02

Timber-framed Construction for Multi-residential Buildings Class 2, 3 & 9c

Design and construction guide for BCA compliant sound and fire-rated construction

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Table of Contents

Introduction

This Guide covers fire and sound.

It also picks up where the BCA leaves off – in areas of increasing interest to users.

Fire and sound are important issues in residential construction. Sound insulation tends to govern the choice of construction system because of its daily impact on the quality of life, while fire-resisting construction is important for protecting against extreme events. This Guide aims to assist in both areas and is specifically written for use by designers, specifiers, builders, code officials and certifying authorities. It is set-out according to a simple step-by-step process shown in Figure 1. The steps are then used as the basis for headings throughout the rest of the document. Details on the scope and other important aspects of the Guide are below.

Scope

For timber-framed construction, this Guide demonstrates achievement of targeted fire- and sound-Performance Requirements in the Building Code of Australia (BCA) for Class 2, 3 and 9c buildings. In this context, the Guide provides certified construction details that utilise the Building Code of Australia Deemed to Satisfy Provisions. Specific areas of performance addressed include:

- sound insulation of wall, floor and ceiling elements relevant to Sole Occupancy Units and surrounding construction; and
- fire-resisting construction of wall, floor and ceiling elements relevant to Sole Occupancy Units and surrounding construction.

In addition, this Guide provides assistance for those wanting to improve and upgrade sound performance beyond minimum BCA requirements, including low frequency impact sound, vibration-induced sound and flanking noise. Evidently, these issues are beginning to dominate end-user requirements and require specific attention.

This Guide does not deal with all aspects of fire safety and sound insulation. For further details on this issue refer to Appendix B – Deemed to Satisfy fire requirements not covered by this Guide.

Finally, this Guide does not provide advice on which tested wall and floor systems should be used as there are many suppliers of these systems. The Guide provides advice in many instances on how these tested systems are joined and interact while maintaining the objectives of the BCA.

Evidence of Suitability

The BCA requires every part of a building to be constructed in an appropriate manner to achieve the requirements of the BCA. This Guide has been prepared from a number of sources, the main being a guide called – Timber-Framed Construction Sacrificial Timber Construction Joints – Technical Design Guide for BCA compliant fire-rated construction. This guide also documents the fire tests and assessments used to support the details used in this manual.

Other information sources that support this guide are referenced in Appendix C.

Although national, some BCA provisions differ by state. It's vital to know key variations for your area.

Regulatory Differences Between States of Australia

This publication focuses on current BCA requirements. From time to time State-based BCA amendments may vary requirements. The user of this Guide should make themselves aware of these differences and should develop a full understanding of the resulting implications. This Guide should be used on this basis.

Design process for sound- and fire-resistant timber-framed construction.

Step 1 – High-Level BCA Design Issues

- Determine the Class of building
- Determine the basis for complying with BCA Performance Requirements, i.e. Deemed to Satisfy Provisions to be used
- Determine the setout of Sole Occupancy Units in the building

Step 2 – Define BCA Sound Design Requirements

- Utilise the Deemed to Satisfy Provisions for sound design
- Determine sound-insulation requirements for elements, e.g. walls. floors

Step 3 – Improving Sound Performance

- Attention to building design (space and form)
- Address flanking noise
- Strategies for improving sound performance

Step 4 – Define BCA Fire Design Requirements

- Utilise the Deemed to Satisfy Provisions for fire design
- Determine the Type of Construction required for fire-resistance
- Determine the Fire Resistance Levels of elements, e.g. walls,
- Address special fire issues, e.g. stairs, shafts

Step 5 – Select fire/sound rated timber construction

- Principles in fire/sound rated timber construction
- Select a fire/sound rated timber-framed system
- Detail the selected system, e.g. joints, penetrations

Step 6 – Further design assistance (Appendices)

- Structural considerations, other BCA requirements, references, glossary

1

Step 1 – High-Level BCA Design Issues

The BCA is the regulatory framework for determining minimum construction requirements for all types of buildings in Australia. It contains different levels of detail that subsequently cause different levels of decisions to be made on a building project. A selection of high-level design issues relating to fire-resisting and sound-insulating construction are addressed in this section of the Guide.

This Guide covers BCA Class 2, 3 and 9c buildings.

1.1 Determine the Class of Building

The Building Code of Australia (BCA) contains mandatory Performance Requirements which apply to 10 primary classes of building. The classes are determined according to the purpose for which the building will be used. The classes relevant to this Guide are:

- **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 which 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); and
  - accommodation for the aged, children or people with disabilities.
- **Class 9c buildings –** a building of a public nature involving aged care.

