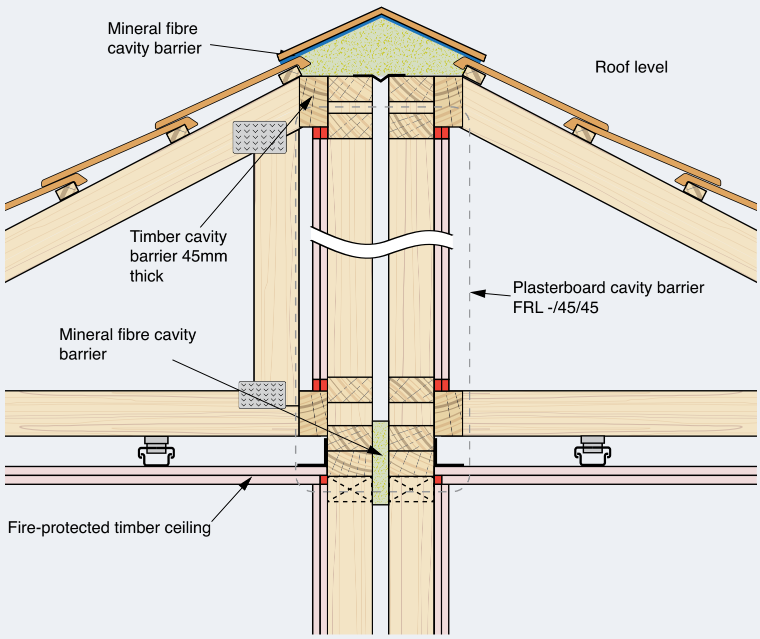


Figure 5.50: Roof space Option 2 fire-protected timber ceiling and cavity barriers within roof space.

If this option is selected it is critical that the seal against the underside of the roof is capable of achieving the required performance and the fire separation provided by the cavity barrier is not interrupted or bypassed at vulnerable positions such as the eaves or where framing members intersect at the extension of the SOU boundary walls.

A horizontal cavity barrier should be provided for timber-framed construction at ceiling level as shown in Figure 5.50.

Depending on the roof design, the roof cavity height can vary from nominally 150 mm to several metres and careful consideration should be given to detailing and checking installations to ensure the design objectives are achieved.

5.14 Service Penetration Treatments

Careful detailing of services and service penetration systems during the design stages and subsequent correct installation during construction can simplify construction details and stream line the construction process as described in early chapters of this Guide.

The general design approach can be expressed as three fundamental principles

- Select services, service locations and service runs to avoid, as far as practical, the need for service penetrations through fire-protected timber elements (e.g. the use of false walls and ceilings can substantially reduce the number of penetrations that require protecting).
- If service penetrations cannot be avoided, where practical they should be grouped and penetrate lined openings or non-combustible shaft walls, which minimises the risk of exposing the cavity during maintenance operations. This approach also simplifies the installation of new services.
- If service penetrations are required to pass through fire-protected timber elements, ensure the FRL and RISF or MRISF as appropriate at service penetration positions.

The following Sections provide typical generic examples. Over time, it is expected that proprietary systems will become available simplifying the installation process. Refer to Section 5.8 Service Shafts for typical interface details between non-combustible shaft construction and fire-protected timber.

5.14.1 Multi-penetration Systems with Lined Openings

Typical multi-penetration systems with lined openings are shown in Figure 5.51.

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<tr><th>System</th><th>Timber Frame</th><th>Massive Timber Panel</th></tr>
<tr><td>Pillow
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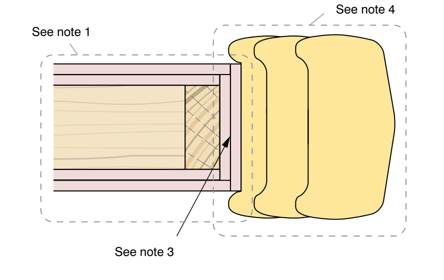
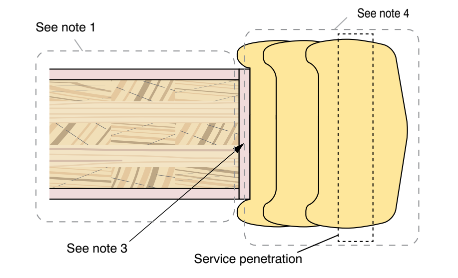
opening</td><td>
</td><td>
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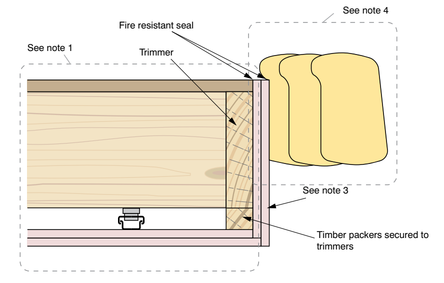
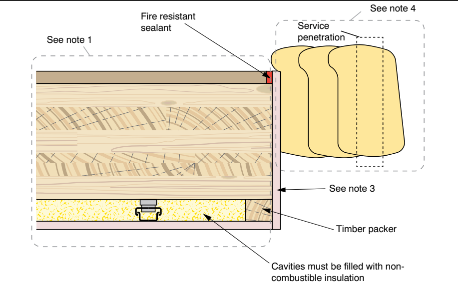
in floor
opening</td><td>
</td><td>
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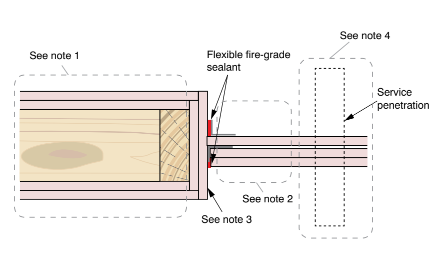
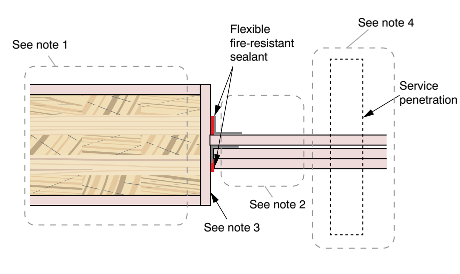
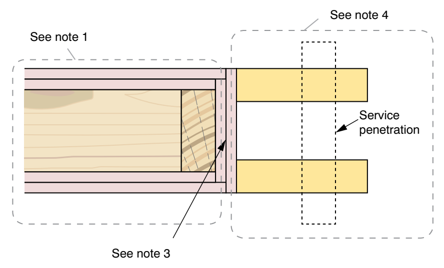
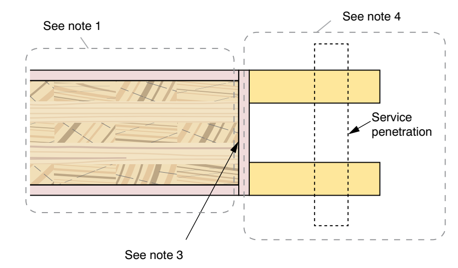
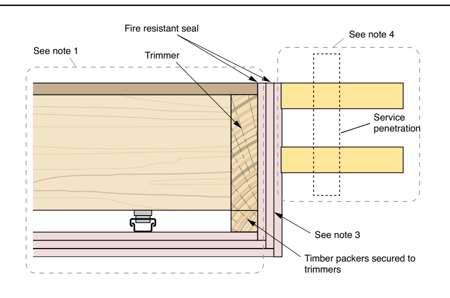
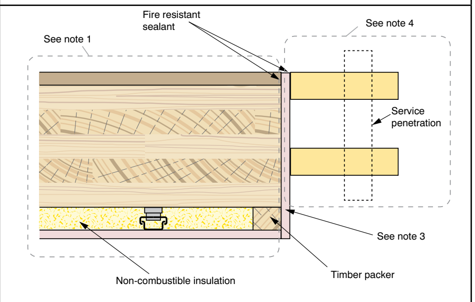
infill in wall
opening</td><td>
</td><td>
</td></tr>
<tr><td>Mineral
fibre
batt wall
opening</td><td>
</td><td>
</td></tr>
<tr><td>Mineral
fibre batt
floor
opening</td><td>
</td><td>
</td></tr>
</table>

Figure 5.51: Typical multi-penetration systems with lined openings.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity Insulation must be non-combustible.

Note 2: Shaft wall construction having the required FRL.

Note 3: Interface protected with the same fire protective coverings that are applied to the fire-protected timber element face.

Note 4: Service penetration protected to achieve the required FRL. Evidence of performance to be in the form of a report from an Accredited Testing Laboratory in accordance with AS 1530.4 and AS 4072.1 as appropriate.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of interface details shown in Figure 5.51

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of interface details shown in Figure 5.52

Interface details shown in Figure 5.51 have been assessed by a registered test laboratory to determine that the details will not reduce the RISF or MRISF to below 45 minutes for the timber stud systems and 30 minutes for the massive timber panel systems (Refer EWFA report RIR 37401400). Other details may be adopted provided appropriate Evidence of Suitability to demonstrate compliance with the NCC requirements is provided.

5.14.2 Fire Damper and Duct Penetrations

The lined opening approach can also be applied to duct and damper penetrations (Figure 5.52).

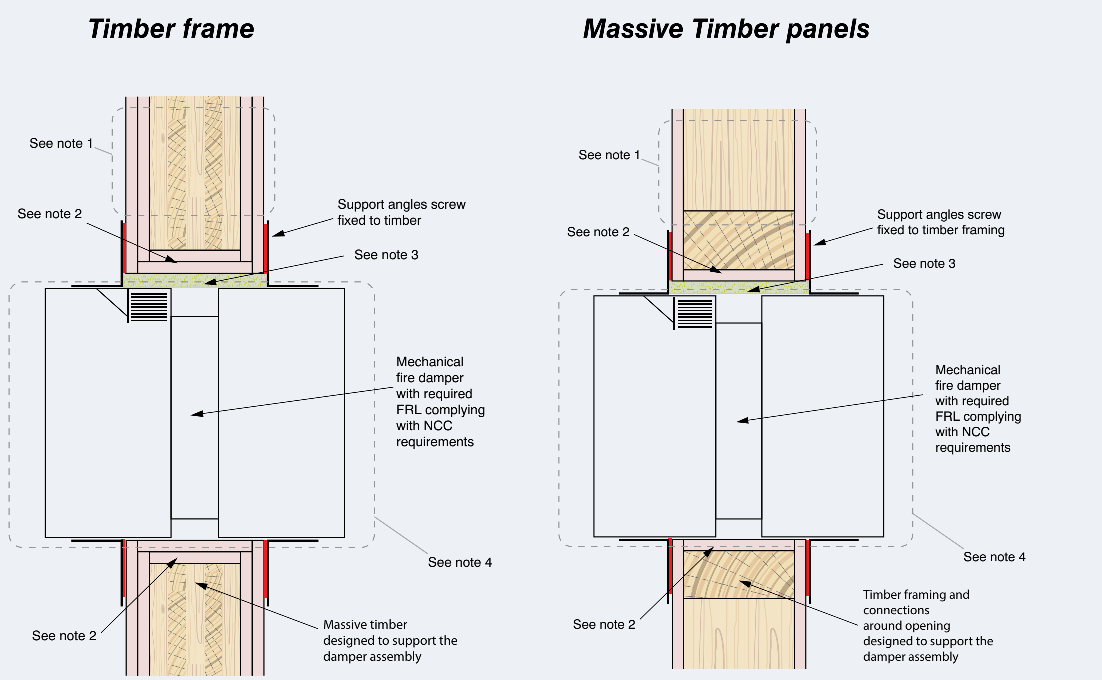


Figure 5.52: Typical details for fire damper and duct penetrations.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

Note 2: Interface protected with the same fire protective coverings that are applied to the fire-protected timber element face.

Note 3: Non-combustible mineral fibre packing may be used for fire damper penetration seal or proprietary fire damper penetration seals that achieve the required FRL with evidence of performance in the form of a report from an Accredited Testing Laboratory to be in accordance with AS 1530.4 and AS 4072.1 as appropriate.

Note 4: Mechanical fire damper having the required FRL when tested in accordance with AS 1530.4 and complying with AS 1682 Parts 1 and 2 as appropriate.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of wall lining detail shown in Figure 5.53

5.14.3 GPO Outlets and Switches

Where practical, the need to protect GPO outlets, switches and similar penetrations should be avoided by mounting them within internal (non-fire-resisting walls) or false (decorative) linings fitted in front of fire-protected timber elements as shown in Figure 5.53.

Methods of attaching non-fire-resisting decorative linings that will not compromise the FRL, RISF or MRISF performance of wall and floor systems, such as shown in Figure 5.53, have been assessed in a report from a Accredited Testing Laboratory (refer EWFA RIR 37401400).

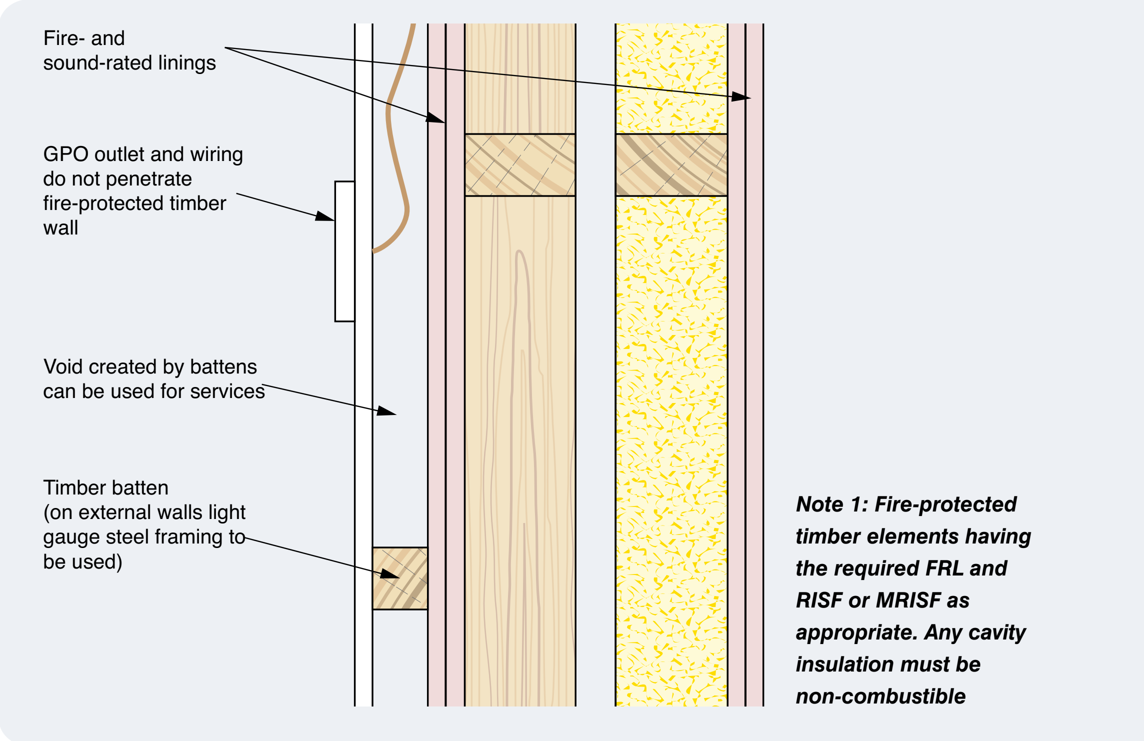


Figure 5.53: False wall system.