These classes are dealt with in Volume 1 of the BCA and so all future references to the BCA are made with relevance to this volume. It is important that users choose which Class is relevant to their building project because it affects the Type of Construction, and consequently its fire-resistance. This in turn, influences the timber-framed construction system that will be needed for the project.

1.2 BCA Compliance – Deemed to Satisfy or Alternative Solution

Refer to: BCA A0.9 and A2.2.

BCA Performance Requirements can be achieved for the above building classes in two ways:

- Deemed to Satisfy Provisions – this means a specific type of construction that is acknowledged as complying with the BCA's Performance Requirements.
- Alternative Solutions – this means a solution not dealt with under Deemed to Satisfy Provisions and must be proven to satisfy BCA Performance Requirements. Suitable assessment methods are identified in the BCA.

The construction systems and details in this Guide comply with the Deemed to Satisfy Provisions. For instance, these provisions direct the level of fire and sound resistance that construction elements must achieve in order to meet minimum BCA requirements. Approved BCA methods of assessment are then used to ensure that the timber-framed construction systems shown in this Guide comply with the levels required.

In the event that a satisfactory timber-framed solution cannot be obtained under the Deemed to Satisfy solutions in the Guide, then an Alternative Solution is required. Alternative Solutions are not dealt with in this Guide.

It is important to note that a mixture of Deemed to Satisfy Provisions and Alternative Solutions can be used to develop an acceptable solution for a building. The user does not need to follow one or the other path.

1.3 Determine the Setout of Sole Occupancy Units (SOU) in the Building

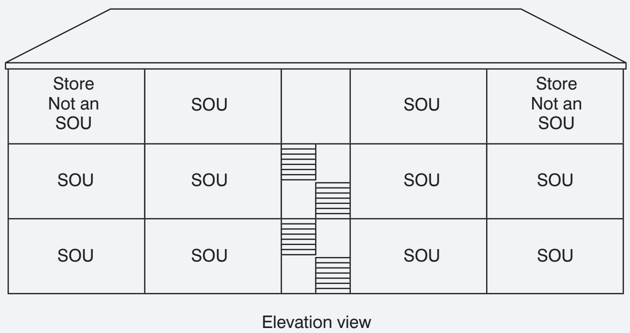
The concept of a Sole Occupancy Unit (SOU) is central to addressing many issues concerning fire and sound performance in Class 2, 3 and 9c buildings. A SOU helps separate a given building into manageable units for dealing with fire and sound performance:

- A SOU is a room or other part of a building for occupation by an owner, leasee, tenant or other occupier, to the exclusion of others.
- SOUs must be designed to restrict fire and sound entering adjoining SOUs and certain other parts of the building.

The wall and floor/ceiling elements that bound an SOU (Figure 2) are central in achieving BCA 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); or
- 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.



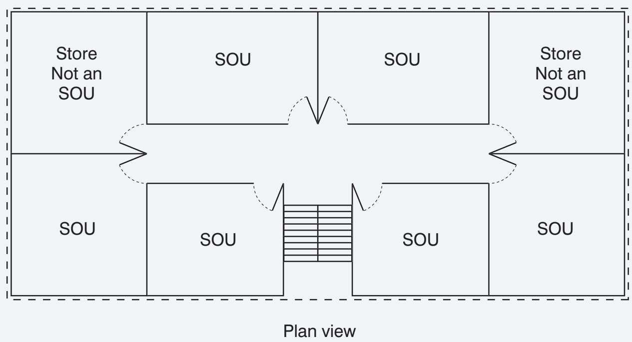


Figure 2: Examples of Sole Occupancy Units.

2

Step 2 – Define BCA Sound-Design Requirements

In today's building design, sound insulation tends to govern the choice of timber-framed construction more so than fire requirements. In terms of the BCA, designing sound resisting construction involves a process of understanding how Performance Requirements translate into the more objective and measurable Deemed to Satisfy Provisions, then selecting timber-framed construction systems that suit these requirements. As will be discussed in Step 3, there is a parallel need to address sound induced by poor spatial design of a building, flanking noise problems, and where appropriate, upgraded sound performance requirements to meet end user needs.

Refer to: BCA F5.0 to F5.7.