If it is impractical to apply an additional lining, a proprietary GPO protection system may be adopted, if it has Evidence of Suitability, demonstrating that the required FRL and RISF or MRISF for the element will not been compromised.

Alternatively, the generic systems shown in Figures 5.54 and 5.55 may be adopted.

New products (e.g. skirting service ducts) also enable services to be run within SOUs without penetrating fire-protective grade linings.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of the GPO interface details shown in Figures 5.54 and 5.55

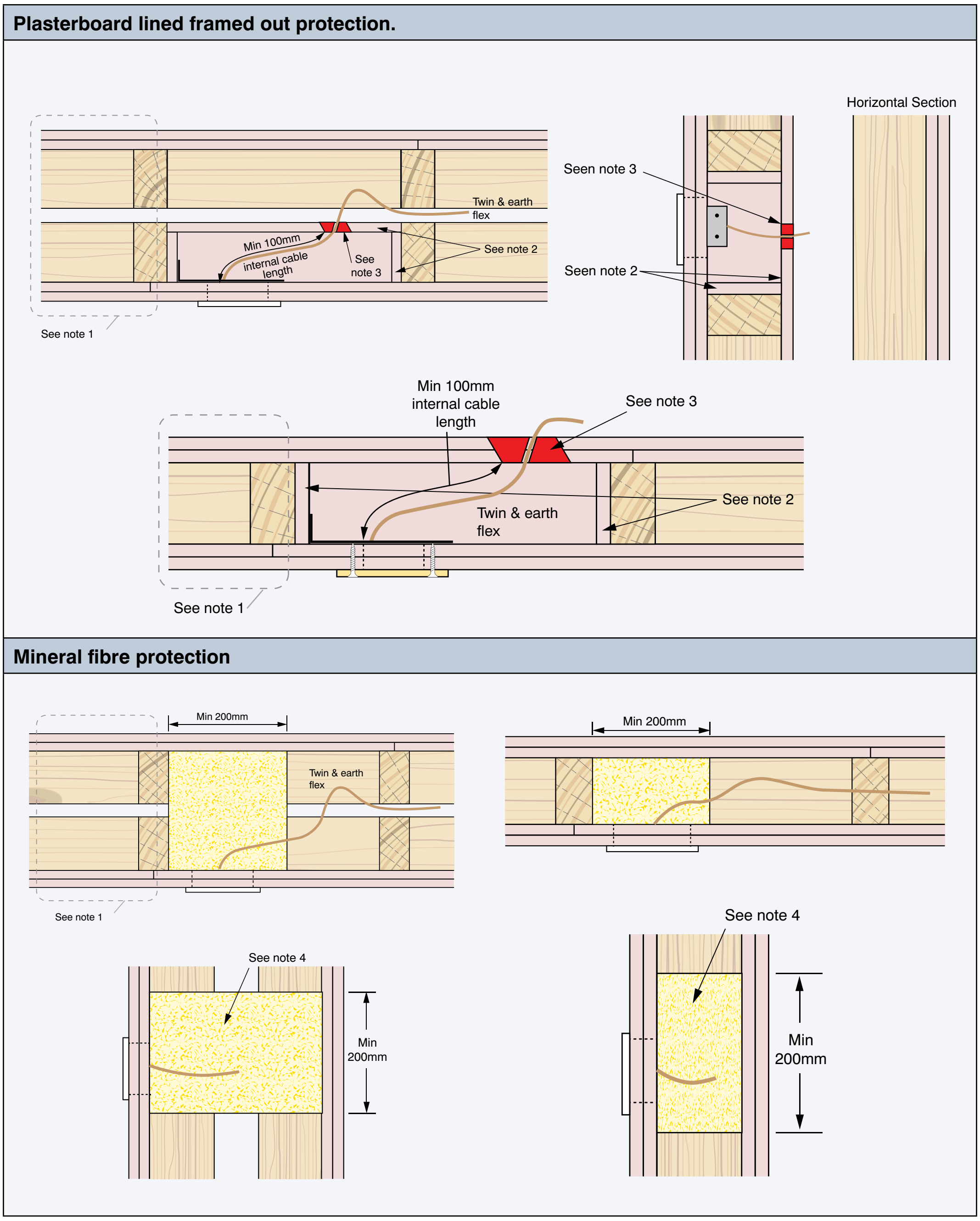


Figure 5.54: Generic GPO protection systems in timber-framed construction.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity Insulation must be non-combustible.

Note 2: Aperture lined with a minimum of 1 layer 16 mm plasterboard. Greater thicknesses/number of layers may be required for the faces of the wall since it forms part of the wall system.

Note 3: Linings must be sealed full depth where penetrated by a service with a 'fire-resistant mastic' The mastic should have evidence of performance in the form of a test report from an Accredited Testing Laboratory demonstrating that when protecting pipe or cable service penetrations through plasterboard elements the system can achieve an FRL of –/60/–.

Note 4: Cavity filled full depth with mineral fibre of minimum density 60 kg/m^3 for at least 100 mm to the sides and above and below the centreline of the GPO.

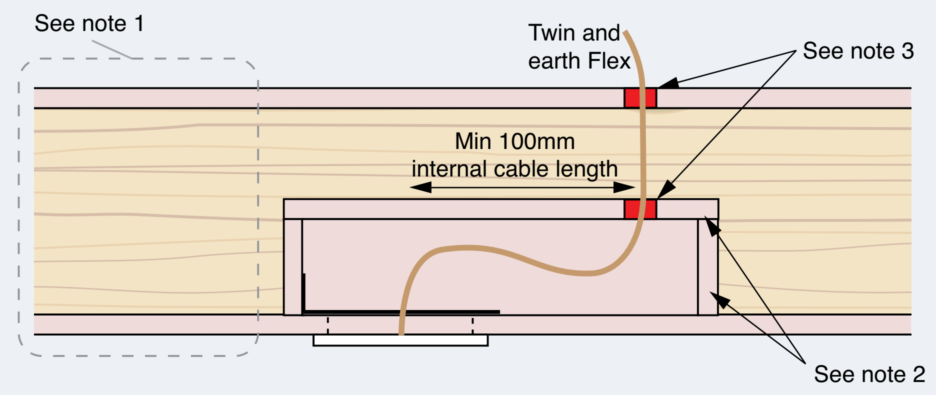


Figure 5.55: Generic GPO protection systems in massive timber construction.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

Note 2: Aperture lined with a minimum of one layer 16 mm plasterboard. Greater thicknesses/number of layers may be required for the faces of the wall since it forms part of the wall system.

Note 3: Linings must be sealed full depth where penetrated by a service with a 'fire-resistant mastic'. The mastic should have a test report from an Accredited Testing Laboratory demonstrating that when protecting pipe or cable service penetrations through plasterboard elements the system can achieve an FRL of –/60/–.

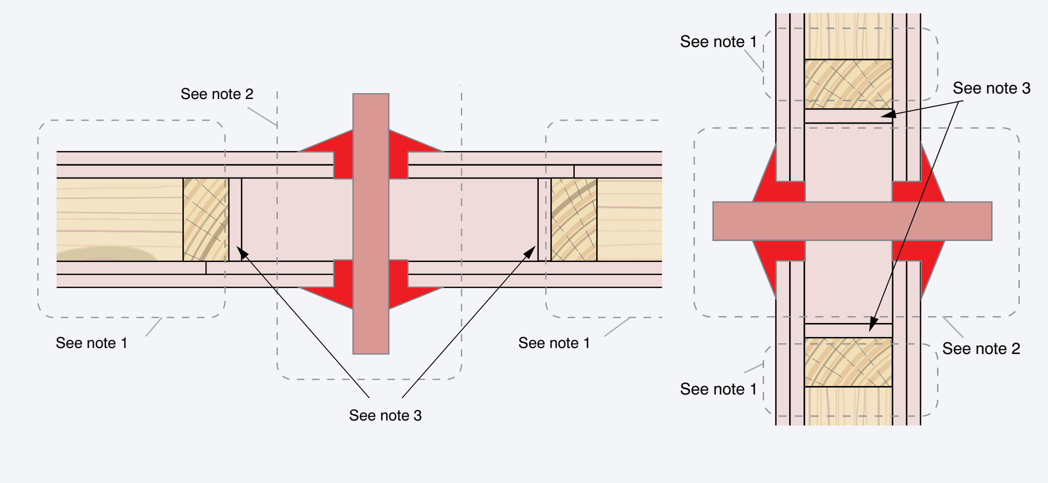
5.14.4 Single Cable and Metal Pipe Penetrations

Where single cable and pipe penetrations through fire-protected timber members cannot be avoided, existing proprietary protection systems that have achieved the required FRL in plasterboard systems can be used in conjunction with internal plasterboard linings or mineral fibre insulation packing as shown in Figure 5.56 to satisfy a RISF of 45 minutes or MRISF of 30 minutes as appropriate.

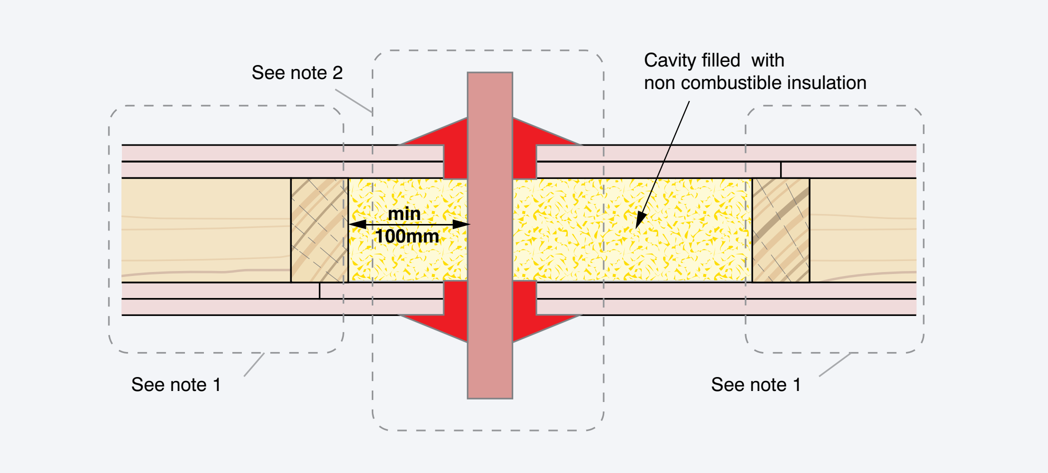
Fire tested proprietary systems may provide more practical options, subject to adequate Evidence of Suitability being available.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of the systems shown in Figure 5.56

Plasterboard lined timber frame. RISF 45 minutes



Mineral fibre fill timber frame. RISF 45 minutes.



Mineral fibre fill massive timber. MRISF 30 minutes.

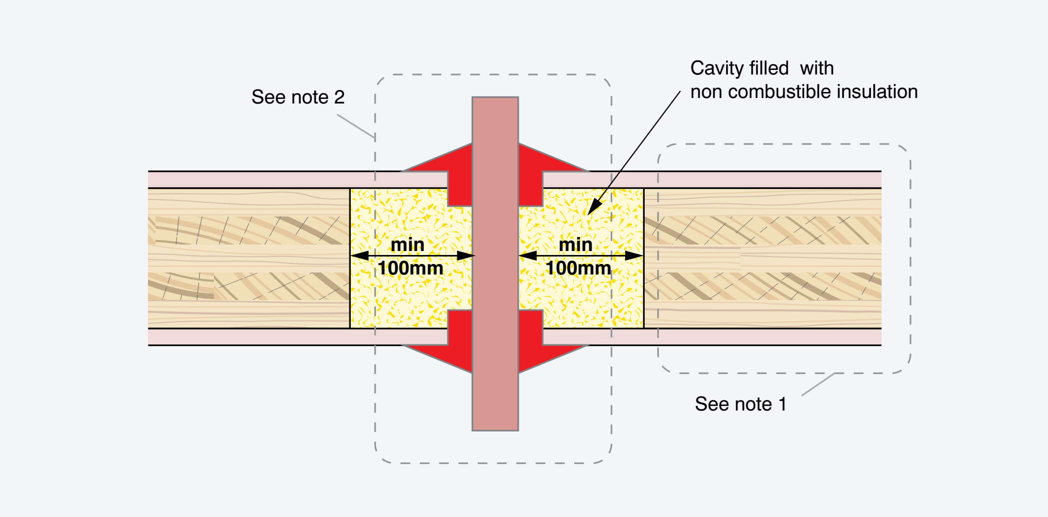


Figure 5.56: Pipe and cable penetrations through fire-protected timber.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity Insulation must be non-combustible.

Note 2: Service penetration protected to achieve the required FRL. Evidence of performance to be in the form of a report from an Accredited Testing Laboratory in accordance with AS 1530.4 and AS 4072.1 as appropriate.

Note 3: Aperture lined with a minimum of 1 layer 16 mm plasterboard. Greater thicknesses/number of layers may be required for the faces of the wall since it forms part of the wall system.

The preferred option for lighting cables, sprinkler pipe penetrations and the like is to run them through the cavity above a false ceiling. A typical false ceiling detail is shown in Figure 5.57. Larger cavities can be provided above false ceilings by using suspended ceiling fixings to accommodate down lights and larger services.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of ceiling lining detail shown in Figure 5.57.

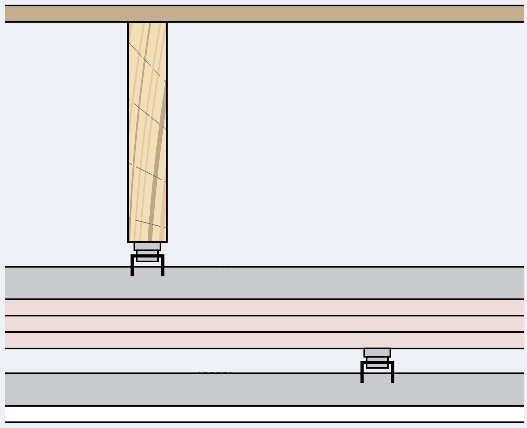


Figure 5.57: False ceiling detail for minimising service penetrations through ceiling systems.