2.1 Utilising the Deemed to Satisfy Provisions for Sound Design

Part F5 of the Building Code of Australia (BCA) is concerned with 'safeguarding building occupants from illness or loss of amenity as a result of excessive noise'. BCA Performance Requirements focus on the sound insulation of wall and floor elements bounding Sole Occupancy Units where separating:

- adjoining units; and
- common spaces from adjoining units.

Airborne and impact sound: different sources need different handling.

Provisions that meet the above Performance Requirements are detailed in the BCA under section F5 which covers the airborne and impact sound-insulation ratings for walls, floors and services (Note: the provisions also include the sound isolation of pumps but issues pertaining to this are not dealt with in this Guide). In interpreting these requirements, it is important to have an understanding of the difference between airborne and impact sound (Figure 3).

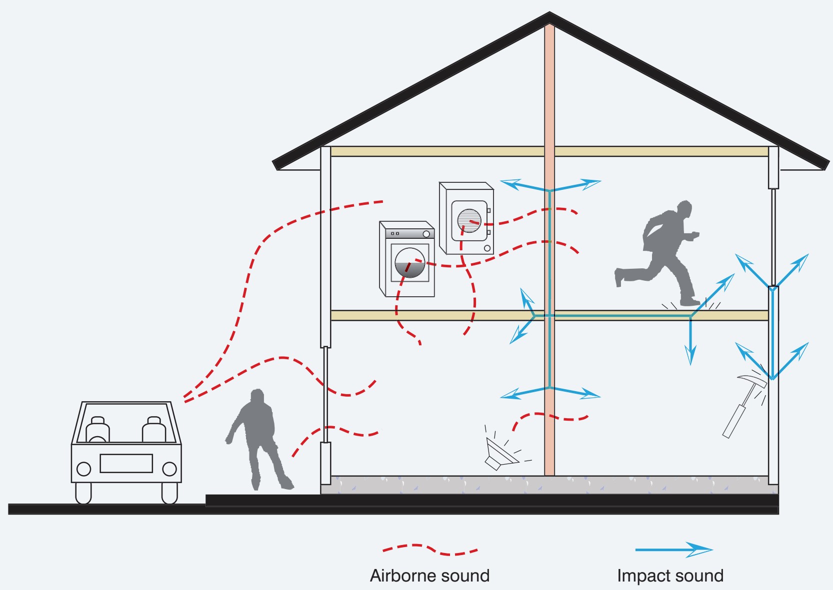


Figure 3: Examples of impact and airborne sound.

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. To this end, the nomenclature used in the Deemed to Satisfy Provisions using results from laboratory requirements, is explained in Figure 4 and Figure 5. NOTE: Alternative methods of sound measurement also exist.