If it is impractical to provide a false ceiling a solution for lighting cable penetrations through fire-protected timber ceilings is to use cover blocks as shown in Figure 5.58. Proprietary systems may be available to protect down-light penetrations and sprinkler pipe penetrations but access for the long-term service and maintenance of these systems and options for reconfiguration would be very limited.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of back blocking system shown in Figure 5.58

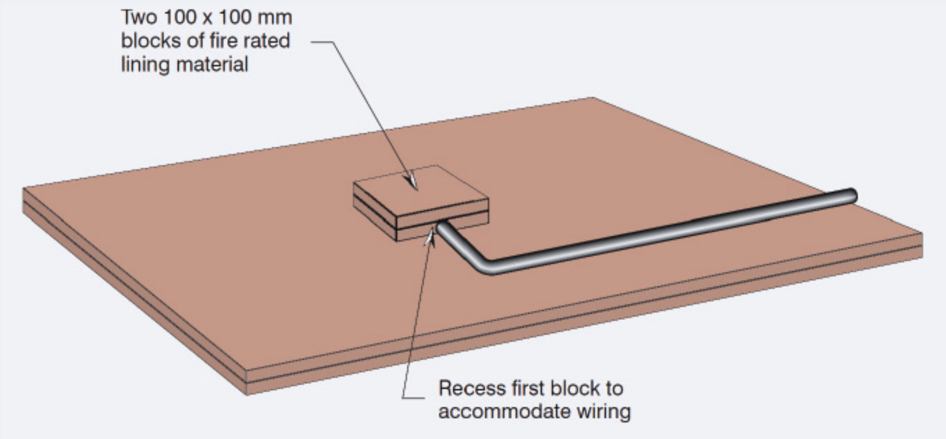


Figure 5.58: Recess block protection system for lighting cables penetrating fire-protected timber floors.

5.14.5 Rebated Ceiling Details for Housing Services

Another alternative for ceiling systems is to create a rebate to house services without penetrating a fire-protected element such as a fire-protected timber floor/ceiling system as shown in Figure 5.59. This detail has been assessed by an Accredited Testing Laboratory as achieving an FRL of 90/90/90 and a RISF of 60 minutes. Care should be taken not to attach the rebate framing members to the floor structure to avoid short-circuiting the sound separation.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of rebated ceiling system shown in Figure 5.59

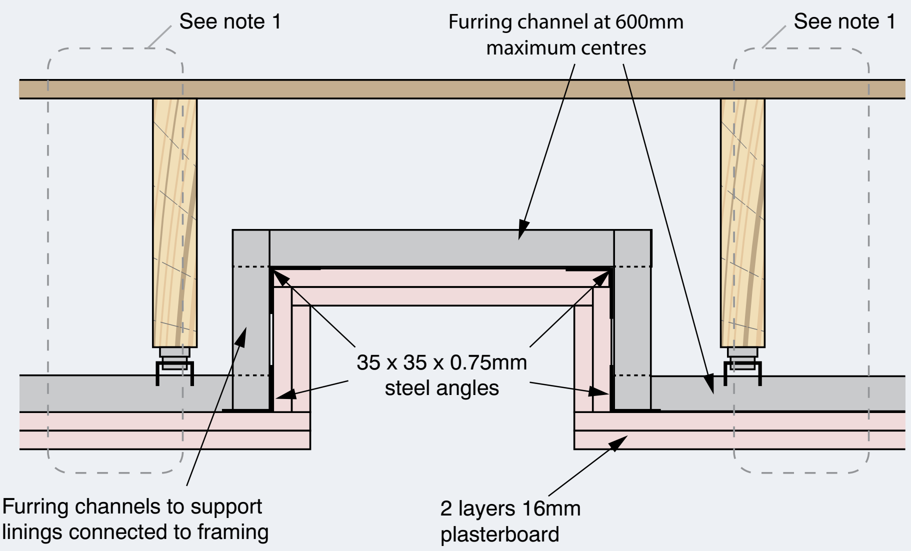


Figure 5.59: Rebated ceiling system.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity Insulation must be non-combustible.

The rebate may be fitted with a grill, a section of false ceiling or may be sized to mount individual items of equipment.

5.14.6 Plastic Pipe Penetrations

Where it is impractical to adopt false wall and ceiling linings or utilise non-combustible shaft construction or lined opening multi-penetration systems, the following details, shown in Figures 5.60, 5.61 and 5.62, have been developed to maintain a RISF of 45 minutes or a MRISF of 30 minutes. The systems must have achieved an FRL of at least -/90/90 in plasterboard partitions when used to protect individual plastic pipe penetrations. The following notes apply:

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity Insulation must be non-combustible.

Note 2: Service penetration protected to achieve the required FRL. Evidence of Suitability to be in the form of a report from an Accredited Testing Laboratory in accordance with AS 1530.4 and AS 4072.1 as appropriate.

Note 3: Aperture lined with a minimum of 1 layer 16 mm plasterboard. Greater thicknesses/number of layers may be required for the faces of the wall since it forms part of the wall system.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of interface details to maintain the RISF and MRISF performance of elements pentetrated by plastic pipes as shown in Figures 5.60 to 5.62

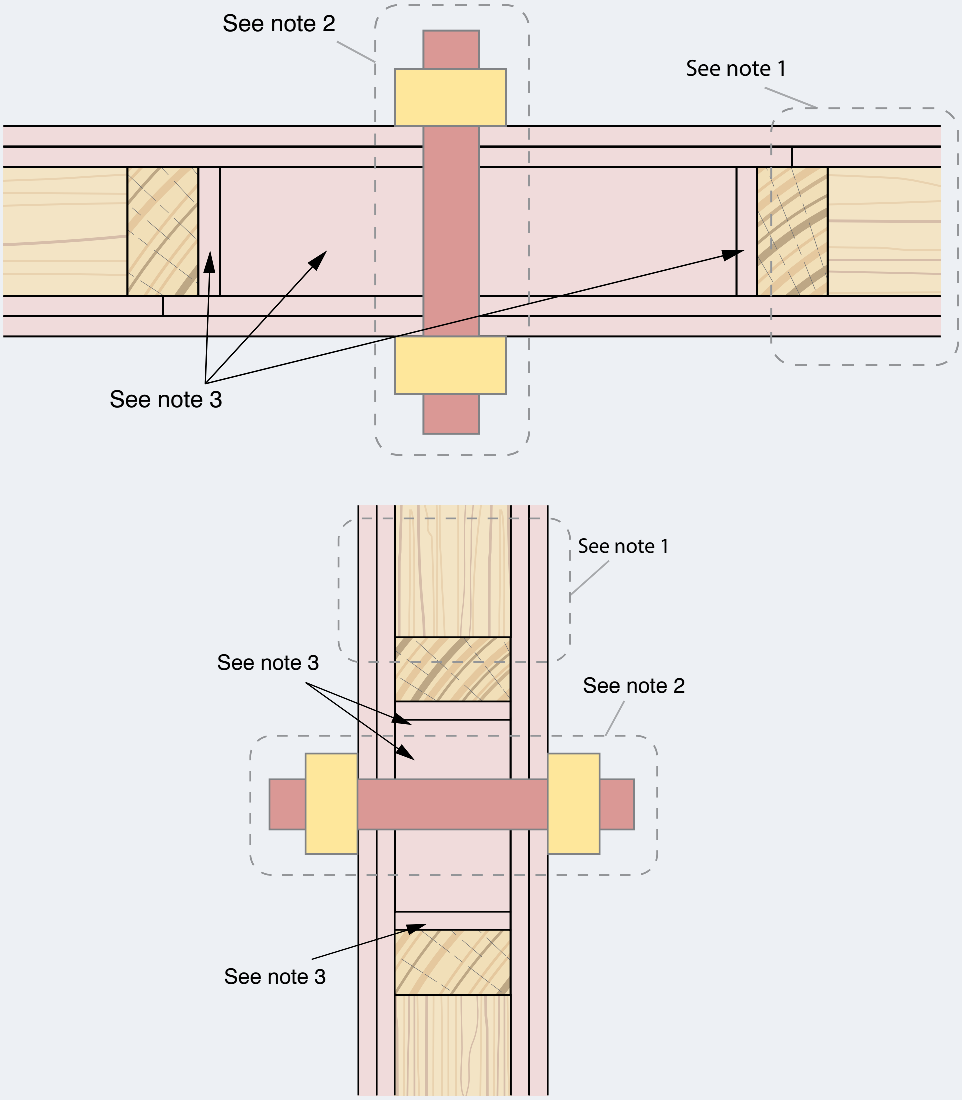


Figure 5.60: Plastic pipe penetration through fire-protected timber-framed walls with internal linings.

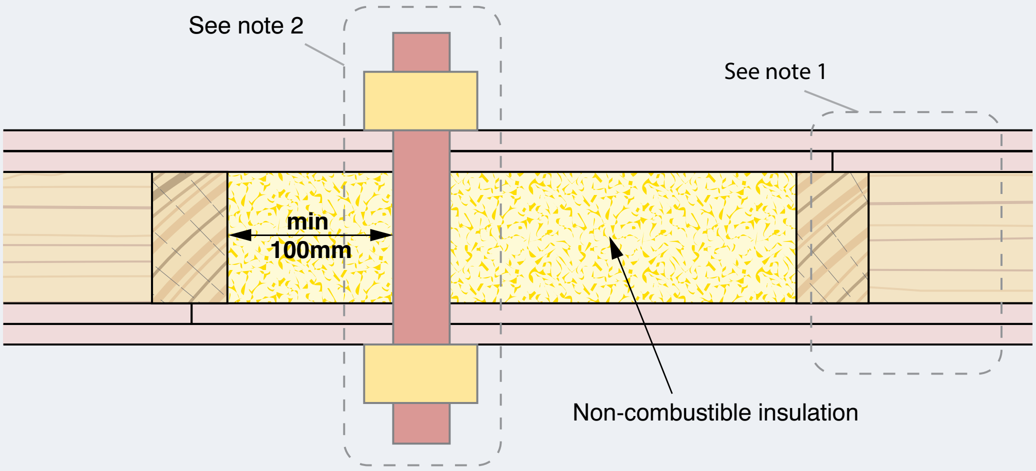


Figure 5.61: Plastic pipe penetration through fire-protected timber-framed walls with non-combustible mineral fibre insulation.

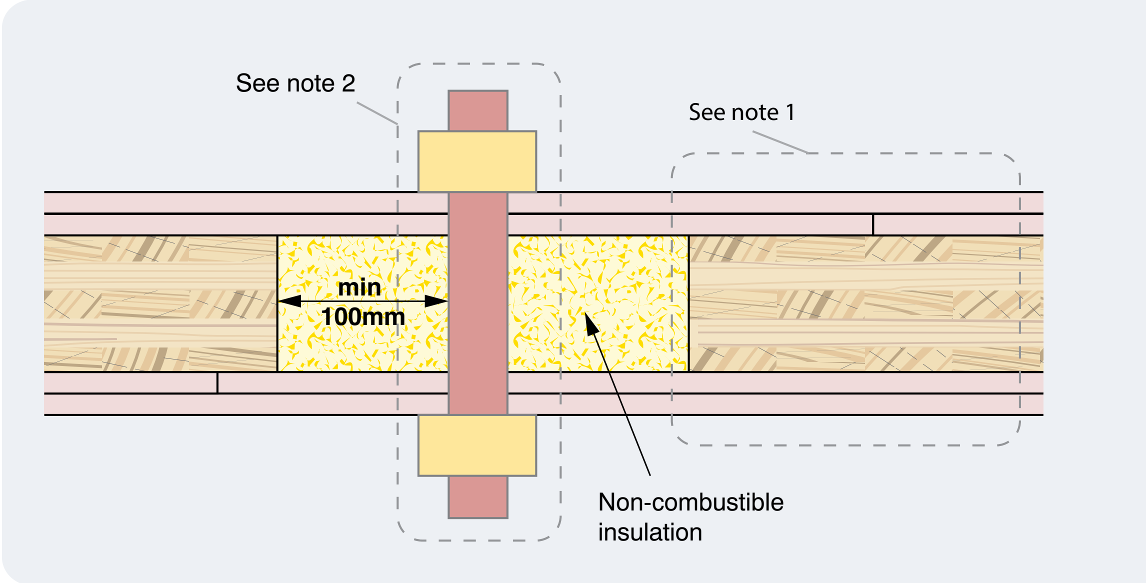


Figure 5.62: Plastic pipe penetration through fire-protected massive timber walls with non-combustible mineral fibre insulation.

Evidence of Suitability required from supplier to confirm required RISF and MRISF performance of penetrated elements is maintained in addition to the FRL for the system shown in Figure 5.63

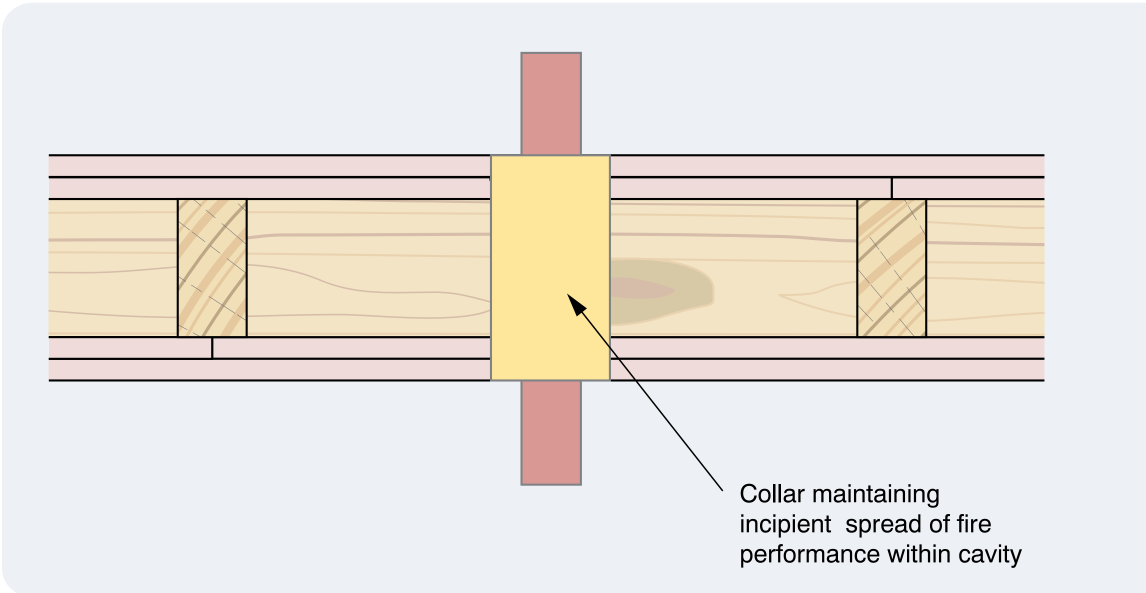


Figure 5.63: Option for a proprietary system with integral insulation protecting a plastic pipe penetration.