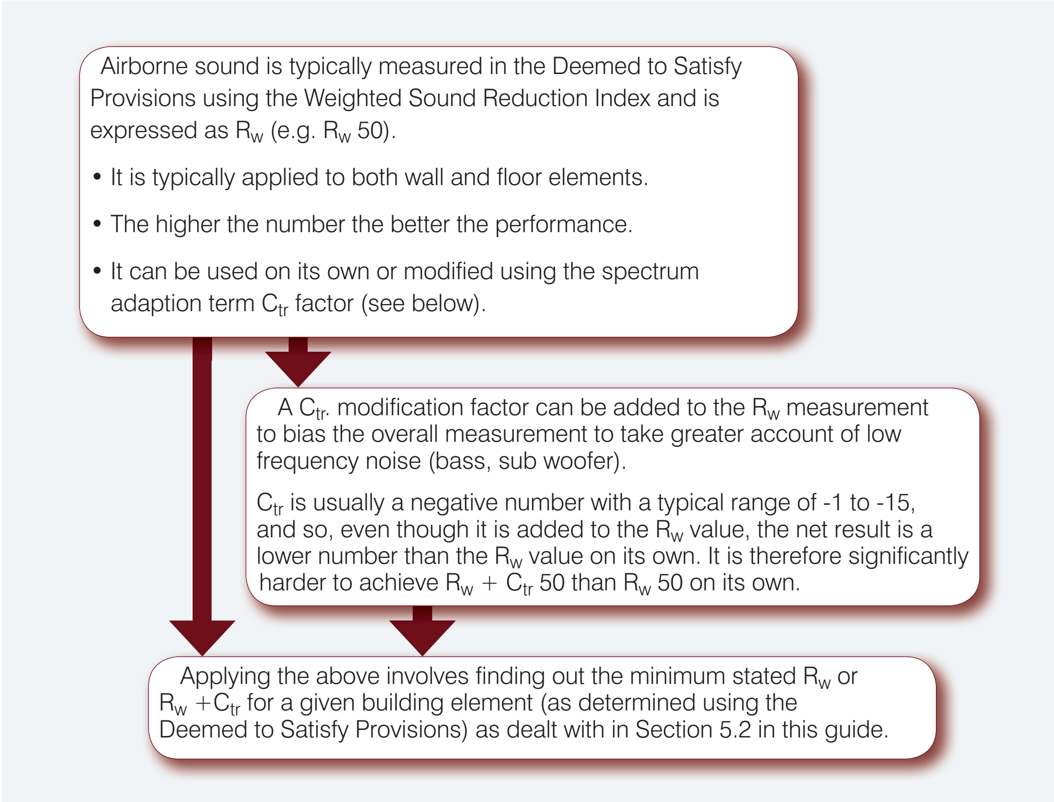


Figure 4: Methods of measuring airborne sound.

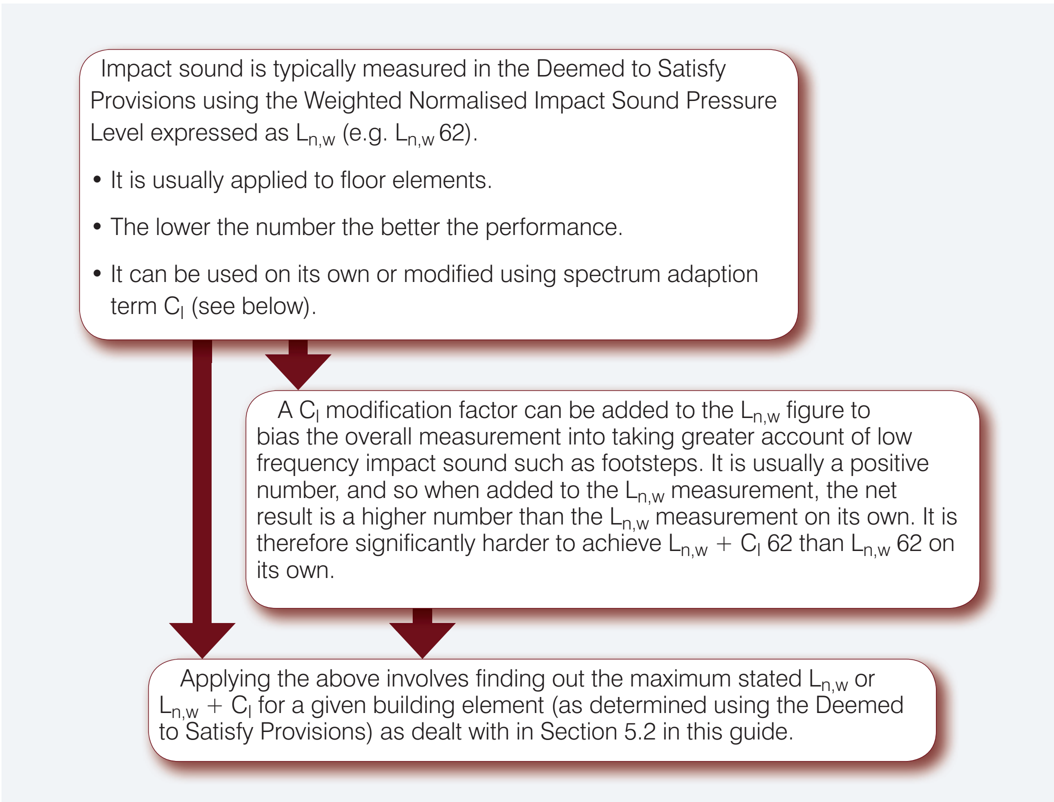


Figure 5: Measuring impact sound.

2.2 Determining Sound Insulation Requirements for Individual Building Elements

Of importance to construction is the minimum airborne and impact sound insulation requirements for individual building elements, e.g. wall and floor elements. Table 1 and Table 2 provide a simple means for finding out such information and is necessary for selecting appropriate timber-framed construction, system.

Table 1: Deemed to Satisfy Sound Insulation Requirements in Class 2 and 3 Buildings.