5.14.7 Access Panels

Access panels may be used to protect openings providing access to a floor/ceiling cavity as shown in Figure 5.64 or to shafts through fire-protected timber walls as shown in Figures 5.65 and 5.66.

Providing access panels will tend to compromise the sound separation and therefore they should normally be located in areas that are not sound 'sensitive'.

The following notes apply to the typical details shown in Figure 5.64 through Figure 5.66.

Note 1: Fire-protected timber element having the required FRL and RISF or MRISF as appropriate. Any cavity insulation must be non-combustible.

Note 2: Interface protected with the same fire-protective coverings that are applied to the fire-protected timber element face.

Note 3: Proprietary access panel system with the required FRL. For access panels providing access to ceiling cavities an RISF rating of 45 minutes or a MRISF rating of 30 minutes as appropriate is also required to be satisfied.

Refer EWFA report RIR 37401400, available from the WoodSolutions website, for assessment of interface details to maintain the RISF and MRISF performance of elements pentetrated by access panels as shown in Figures 5.64 to 5.66

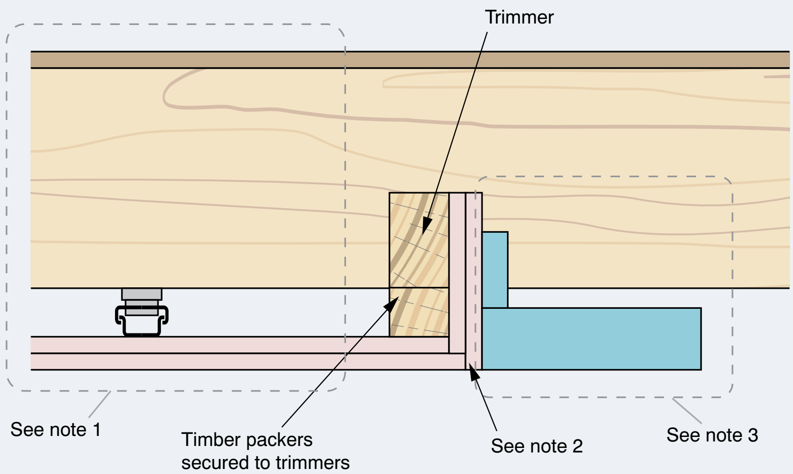


Figure 5.64: Access panel in a fire-protected floor/ceiling system.

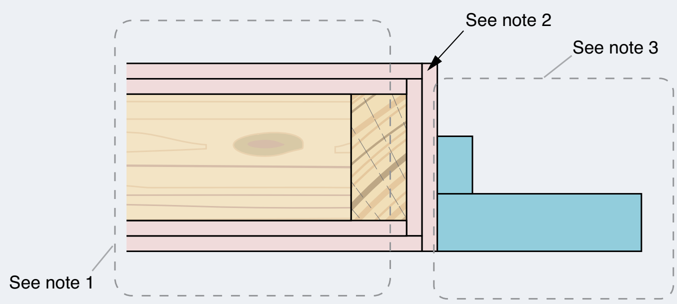


Figure 5.65: Access panel in a fire-protected timber-framed wall.

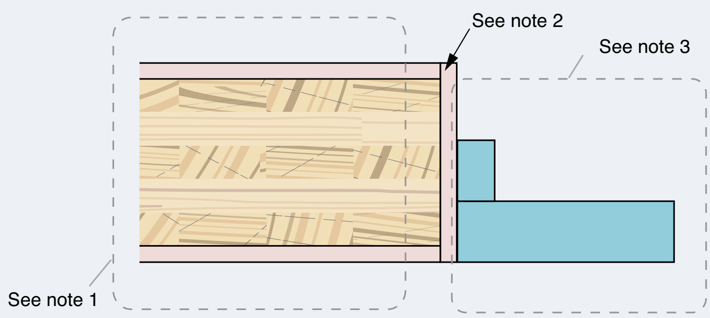


Figure 5.66: Access panel in a fire-protected massive timber wall.

5.15 Automatic Fire Sprinkler Systems

The provision of an automatic fire sprinkler system is accordance with NCC Specification E1.5 (other than a FPAA101D or FPAA101H system) is a mandatory requirement for mid-rise timber buildings if the DTS solution pathway is adopted.

The automatic fire sprinkler system is a critical component of the fire safety design and must be designed and installed by organisations and/or individuals with appropriate competency. Detailed information about the design of automatic fire sprinkler systems is outside the scope of this Guide, however in common with all services there is a need for the design to be integrated with the architectural, structural and passive fire protection systems. The following sub-sections highlight some key considerations but it is not an extensive summary.

It is important that the design documentation clearly specifies the requirements for the sprinkler systems such as locations of pipe runs, types of materials and components to be used, treatment of penetrations, types of sprinkler head and positions.

5.15.1 Piping Materials and Connections

Materials for piping and connection details for fire sprinkler systems should be carefully selected to:

- comply with the NCC Specification E1.5 requirements (other than a FPAA101D or FPAA101H system)
- suit the environment
- minimise the time the system is unavailable after maintenance/repair
- minimise hot works on site such as cutting and welding metal pipes
- facilitate the reinstatement of the performance of fire-protected timber at the points of penetration by sprinkler pipes.

While plastic pipes (e.g. cPVC) can largely negate the need for hot works, if alterations are made to plastic pipes, the sprinkler system could be unavailable overnight while the adhesive sets. This is an important consideration for residential buildings. The reinstatement of the performance of fire-protected timber when penetrated by plastic pipes can be more complex than metal pipe penetrations

Metal pipes may be more appropriate for some applications but they should be pre-prepared so that, as far as practical, all on-site connections can be made without hot works. Many suppliers can providing fittings that can be adjusted on site, such as flexible sprinkler fittings.

Once the materials and components have been selected the pipe runs should be clearly defined to minimise the number of penetrations through fire-protected timber and that if they cannot be avoided they occur where the performance of the fire-protected timber can be readily reinstated.

5.15.2 Sprinkler Head Selection

Although not mandatory in AS 2118.1, residential heads should be used in the residential parts of Class 2 and 3 buildings in line with the sprinkler head listing. They respond faster, reducing the risk to occupants close to the fire.

Sprinkler head options include concealed and semi-recessed. Concealed heads are a common choice for residential settings because they are unobtrusive. However, the following issues should be considered during the selection process and adoption of appropriate mitigation measures:

- Larger cut outs in ceilings are required which can be addressed by use of a non-rated false ceiling. The false ceiling depth should be designed to allow for the fitting of the concealed heads and related pipework.
- The response time will tend to be slower - this should be checked with the manufacturer.
- Overpainting and use of sealants to retain covers can compromise the performance of a head - this should be addressed through regular inspections.

Concealed sprinkler heads are also useful in public areas because they can reduce the risk of vandalism and accidental impacts.

Another useful type of head to consider is the sidewall sprinkler. For some rooms, adequate coverage can be achieved by fitting a sidewall sprinkler, which avoids the need for ceiling mounting and in some applications the sprinkler can be fitted to a non-fire-resisting wall within an apartment minimising the need for penetrations through fire-resisting construction.

5.15.3 Monitored Isolation Valves

The reliability of an automatic fire sprinkler system can be enhanced by specifying monitored isolation valves incorporating a check valve and flow switch at each level that is permanently connected to a fire alarm monitoring service provider by a direct data link.

This approach allows the water supply to the sprinkler system on individual floors to be isolated for maintenance or reconfiguration of the system without the need to isolate the whole building. Since the valves are monitored, the risk of the water supply not being reinstated is also significantly reduced.

This arrangement is compatible with the progressive commissioning of automatic fire sprinkler systems during construction, allowing protection of the lower levels while work progresses on the upper levels and individual floors to be easily isolated for adjustments to systems. This may be adopted as part of the fire safety strategy to address fire safety during construction.

5.15.4 Fire-isolated Stairs and Passageways with Timber Stairways

The NCC allows the use of timber stairways in fire-isolated stairs and passageways subject to the automatic fire sprinkler system coverage being extended to cover the fire-isolated stair in addition to other precautions (refer Section 4.8.2).

In the absence of other specifications, sprinkler heads should be provided in the following locations:

- at the top of the shaft
- under the landings at each floor level
- under intermediate landings
- providing coverage to other positions where there is a significant risk of accumulation of combustible materials.

Spec E1.5a 2(b) requirements are consistent with Sections 5.15.2 and 15.5.3 of this Guide and reflect good practice. Refer NCC Specification E1.5a for further details

5.15.5 NCC Specification E1.5a Additional Sprinkler System Enhancements

If Specification E1.5a concessions are to be adopted a number of enhancements to the basic Specification E1.5 sprinkler system designs are required to be implemented including:

- connection of the sprinkler system to a permanent fire alarm monitoring system connected to a fire station / dispatch centre in accordance with NCC Specification E2.2d
- the automatic fire sprinkler system is fitted with residential sprinkler heads complying with Clauses 4.4, 4.5 and 5.5.2 of AS 2118.4 in bedrooms.

5.16 Other NCC Requirements

This is a guide to the use of fire-protected timber for mid-rise timber buildings as a DTS solution in the NCC. It does not address all NCC requirements that apply to mid-rise buildings nor does it address all NCC fire-related requirements (e.g. fire hazard properties of linings).

Advice should be sought from appropriately qualified practitioners and relevant regulatory authorities regarding compliance with the NCC for specific projects.

Appendix A – Determination of Compliance of Fire-protected Timber

Refer NCC A5.4 and Schedule 5 for FRL

Refer NCC A5.6 for RISF

Refer NCC A5.2 for non- combustibility

There are three components to the performance of fire-protected timber that need to be satisfied:

- the protected element must achieve the required Fire Resistance Level (FRL)
- the protected element must achieve the required Resistance to the Incipient Spread of Fire (RISF).
- fire-protective coverings must be non-combustible.

A1 Non-Combustible Fire-Protective Covering

Unless the NCC deems a material or element of construction to be non-combustible, non-combustible means:

- Applied to a material – not deemed combustible as determined by AS 1530.1 – Combustibility Tests for Materials.
- Applied to construction or part of a building – constructed wholly of materials that are not deemed combustible.

If the fire-protective covering is a composite or multi-layer system, each layer must be non-combustible. It is not acceptable to undertake a single combustibility test on the composite or just the facing materials and claim the fire-protective covering is non-combustible.

Typical examples of multi-layer systems are shown in Figure A1.

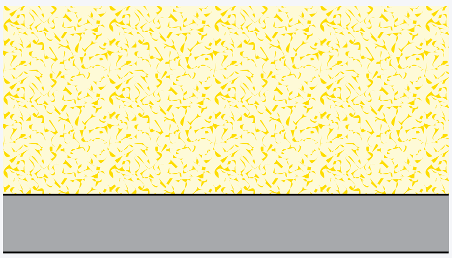
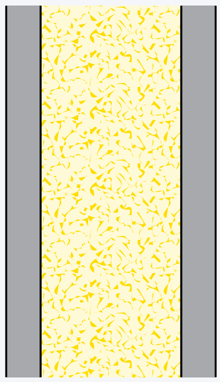
	
Multi-layer system – each layer must be non-combustible	Composite panels – each layer of the composite must be non-combustible
Commonly fire-resistant board supporting non-combustible lightweight insulation used in ceilings protecting floors/beams	Commonly non-combustible lightweight insulating core between non-combustible durable facings used for external claddings

Figure A1: Example of multi-layered fire-protective coverings (all layers).

Clause C1.9(e) of the NCC allows (deems) the following materials, though combustible or containing combustible fibres, to be used wherever a non-combustible material is required:

- plasterboard
- perforated gypsum lath with a normal paper finish
- fibrous-plaster sheet
- fibre-reinforced cement sheeting
- pre-finished metal sheeting having a combustible surface finish not exceeding 1 mm thickness and where the Spread-of-Flame Index of the product is not greater than 0
- sarking-type materials that do not exceed 1 mm in thickness and have a Flammability Index not greater than 5
- bonded laminated materials where:
  - each laminate is non-combustible
  - each adhesive layer does not exceed 1 mm in thickness
  - the total thickness of the adhesive layers does not exceed 2 mm
  - the Spread-of-Flame Index and the Smoke-Developed Index of the laminated material as a whole does not exceed 0 and 3 respectively.

All materials forming the fire-protective covering are either permitted to be used in accordance with NCC Clause C1.9(e) or determined to be non-combustible by testing to AS1530.1.

A2 Fire Resistance Level

A fire-protected timber element must achieve the required FRL specified in the NCC for the particular application. The fire resistance of a fire-protected timber element has to be determined in accordance with Schedule 5.2(b) and (c) of the NCC.

Generally, Schedule A5.2(b) requires a prototype to be submitted to the Standard Fire Test (AS1530.4), or an equivalent or more severe test, and the FRL achieved by the prototype, without the assistance of an active fire suppression system, is confirmed in a report from an Accredited Testing Laboratory which:

- describes the method and conditions of the test and the form of construction of the tested prototype in full
- certifies that the application of restraint to the prototype complied with the Standard Fire Test;

or differs in only a minor degree from a prototype tested under Schedule 5.2(b) and the FRL attributed to the building element is confirmed in a report from an Accredited Testing Laboratory which:

- certifies that the building element is capable of achieving the FRL despite the minor departures from the tested prototype; and
- describes the materials, construction and conditions of restraint which are necessary to achieve the FRL.

The option to use AS 1720.4 char-based calculation methods to determine the fire resistance is not permitted for fire-protected timber. This is because concerns were expressed with respect to the suitability of the AS 1720.4 approach for certain types of adhesives and connections forming parts of engineered timber products. The proprietary nature of massive timber panel products and lack of standardisation of adhesives and other critical materials used in their construction meant that there was insufficient data available at the time to demonstrate the suitability or otherwise of AS 1720.4.

A3 Resistance to the Incipient Spread of Fire

A3.1 Determine Applicable Resistance to the Incipient Spread of Fire Requirements

The Resistance to the Incipient Spread of Fire (RISF) in relation to a fire-protective covering means the ability of the covering to insulate voids and the interfaces with timber elements so as to limit the temperature rise to a level that will not permit ignition of the timber and the rapid and general spread of fire throughout any concealed spaces. The performance is expressed as the period in minutes that the covering will maintain a temperature below the specified limits when subjected to a test in accordance with AS 1530.4.