Situation		Floor Rating	Wall Rating	Entry Door Rating
First SOU/space	**Adjoining SOU/space**			
SOU – generally all spaces except those noted below	SOU – generally all spaces except those note below	$R_w + C_{tr} \geq 50$, & $L_{n,w} + C_I \leq 62$	$R_w + C_{tr} \geq 50$	N/A
SOU – bathroom sanitary compartment, laundry kitchen	SOU – habitable room (except kitchen)	$R_w + C_{tr} \geq 50$, & $L_{n,w} + C_I \leq 62$	$R_w + C_{tr} \geq 50$ and of discontinuous[1] construction	N/A
Public corridor, areas of different classification, public lobby or the like	SOU – all spaces	$R_w + C_{tr} \geq 50$, & $L_{n,w} + C_I \leq 62$	$R_w \geq 50$	$R_w \geq 30$
Stair and lift shaft	SOU – all spaces	N/A	$R_w \geq 50$	$R_w \geq 30$
Plant room	SOU – all spaces	$R_w + C_{tr} \geq 50$, & $L_{n,w} + C_I \leq 62$	$R_w \geq 50$ and of discontinuous[1] construction	$R_w \geq 30$

Notes: 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.

Clear definitions + accurate measurements = optimal results.

Table 2: Deemed to Satisfy Requirements for Sound Insulation of Wall and Floor Elements in Class 9c Buildings.

<table>
<tr><th colspan="2">Situation</th><th rowspan="2">Floor Rating</th><th rowspan="2">Wall Rating</th></tr>
<tr><th>First Tenancy</th><th>Adjoining Tenancy/space</th></tr>
<tr><td>SOU – all spaces</td><td>SOU – all spaces except those below</td><td rowspan="3">$R_w \geq 45$</td><td>$R_w \geq 45$</td></tr>
<tr><td rowspan="2">SOU – all spaces</td><td>Laundry, kitchen</td><td>RW ≥ 45 and of discontinuous construction</td></tr>
<tr><td>Plant room, utilities room, bathroom, sanitary compartment (but not an associated ensuite)</td><td>$R_w \geq 45$</td></tr>
</table>

Notes: 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, such as wall top plates.

Where a wall is 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 ceiling to the required wall sound insulation).

Refer to:
BCA F5.6.

2.3 Services

If a duct, soil, waste or water supply pipe serves or passes through more than one dwelling, the duct or pipe 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; or
- 25 if it is adjacent to a kitchen or bathroom.

It is also required where a duct or pipe is located with a wall or ceiling cavity.

2.4 The Next Step

Having used the previous information to obtain an understanding of the BCA's minimum sound-insulation requirements, the next step is to either:

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

Once sound-insulation requirements are satisfied, the next Step is Step 4 Fire Design Requirements.

3

Step 3 – Improve and Upgrade Sound Performance

Quiet dwellings command premium prices, so it may pay to exceed minimum sound performance standards.

Sound performance can often be improved by simple attention to the form and spatial arrangement of the building design. Attention to flanking noise represents another important means of improving sound performance. In addition, many end users of dwellings want higher sound performance than the minimum levels required in the BCA. As a result of these issues, 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 therefore best for the service rooms in one dwelling to back onto the same type of rooms in an adjoining dwelling (but not back onto habitable rooms). Also, try to ensure entrances to dwellings are an appropriate distance from adjacent units (Figure 6).

3.1.2 Windows

Windows and doors can thwart the best wall systems, but there are smart acoustic solutions.

Windows normally have lower sound insulation than the walls they are located within. 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 the weak link in sound rated wall systems. Where sound-control is desired, solid core doors should be used and should be treated with soft acoustic gaskets at interfaces with door jambs. Threshold closers at the bottom of the door or air seals will also reduce sound transmission. In most cases, the sound rating required to be met will require 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 resistant service shafts. In all instances, service pipes should be located away from noise sensitive parts of the dwelling such as bedrooms (Figure 6).

Flanking noise (that which passes around walls and floors) can turn up where it's neither wanted nor expected.