The general requirement for fire-protected timber is an RISF of 45 minutes.

The NCC permits a relaxation to the RISF requirements for fire-protected timber providing both the following additional criteria are satisfied.

- the minimum timber panel thickness is not less than 75 mm
- there are no cavities between the surface of the timber and the fire protective covering or between timber members.

The 75 mm dimension relates to the inherent fire resistance achieved when using a timber panel member. If the relaxation conditions are satisfied, the Modified Resistance to the Incipient Spread of Fire (MRISF) criteria are applicable. Typical examples of massive timber installations satisfying these conditions are shown in Figure 4.3 in the body of this Guide.

Figure A2 shows the process for determining the applicable Resistance to the Incipient Spread of Fire requirements. The general requirement for fire-protected timber is a RISF of 45 minutes.

The relaxed requirements for massive timber construction without voids and cavities is a MRISF that applies a higher interface temperature limit and the time periods for which the temperature limit applies varies according to the application in accordance with Table A1.

Table A1: Modified Resistance to the Incipient Spread of Fire required performance for applications where criteria are relaxed (massive timber construction without voids and cavities).

Application	Modified Resistance to the Incipient Spread of Fire (MRISF)
Inside a fire-isolated stairway or lift shaft	20 min
External walls within 1 metre of an allotment boundary or 2 metres of a building on the same allotment	45 min
All other applications	30 min

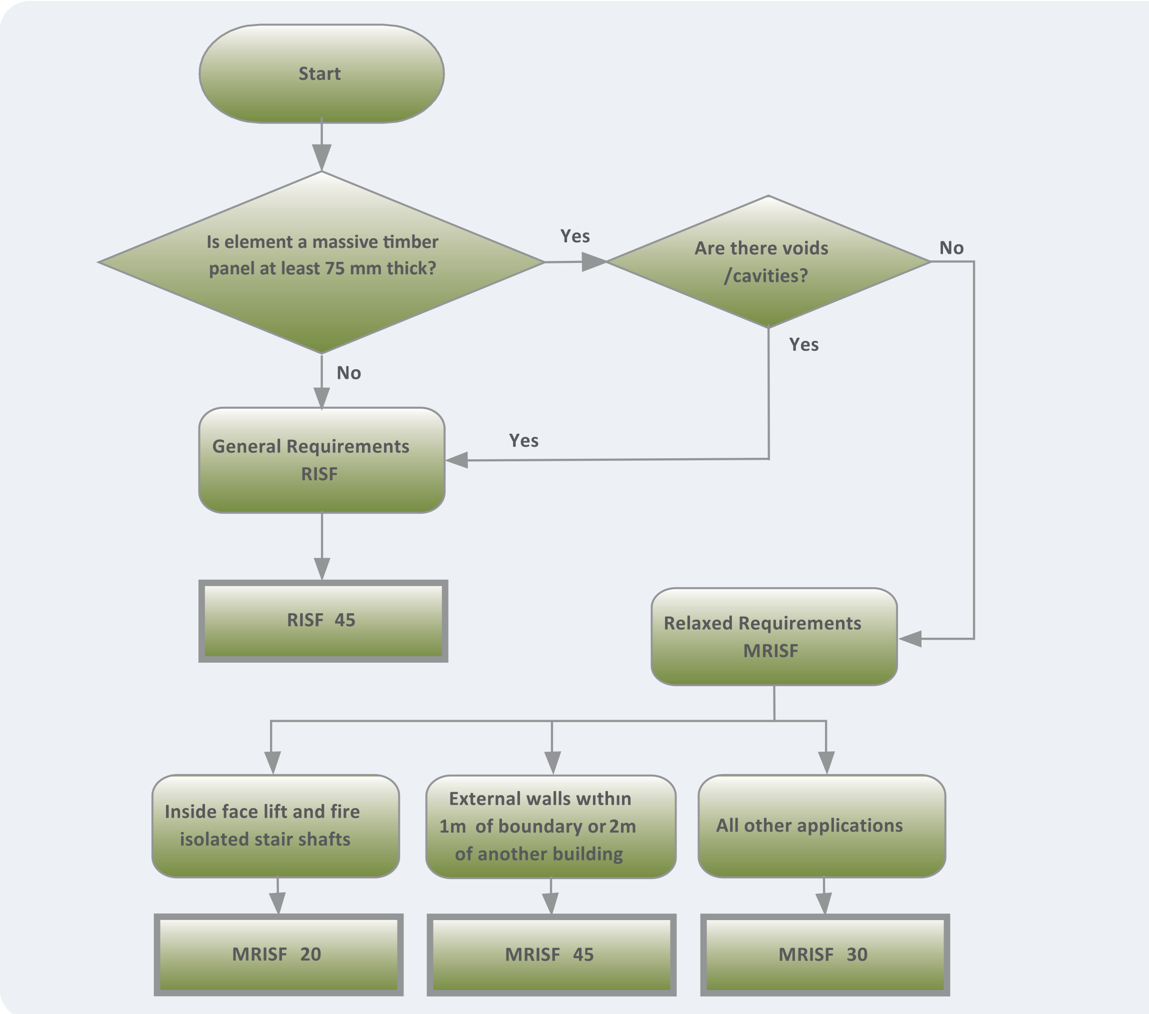


Figure A2: Determination of Resistance to the Incipient Spread of Fire acceptance requirements.

A3.2 Compliance Paths for Resistance to the Incipient Spread of Fire

Three paths are permitted to demonstrate compliance with the RISF requirements;

- simultaneous determination during a full-scale fire resistance test
- smaller-scale fire resistance test (at least 1 metre x 1 metre specimen)
- selection of Deemed-to-Satisfy fire-resisting grade plasterboard coverings.

Simultaneous determination during a full-scale fire resistance test

When a fire resistance test is undertaken to determine the FRL of an element, additional instrumentation can be included in the test to also determine the RISF or MRISF performance, providing a cost-effective approach for new protection systems.

Smaller-scale fire resistance test

There are a large number of systems that have been tested previously to determine their FRLs but in most cases insufficient data will have been recorded to determine the RISF or MRISF performance. Under these circumstances, the use of a smaller specimen (not less than 1 metre x 1 metre) is permitted to obtain supplementary data to determine the RISF or MRISF of the system in a cost effective manner. The fire-protective covering should be fitted in the same manner as that used for the original test that determined the FRL of the system.

Deemed-to-Satisfy Fire-Protective Grade Plasterboard coverings

Specification C1.13 deems fire-protective grade plasterboard facings, if fixed in accordance with the requirements to achieve the required FRL of the element, to also satisfy the requirements for Resistance to the Incipient Spread of Fire (RISF) or Modified Resistance to the Incipient Spread of Fire (MRISF). Table A2 shows the minimum requirements for plasteboard coverings.

Table A2: Fire-protective grade plasterboard coverings Deemed-to-Satisfy RISF requirements.

Requirements	Application	Performance	Minimum Deemed-to-Satisfy fire-protective grade plasterboard
General Requirements	All applications	RISF 45min	2 layers x 13 mm thick
Relaxed requirements for timber panels not less than 75 mm thick without cavities voids or cavities voids filled with non-combustible material	Inside a fire-isolated stairway or lift shaft	MRISF 20 min	1 layer x 13 mm thick
	External walls within 1 metres of an allotment boundary or 2 metres of a building on the same allotment	MRISF 45 min	2 layers x 13 mm thick
	All other applications	MRIFS 30 min	1 layer x 16 mm thick

A3.3 Resistant to the Incipient Spread of Fire (RISF) Test Procedures

The test procedure for determining the Resistance to the Incipient Spread of Fire (RISF) of horizontal elements during a full-scale fire resistance test is provided in Section 4 of AS 1530.4 . Specification C1.13a of the NCC requires the relevant procedures from AS 1530.4 Section 4 to be applied to other elements.

AS 1530.4 requires walls to be full size or not less than 3 m high x 3 m wide and floor/ceiling systems to be full size or not less than 4 m long x 3 m wide. Floor systems are exposed to furnace heating conditions (Figure A3) from the underside and fire-resisting walls are exposed from one side. Asymmetrical walls generally require two tests to evaluate the response to exposure to fire from either side unless the side exposed to fire is specified.

Smaller-scale specimens (not less than 1 m x 1 m) can be used to retrospectively determine the RISF performance of a floor or wall system that has previously achieved the required FRL in a fire resistance test satisfying the minimum size requirements specified in AS 1530.4.

For universal application of results the minimum cavity depth should be fire tested.

To determine the RISF, five thermocouples with insulating pads as prescribed in AS 1530.4 are fixed to the inner face of the fire-protective covering system. They are placed at approximately the centre and the centre of each quarter section as shown in Figure A4.

When testing corrugated specimens, increase the number of thermocouples to six to provide an equal number of thermocouples at the maximum and minimum specimen thickness.

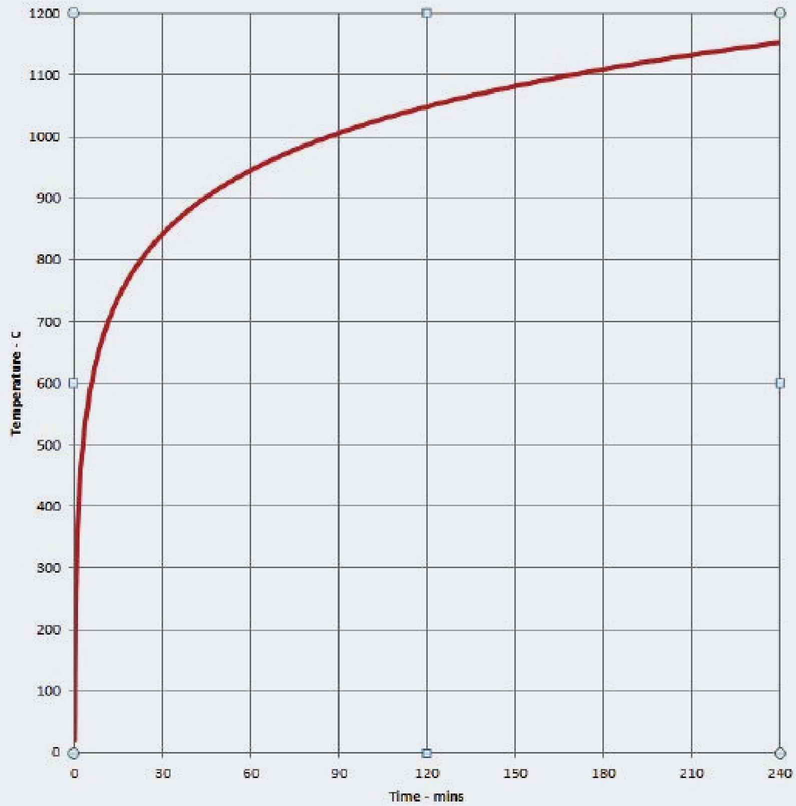


Figure A3: Standard fire resistance test heating regime.

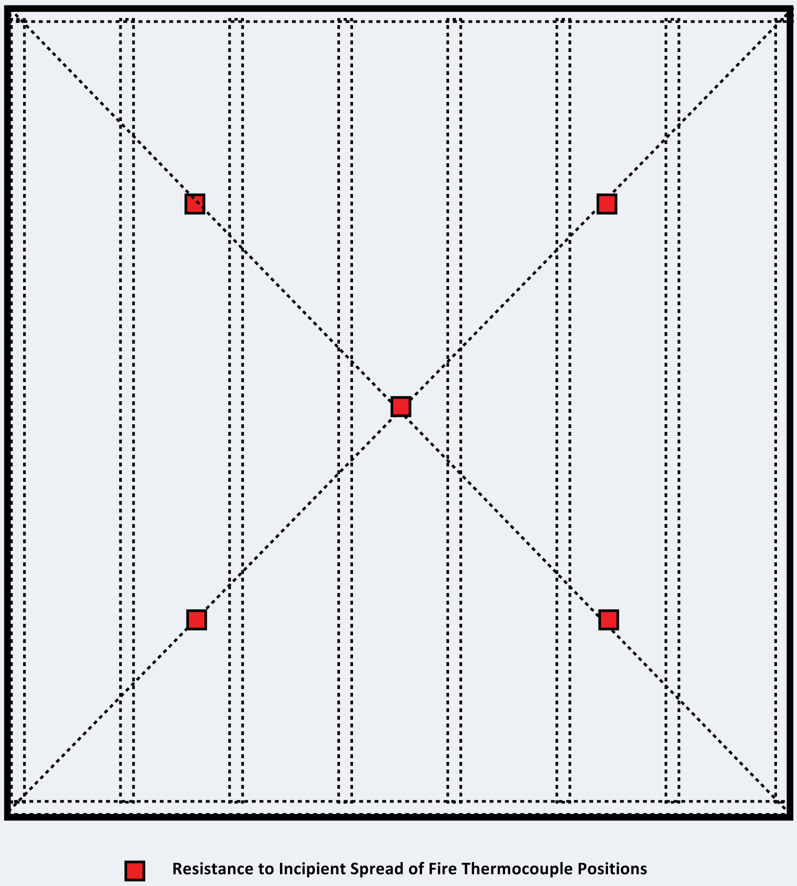


Figure A4: Elevation of a wall showing RISF thermocouple positions.

Sections through typical specimen configurations are shown in Figure A5 to illustrate the correct surfaces to apply thermocouples to determine the RISF. For fire-protected timber, the temperature has to be maintained below the prescribed temperature on the surface of the fire-protective covering facing the void and at the interface with timber elements within the wall or floor. If a wall or ceiling system is protected by a board system, for example, the temperatures are measured on the board surface within the cavity even if non-combustible insulation is applied between the timber studs or beams. However, if the non-combustible insulation forms a continuous layer between the timber elements and the board the thermocouples (t/c) should be applied to the surface of the insulation as shown in Figure A5.

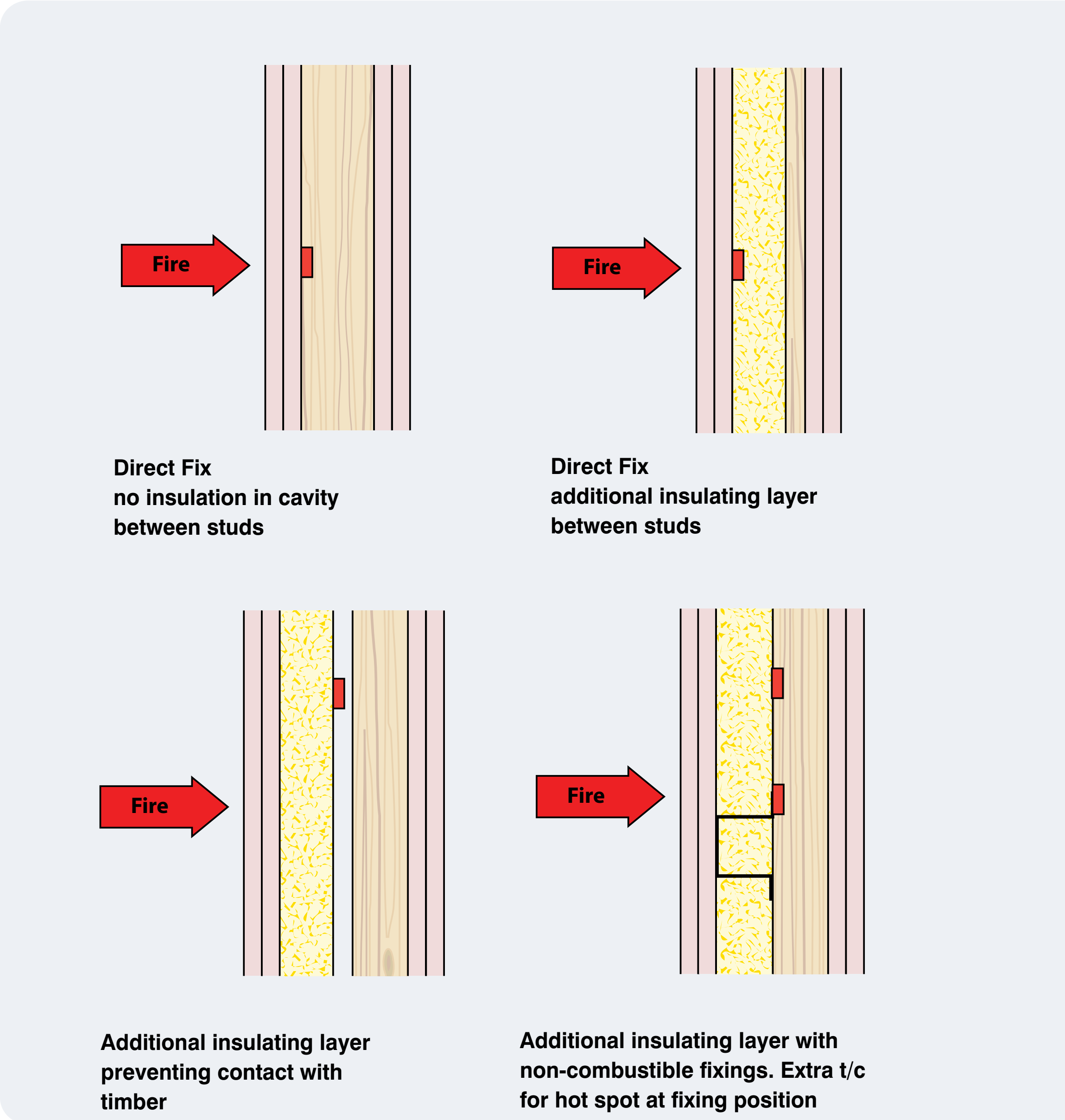
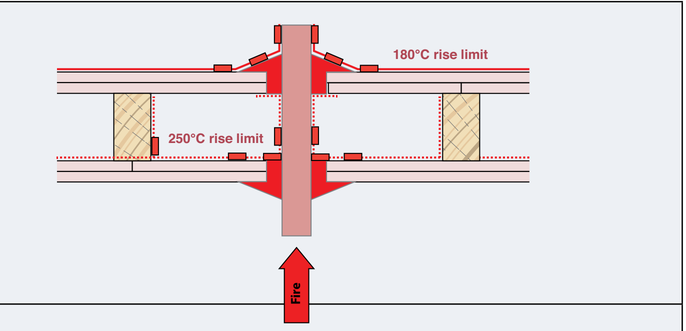


Figure A5: Resistance to the incipient spread of fire thermocouple positions for typical specimen configurations.

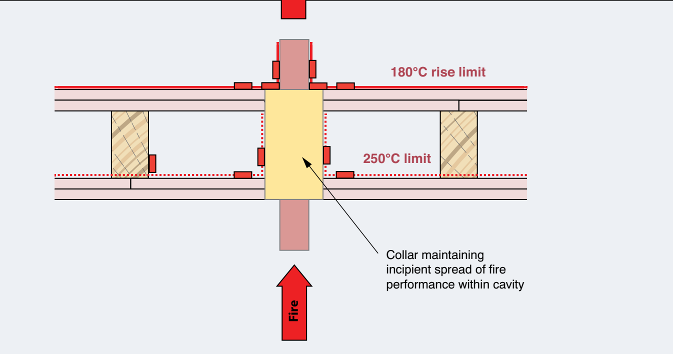
Failure in relation to the RISF is deemed to occur when the maximum temperature of the thermocouples described above exceeds 250°C.

Smaller scale specimens 1 m x 1 m can be used to determine the performance of services penetrations in fire-protected timber. Typical examples of thermocouple configurations for various types of service penetrations are shown in Figure A6. Additional thermocouples are shown to allow the simultaneous determination of the FRL of the service penetration system.

Cable/metal pipe penetration protected with fire-resistant mastic.

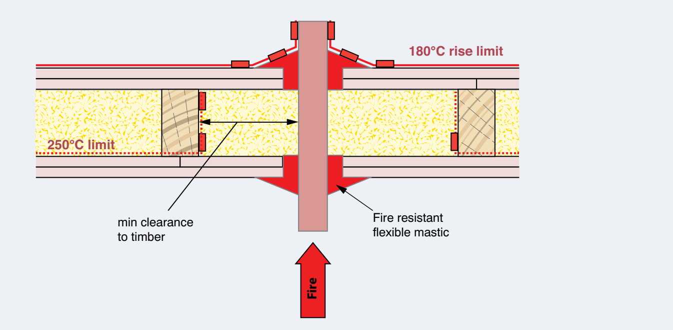


Plastic pipe protected by insulating collar system.



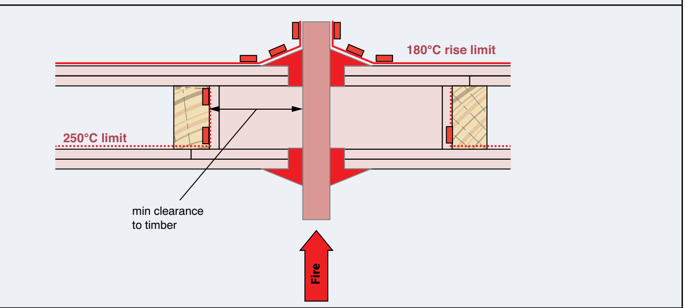
Cable/metal pipe penetration protected with fire resistant mastic and non-combustible cavity infill.

The critical interface for RISF for the service penetration system is the surface of the insulation where it is in contact with timber elements. Note: plasterboard surface is the critical surface for determining the RISF of the wall system



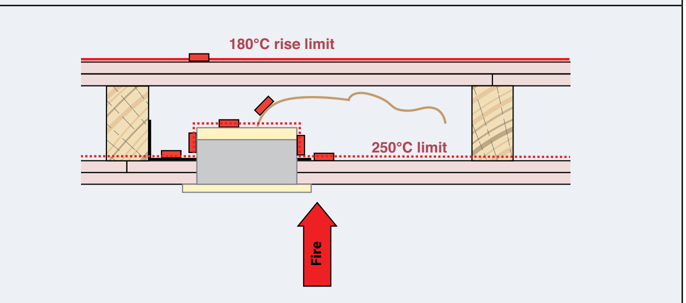
Cable/metal pipe penetration protected with fire-resistant mastic and cavity lined with non-combustible board.

The critical interface for RISF for the service penetration is the surface of the lining board where it is in contact with timber elements.



Proprietary GPO outlet protection system.

Note: Thermocouples applied to cable surface connected to the GPO, on fixing bracket and adjacent element.



GPO outlet with non-combustible cavity infill protection.

The critical interface for RISF is the surface of the insulation where it is in contact with timber elements. Note: plasterboard surface is the critical surface for determining the RISF of the wall system

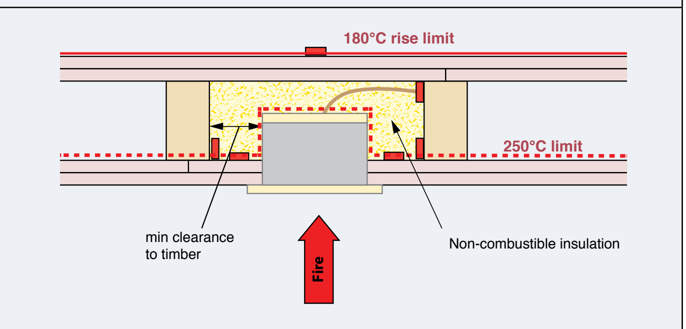


Figure A6: Typical thermocouple positions for determining the RISF of service penetrations.

The thermocouples positions must satisfy the following requirements:

- At not less than two points about 25 mm from the edge of the hole made for the passage of the service.
- Attached to adjacent structural members and those elements that support the penetrating service.
- At points on the surface of the penetrating service or its fire stopping encasement, as follows:
  - at least two thermocouples about 25 mm from the plane of the general surface of the covering and non-combustible insulation
  - where the seal or protection around the service is tapered or stepped, two additional thermocouples beyond the step or the end of any taper if it is expected that the temperatures will be higher at these points.
- Where practicable, at two points on the seal or protection around the service.
- One in the centre of the surface of the penetration nominally parallel to the plane of the fire protective covering if it terminates within the cavity (e.g GPO outlets or down lights).

Failure in relation to the RISF is deemed to occur for the service penetration when the maximum temperature of the thermocouples described above exceeds 250^{0}C.

A3.4 Modified Resistance to the Incipient Spread of fire (MRISF) Test Procedures

The MRISF is applicable to massive timber panels having a thickness not less than 75 mm if there are no voids/cavities through which fire and smoke can spread. The MRISF, amongst other things, relaxes the failure temperature from 250˚C to 300˚C to reflect the reduced risk of fire spread through cavities and higher inherent fire resistance of timber with larger cross-sections. The test procedures are described in Section 3 of Specification C1.13a of the NCC and are summarised below:

- Tests must be carried out in accordance with AS 1530.4, or an equivalent or more severe test, on the timber element with the proposed non-combustible fire protective coverings fixed in a representative manner.
- Smaller scale specimens (not less than 1m x 1m) can be used to retrospectively determine the MRISF performance of a system that has previously achieved the required fire resistance level in a fire resistance satisfying the minimum size requirements specified in AS 1530.4. If a fire protection system incorporates joints, the test specimens must incorporate representative joints.

To determine the MRISF interface, temperatures must be measured over the following features by a minimum of two thermocouples complying with Appendix C1 and Section 2 of AS 1530.4 as appropriate:

- at joint positions in the protection systems
- at least 200 mm from any joint
- at any other locations where, in the opinion of the Accredited Testing Laboratory, the interface temperature may be higher than the above positions.

Where the fire protective covering is not in contact with the timber (e.g. multi-layer system), the surface of the fire-protective covering is deemed to be the interface.

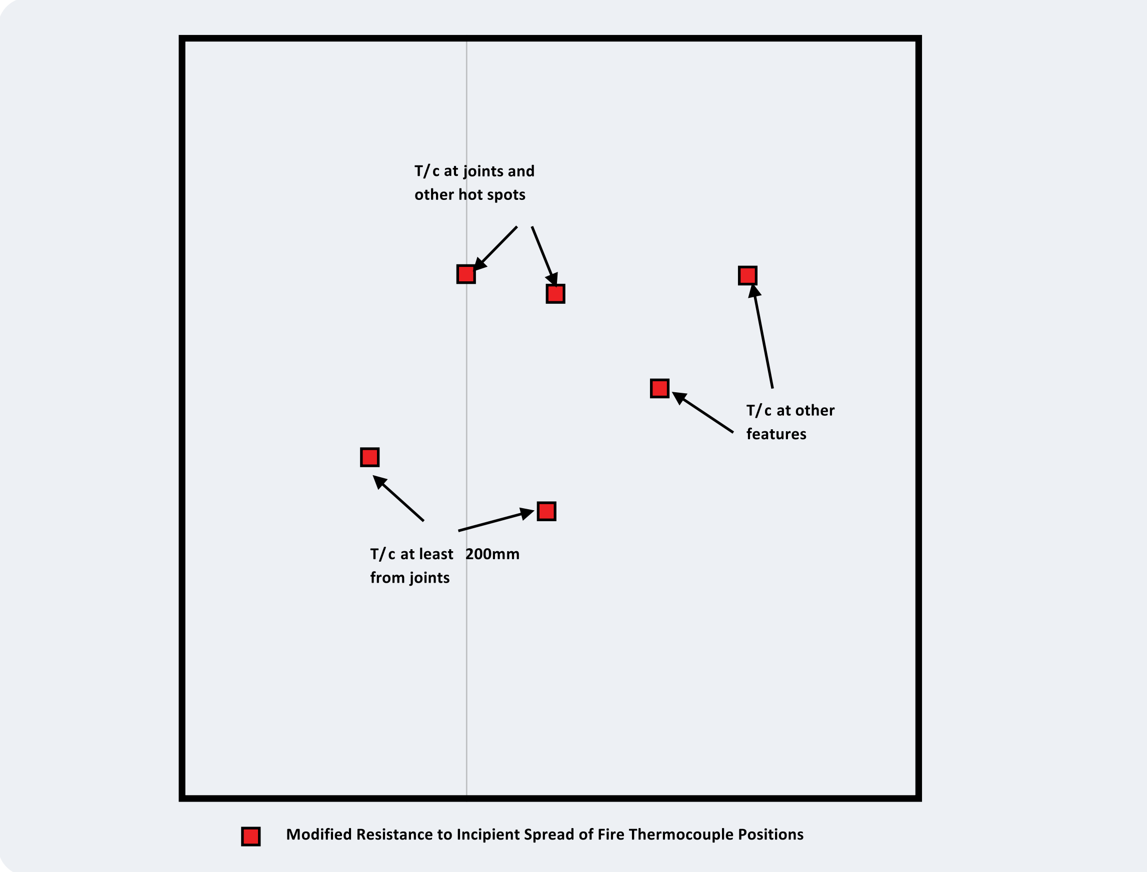


Figure A7: Elevation of a wall showing modified RISF thermocouple positions.