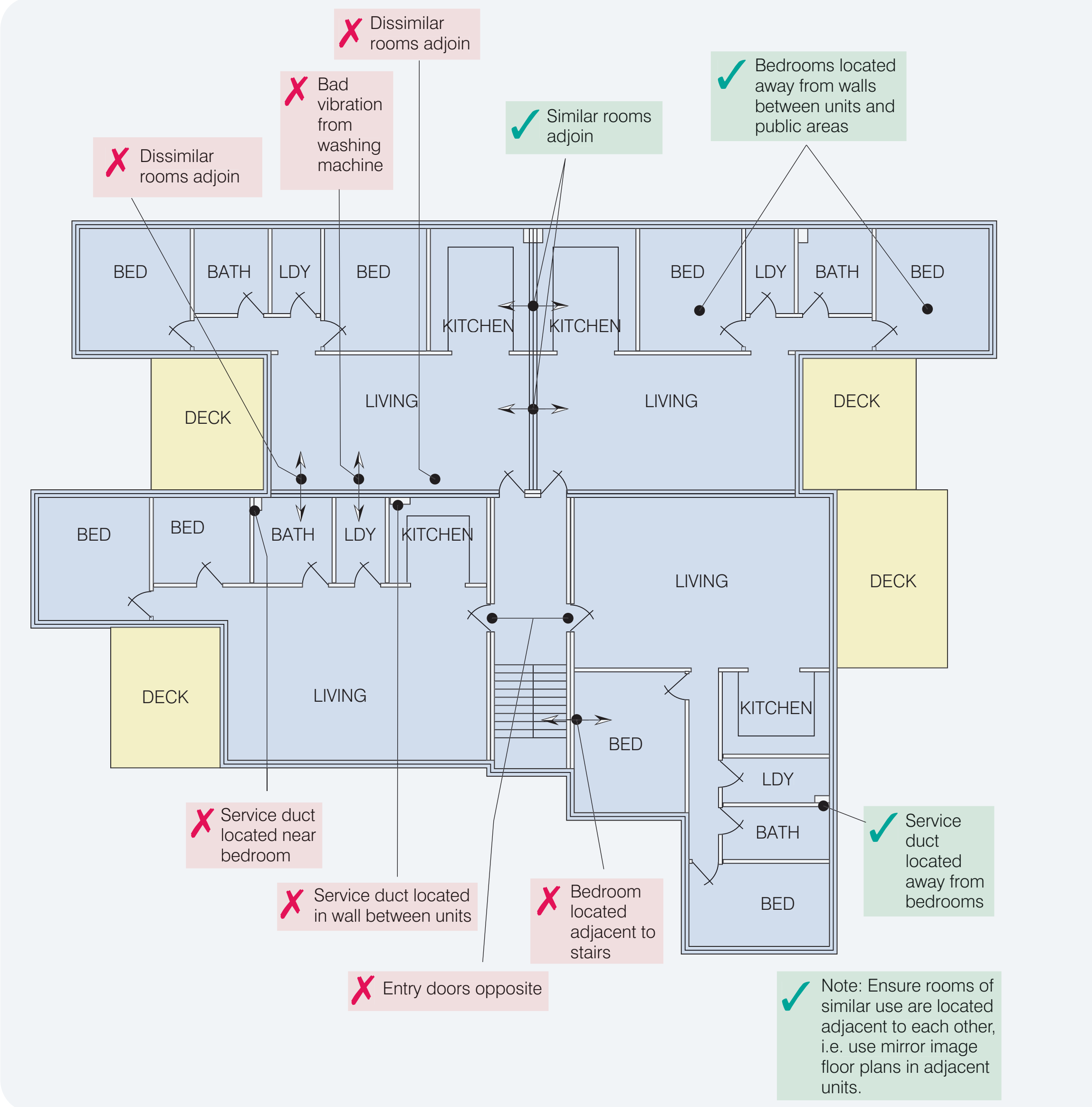


Figure 6: Good and bad sound design practices in building layout – plan view.

3.2 Addressing Flanking Noise

The ability to insulate against sound moving from one dwelling to the next is dependent 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, thus causing sound to unexpectedly manifest itself in unwanted places.

The main flanking routes around wall and floor elements are shown in Figure 7. 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.