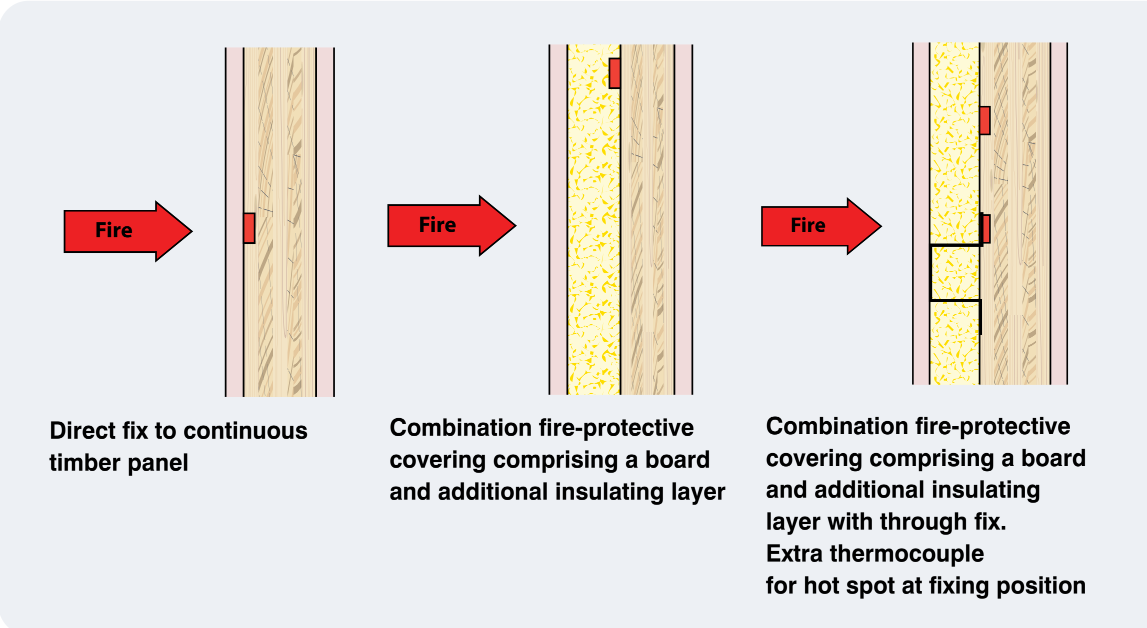


Figure A8: Modified RISF thermocouple positions for typical specimen configurations.

Failure in relation to the MRISF is deemed to occur when the maximum temperature of the thermocouples described above exceeds 300°C.

Smaller scale specimens 1 metre x 1 metre can be used to determine the performance of services penetrations in fire-protected timber. Typical examples of thermocouple configurations for various types of service penetrations to determine both the MRISF and FRLs are shown in Figure A9.

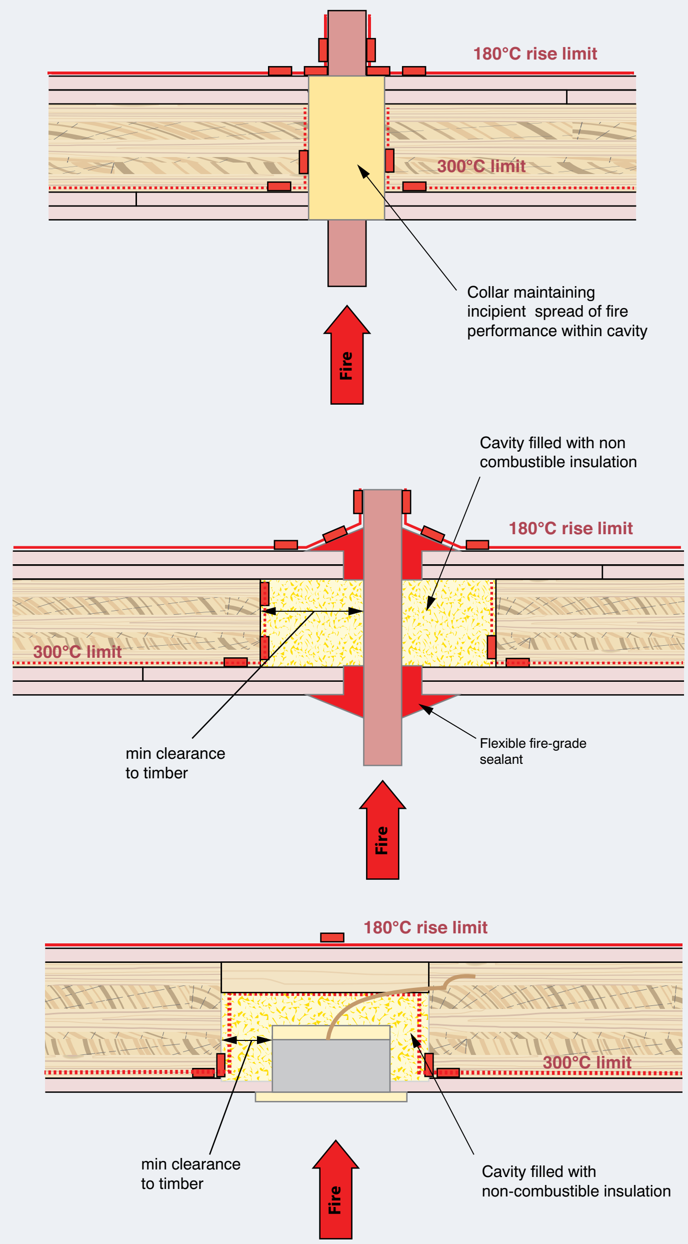


Figure A9: Typical thermocouple positions for determining the MRISF of service penetrations.

B

Appendix B – Determination of the Performance of Cavity Barriers in Fire-Protected Timber Construction

Specification C1.13 of the NCC sets out the requirements for cavity barriers in fire-protected timber construction.

The following compliance options are provided for cavity barriers:

- the cavity barrier system must achieve the FRLs specified in Table B1 when mounted in timber elements having the same or a lower density than the timber members in the proposed application or
- comprise timber of minimum thickness as specified in Table B1 or
- comprise polythene-sleeved mineral wool or non-sleeved mineral wool slabs or strips placed under compression and of minimum thickness as specified in Table B1 or
- another option is that, for cavity barriers around doors and windows, steel frames are also Deemed-to-Satisfy the requirements for cavity barriers provided that the steel frames should be tightly fitted to rigid construction and mechanically fixed. It should, however, be noted that if the windows or doors are of fire-resistant construction, the windows or door system needs to be capable of achieving the required fire resistance when mounted in the wall system, notwithstanding the requirements for cavity barriers.

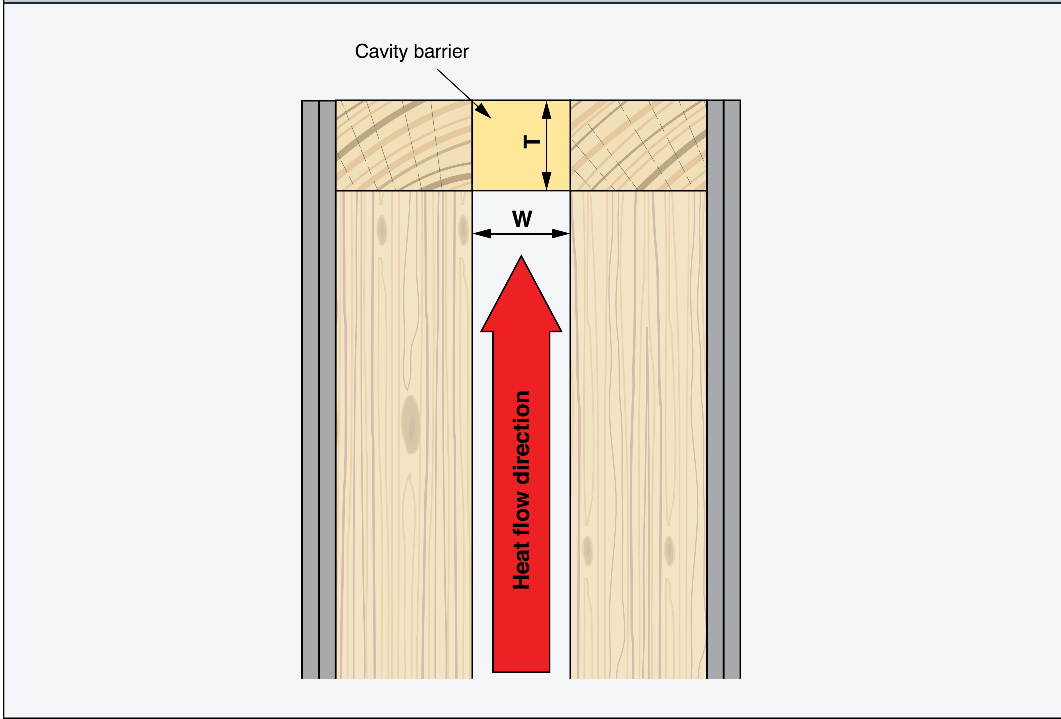
Table B1: Cavity barrier requirements for fire-protected timber.

Cavity Barrier Compliance Options	**FRL required for element cavity barrier is fitted to (minutes)**	
	–/90/90 or less	greater than –/90/90
Cavity Barrier Required FRL – minutes	–/45/45	–/60/60
Timber required minimum thickness	45 mm	60 mm
Mineral wool required minimum thickness	45 mm	60 mm

The minimum thicknesses of protection are required to be measured in the direction of heat flow. The role of a cavity barrier is normally to prevent a fire spreading from the cavity on one side of the cavity barrier to the other. The top plate of a double stud partition (Detail A of Figure B1) is a typical example of this where the direction of heat flow for the cavity barrier would be from the underside to the upper face of the barrier.

The other role for cavity barriers is to reduce the risk of fire spread to cavities occurring around openings for doors and windows within a fire-resisting wall. This configuration is shown as Detail B in Figure B1. For this scenario, the heat flow is from the occupied area of the building through the framing to the cavity. In the Figure, the thickness dimension is identified as 'T'.

Detail A
Cavity barrier at the head of a double stud partition



Detail B
Cavity barrier around door opening

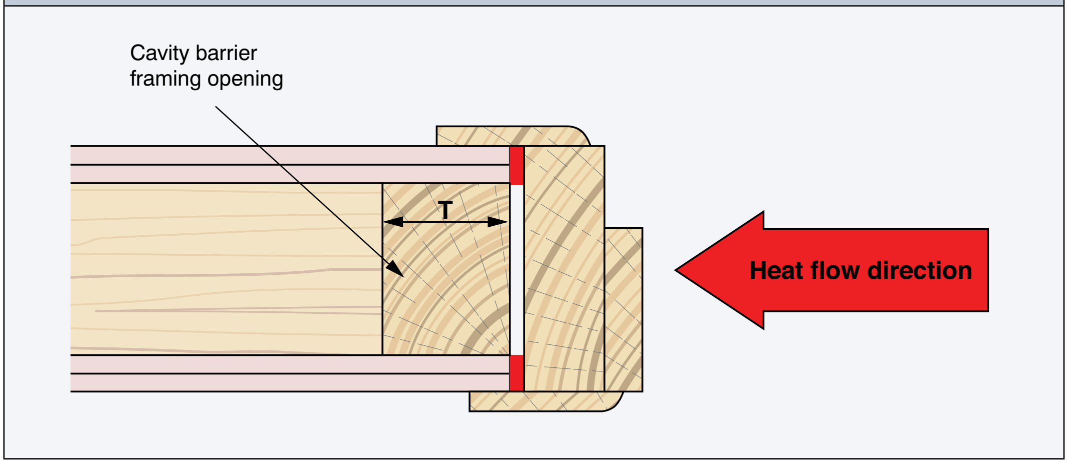


Figure B1: Heat flow direction for cavity barriers.

Proprietary cavity barrier systems may provide more practical options than the Deemed-to-Satisfy solutions for some applications. To encourage the development and use of these systems a compliance path has been provided through the specification of FRLs. For smaller cavity barriers, the performance should be determined by testing the cavity barrier as a control joint system in accordance with Section 10 of AS 1530 using timber members as the separating element. Specification C1.13 permits the results from such a test to be used for applications where the fire-protected timber is constructed from timber with a nominal density at least equal to the tested timber.

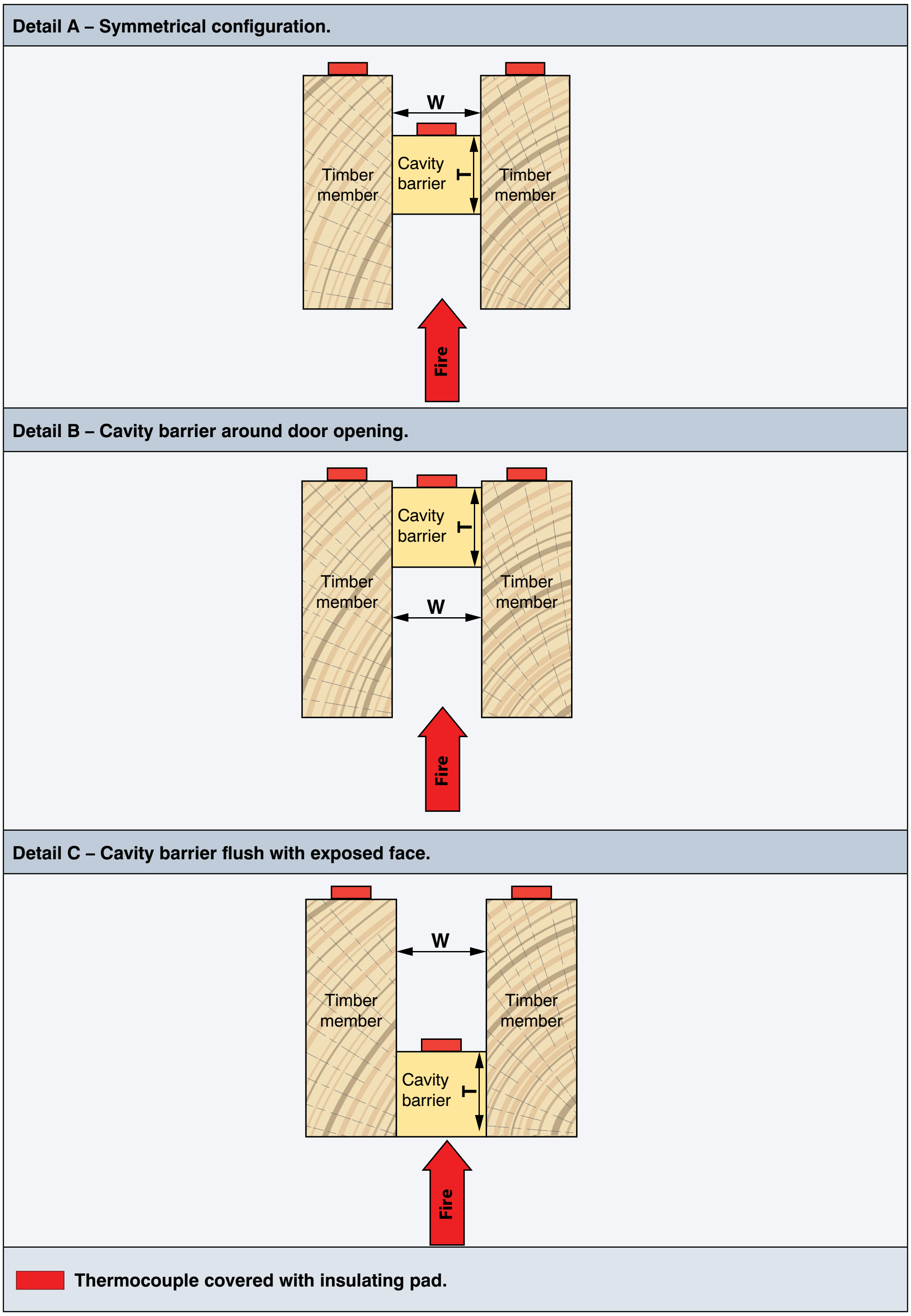


Figure B2: Typical cavity barrier test configurations.