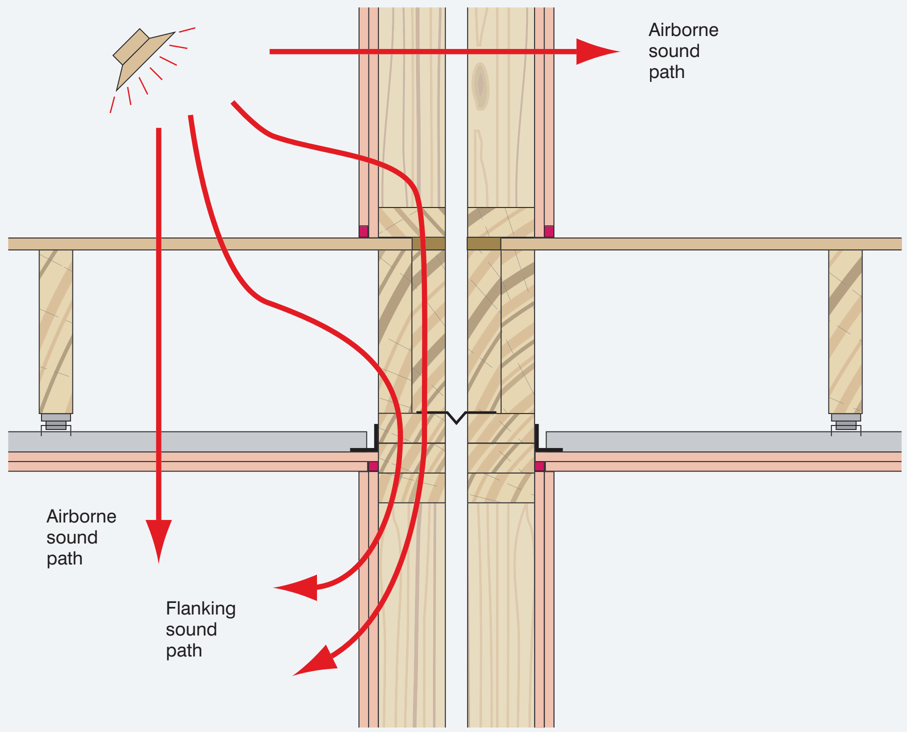


Figure 7: Flanking and airborne noise pathways – elevation view.

Solutions to flanking noise may need to be as oblique as the problem.

There are no minimum requirements addressing flanking noise in the BCA'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.

In developing this Guide consideration was given to reducing the flanking noise paths wherever possible. In some instances, limits on what could be achieved in reducing flanking were imposed because of their affect on fire and structural integrity. Therefore details given in this Guide are the conclusion of careful thought, taking into account all these issues. 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. This has been done purely to reduce flanking noise and has no other purpose (Figure 8).

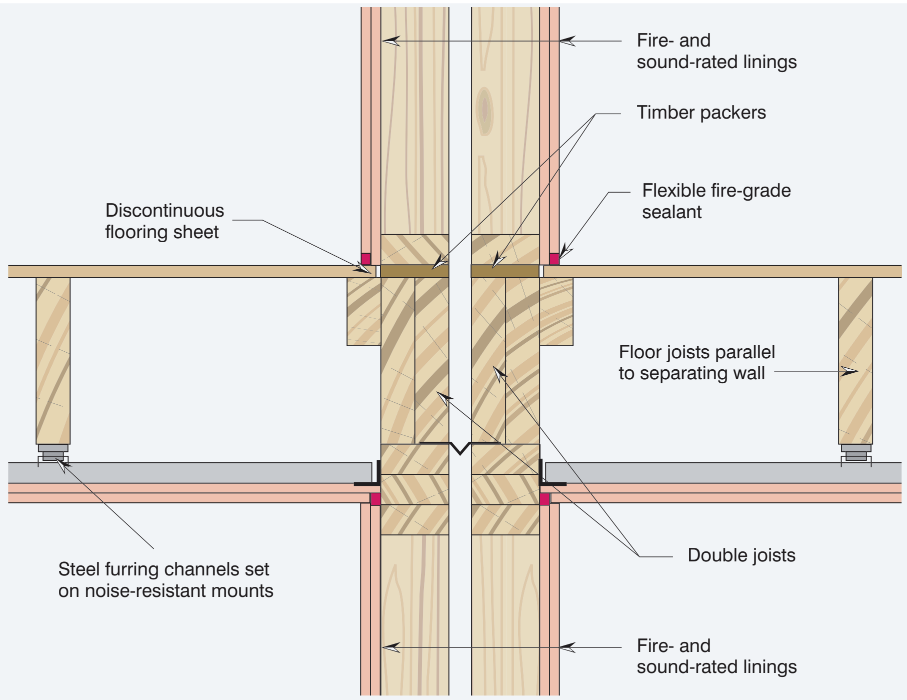


Figure 8: Discontinuous floor joist and floor sheeting – elevation view.

Where user tastes (e.g. for powerful home entertainment units) outpace BCA standards, you must think outside the square.

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

- Limit the noise getting into wall/floor element e.g. carpet, floating floors (Figure 9).
- Limit the ability of the noise to migrate from one element to another e.g.dampening and isolation at junctions between elements (Figure 8).