Typical test configurations are shown in Figure B2. The selection of the test configuration(s) depends on how the cavity barrier will be mounted. If it is symmetrical (e.g. fitted at the mid-depth of a timber member), Detail A is appropriate. If the cavity barrier system is not symmetrical both details B and C should be tested unless the most onerous configuration can be determined by the test laboratory or the cavity barrier use is restricted to one configuration. A report from an Accredited Testing Laboratory should state the field of application for the cavity barrier based on the test results.

Cavity barriers can be of combustible construction and therefore a timber framed partition with exposed timber members could be used subject to the wall achieving the required FRL.

In some instances, it may be more practicable to continue the fire-resisting walls up to roof level in lieu of providing a fire-protected timber roof system with cavity barriers. This option is shown in Figure B3.

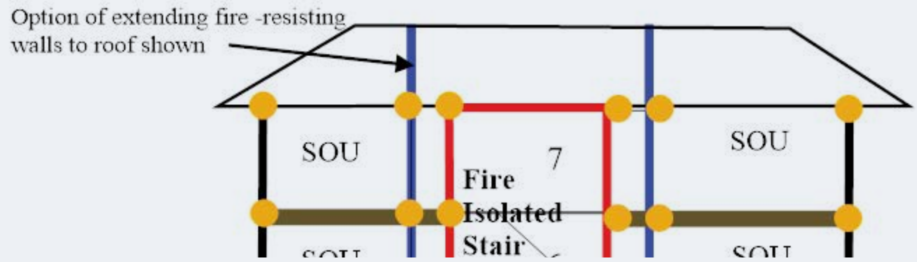


Figure B3: Design option to extend fire walls to roof level in lieu of using large cavity barriers within a fire-protected timber roof system.

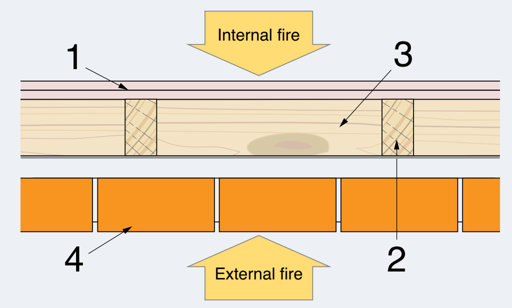
C

Appendix C – Example Data Sheets for an External Wall System

The following data sheet provides an example of the Evidence of Suitability required by the NCC. A brick veneer external wall system has been used because, in addition to fire and sound requirements, thermal resistance, weatherproofing and structural tests apply.

System External Wall 1

External Brick Veneer Timber framed wall system



1 Fire protective grade plasterboard, 2 x 13 mm thick

2.Timber framing in accordance with Evidence of Suitability

3 Cavity. – Cavity insulation may be required to achieve sound ratings and R –value (insulation must be non-combustible)

4 Outer brick veneer 90 mm thick

Typical Performance

Fire-protected timber	FRL90/90/90: RISF45: NC
Sound transmission and insulation	R_w 50: R_w+C_{tr} 50
Thermal resistance	R Value 3.3 m^{2}K/W
Damp and weatherproofing	NCC performance requirement FP1.4
Structural tests	NCC specification C1.8 Clause 3.4

Evidence of Suitability

Fire-protected timber:	
Internal Fire Exposure	FRL Test or assessment report from an Accredited Testing Laboratory complying with NCC A5.4 – (e.g.Exova Warringtonfire report 22567A-01) RISF – 45 (NCC Spec C1.13a DTS)
External Fire Exposure	FRL Test or assessment report from an Accredited Testing Laboratory complying with NCC A5.4 or design in accordance with AS 3700 RISF – 45 (AS 3700 design for insulation or test or assessment report from an Accredited Testing Laboratory)
Non-combustibility	Plasterboard NCC C1.9(e)(i) DTS Fire-protected timber NCC C1.13 Concession Cavity Insulation AS 1530.1 test report Brickwork –traditional building material

Obtain Evidence of Suitability from product supplier before specifying or installing any product or system

Sound Transmission and Insulation No NCC requirement for external walls in NCC 2016 but commonly specified for inner city locations. Report from a laboratory or acoustics engineer stating performance achieved.

Thermal Resistance R-Value Report complying with NCC Clause A5.2

Weatherproofing Statement of compliance with relevant requirements of AS 3700 and report confirming applicability of AS 3700 – complying with NCC Clause A5.2.

Structural tests for lightweight construction Report complying with NCC Clause A5.2 expressing results of tests in accordance with NCC specification C1.8.

Notes

Selection of systems that are fit for the purpose and the provision of Evidence of Suitability to the satisfaction of the relevant authority is the responsibility of the designers and product suppliers. Forest and Wood Products Australia Limited (FWPA) and the authors of this Guide make no warranties or assurances with respect to the fitness for purpose of the systems described in this Guide.

Ensure installation is in accordance with Evidence of Suitability, manufacturer's instructions and design drawings.

Primary Distributors

Various plasterboard distributors

D

Appendix D: Glossary

National Construction Code (NCC)
National Construction Code Volume One: Building Code of Australia 2019.

Cavity barrier
A barrier placed in a concealed space, formed within or around the perimeter of fire-protected timber building elements, that complies with Specification C1.13 of the NCC, to limit the spread of fire, smoke and hot gases to other parts of the building.

C_{tr}
refer Spectrum adaption term (airborne noise.)

Discontinuous construction
A wall system typically having a minimum of 20 mm cavity between two separate wall frames (leaves) with no mechanical linkage between the frames except at the periphery intended to reduce sound transmission.

Exit
Includes any of the following if they provide egress to a road or open space:

- an internal or external stairway
- a ramp complying with Section D of the NCC
- a doorway opening to a road or open space
- a fire-isolating passageway
- horizontal exit.

Fire-protected Timber
Fire-resisting timber building elements that comply with Specification C1.13a of the NCC.

Fire-protective grade plasterboard
Plasterboard with glass fibre and mineral additives used to improve strength and control shrinkage under fire conditions. Typically a lightweight loadbearing timber framed wall protected by one layer of 16 mm fire-protective grade plasterboard applied to each face would be expected to achieve an FRL of at least 60/60/60 and if protected by two layers of 13 mm fire-protective grade plasterboard on each face an FRL of at least 90/90/90.

Fire-isolated stair or ramp
A stair or ramp construction of non-combustible materials and within a fire-resisting shaft or enclosure.

Fire-isolated passageway
A corridor or hallway of fire-resisting construction that provides egress to a fire-isolated stairway or ramp or to open space.

Fire Resistance Level (FRL)
The time in minutes, determined in accordance with Clause A5.4 (of the BCA) for the following, in order:

- structural adequacy
- integrity
- insulation

Fire-resisting
As applied to a building element means, having the FRL appropriate for that element

Fire-resisting sealant
Fire-grade material used to fill gaps at joints and intersections in fire-protective linings and around service penetrations to maintain Fire Resistance Levels and Resistance to Incipient Spread of Fire performance of elements of construction. Note: The material should also be flexible to allow for movement and where necessary waterproof.

Fire-source feature

- The far boundary of a road adjoining the allotment; or
- a side or rear boundary of the allotment; or
- an external wall or another building on the allotment which is not of Class 10.

Habitable room
A room for normal domestic activities, e.g. bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room and sunroom. Excludes bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.

Internal walls
Walls within, between or bounding separating walls but excluding walls that make up the exterior fabric of the building. Note: Fire walls or common walls between separate buildings or classifications are NOT internal walls.

$L_{n,w}$
refer Weighted normalised impact sound pressure level.

Lightweight construction
Construction that incorporates or comprises sheet or board material, plaster, render, sprayed application, or other material similarly susceptible to damage by impact, pressure or abrasion.

Massive Timber 'Concession'
A relaxation allowing the Resistance to Incipient Spread of Fire requirements for fire-protected timber to be modified if both the following conditions are satisfied:

- the timber is at least 75 mm thick
- any cavity between the surface of the timber and the fire-protective covering is filled with non-combustible materials.

Massive Timber Panels
Large engineered wood panels of minimum thickness of 75 mm thick. Typical examples include Cross-laminated Timber (CLT), Laminated Veneer Lumber (LVL) and Glulam panels.

Modified Resistance to the Incipient Spread of Fire (MRISF)
The MRISF, amongst other things, relaxes the RISF limiting temperature from 250˚C to 300˚C to reflect the reduced risk of fire spread through cavities and higher inherent fire resistance of timber with larger cross-sections. The test procedures for MRISF are described in Section 3 of Specification C1.13a of the NCC.

Multi-service penetration system
A service penetration system used to protect a group of services penetrating a single opening in a fire-resisting element such that the FRL, RISF or MRISF of the element is not reduced. Note: Fire protective coverings or other means may be required to be fitted around the opening to ensure that the RISF or MRISF are not reduced.

Non-combustible
Applied to a material not deemed combustible under AS 1530.1 – Combustibility Tests for Materials; and applied to construction or part of a building – constructed wholly of materials that are not deemed combustible.

Performance Requirements
The requirements in the NCC that describe the level of performance expected from the building, building element or material.

Resistance to the Incipient Spread of Fire (RISF)
The ability of a fire-protective covering to insulate voids and the interfaces with timber elements to limit the temperature rise to a level that will not permit ignition of the timber and the rapid and general spread of fire throughout any concealed spaces. The performance is expressed as the period in minutes that the covering will maintain a temperature below the specified limits when subjected to a test in accordance with AS 1530.4.

R_w
Refer to Weighted sound reduction index.

Sole-Occupancy Unit (SOU)
A room or other part of a building for occupation by one or joint owner, lessee, tenant, or other occupier to the exclusion of any other owner, lessee, tenant, or other occupier and includes:

- a dwelling (e.g. apartment)
- a room or suite of rooms in a Class 3 building which includes sleeping facilities
- a room or suite of associated rooms in a Class 5, 6, 7, 8 or 9 building
- a room or suite of associated rooms in a Class 9c building, which includes sleeping facilities and any area for the exclusive use of a resident

Spectrum adaption term (C_{tr})
Used to modify the sound performance of wall and floor/ceiling systems to reflect low frequency performance. In combination with Rw (i.e. R_w+C_{tr}) is used to account for low frequency noise.

Weighted sound reduction index (R_w)
The rating of the sound isolating properties of building element as described in AS/NZS ISO 717.1.

Weighted normalised impact sound pressure level ($L_{n,w}$)
The measurement of how much sound reaches a receiving room through a building element from a standard tapping machine.

References

WoodSolutions Technical Design Guides

#1 Timber-framed Construction for Townhouse Buildings Class 1a

#2 Timber-framed Construction for Multi-residential Buildings Class 2 and 3

#3 Timber-framed Construction for Commercial Buildings Class 5, 6, 9a & 9b

#4 Building with Timber in Bushfire-prone Areas

#5 Timber service life design – Design guide for durability

#16 Massive Timber Construction Systems: Cross-laminated Timber (CLT)

#17 Alternative Solution Fire Compliance, Timber Structures

#18 Alternative Solution Compliance Facades Forest and Wood Products Australia Ltd 2015

#20 Fire Precautions during Construction of Large Buildings

#39 Robustness in Structures

#38 Fire Safety Engineering Design of Mid-Rise Buildings

Other:

R-values for Timber-framed Building Elements

Australian Standards

AS 2118.1 Automatic fire sprinkler systems – General requirements

AS 2118.4 Automatic fire sprinkler systems – Sprinkler protection for accommodation buildings not exceeding four storeys in height

AS 2118.6 Automatic fire sprinkler systems – Combined sprinkler and hydrant systems in multi-storey buildings

AS 1170 series – Structural design actions

AS 1720.1 Timber structures – Design methods

AS 5113 Amd 1 Classification of external walls of buildings based on reaction to fire performance

AS 1905.1 Components for the protection of openings in fire-resistant walls – Fire-resistant doorsets

AS 1530.1 Methods for fire tests on building materials, components and structures - Combustibility test for materials

AS 1530.4 Methods for fire tests on building materials, components and structures - Fire-resistance tests for elements of construction

AS 4072.1 Components for the protection of openings in fire-resistant separating elements – Service penetrations and control joints

AS 2444 Portable fire extinguishers and fire blankets – Selection and location

AS 1682.1 Fire, smoke and air dampers – Specification

AS 1682.2 Fire, smoke and air dampers – Installation

Other References

National Construction Code Volume One: Building Code of Australia 2019 – Australian Building Codes Board, Canberra ACT – © Commonwealth of Australia and the States and Territories 2019

International Fire Engineering Guidelines (2005) – Australian Government, Sate and Territories of Australia

Safe Design of Structures – Safe Work Australia

Exova Warringtonfire Australia Pty Ltd (EWFA) Regulatory Information Reports (RIR) issued to Forest & Wood Products Australia:

RIR 22567A-04 – The fire resistance performance of timber-framed walls lined with plasterboard if tested in accordance with AS1530.4-2005

RIR 37600400 – The fire resistance level (FRL) of timber-framed floor/ceiling systems incorporating timber and metal web floor trusses or various engineered joists when tested in accordance with AS 1530.1-2014

RIR 37401400 – The fire resistance level (FRL), Resistance to the Incipient Spread of Fire (RISF) and Modified Resistance to the Incipient Spread of Fire (MRISF) performance of various timber-framed and massive timber panel systems

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