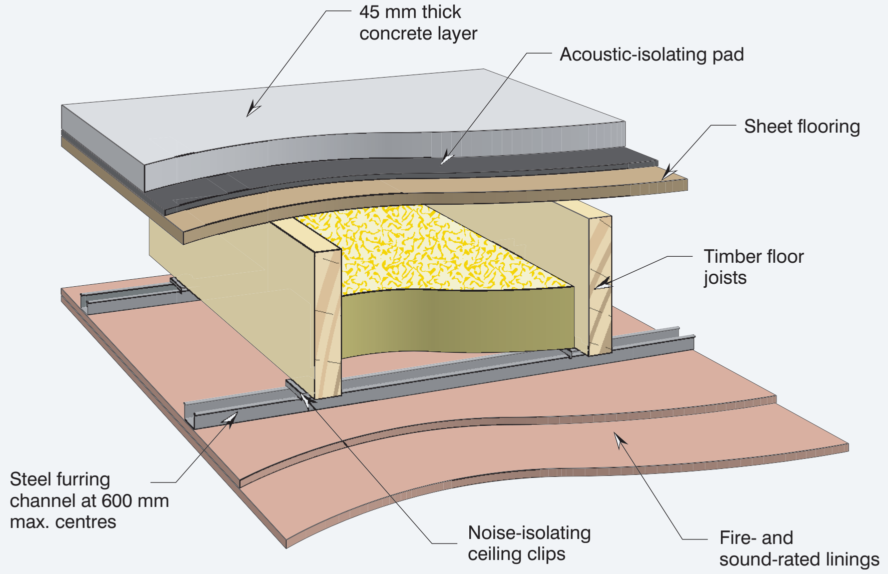


Figure 9: Acoustic isolating pad to reduce flanking noise.

In addition to the strategies above, timber-framed construction details orientated to improving flanking sound are provided in Section 5.3, and include:

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

3.3 Strategies for Upgrading Sound Performance in Construction

Building occupants often want higher sound performance than the minimum requirements in the BCA. This is especially the case for impact sound and the related issue of vibration which comes from footsteps, water movement through pipes, water hammer and any source of vibration including washing machines, air conditioning units and dishwashers. Other scenarios not dealt with in the BCA 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 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 (cellulose fibre, 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.

3.3.1 Walls

Extra mass on the walls – the addition of mass is a simple yet important means of improving sound performance in timber-framed construction. In its simplest form, this involves adding extra layers of material such as plasterboard to 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_{rt} scores (being the modification factor for low frequency bass noise applied to R_w scores). The simplest means of doing 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 different types and grades of insulation batts available in the market place. Sound insulation specific batts are best and in addition, high density materials tend to outperform low density materials. This is the case up to a density of 60 kg/m^2, above this the density has a minor effect. It is recommended that at a minimum of 10 kg/m^2 be used.

3.3.2 Floors

Sound reduction needn't be high tech. Adding mass is a simple yet highly effective measure.

Extra mass on the ceilings – the addition of mass is a simple yet important means of improving 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.

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 to either:

- 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-framed construction in Step 5; or
- go to Step 5 to select timber-framed construction that will comply with minimum BCA sound and fire requirements.

4

Step 4 – Define BCA Fire-Design Requirements

Designing fire-resistant construction involves a process of understanding how the BCA's Performance Requirements translate into the more objective and measurable Deemed to Satisfy Provisions, then selecting timber-framed construction systems that suits these requirements.

4.1 Utilising the Deemed to Satisfy Provisions for Fire Design

Refer to: BCA CP1 – CP9.

Part C of the Building Code of Australia Performance Requirements are concerned with safeguarding people when a fire in a building 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 physical damage caused by structural failure of the building as a result of fire.

Deemed to Satisfy Provisions that meet the above Performance Requirements are detailed in the BCA under:

- Part C1 – Fire-resistance and stability.
- Part C2 – Compartmentalisation and separation.
- Part C3 – Protection of openings.

These Parts deal with a wide range of issues but it is only the fire-resistance of specific building elements (e.g. wall and floor/ceiling elements) that are dealt with in this Guide, as these elements can be of timber-framed construction. To this end, only relevant clauses from Parts C1, C2 and C3 are discussed in more detail below. To help users understand the full range of issues contained in these Parts, a checklist is provided in Appendix B.

4.2 Determining the Type of Construction Required

Refer to: BCA C1.2 BCA C1.5 BCA C1.1.

Given the previous discussion, the main issue of interest for timber-framed construction relates to determining the Type of Construction, as defined in the BCA, required to resist fire for a given building. The issues involved are described below:

- Calculate the number of 'rise in storeys' of the building (Note: This is a BCA term and reference to BCA C1.2 is recommended)
- Take into account concessions for two storey Class 2, 3 and 9c buildings. Relevant factors include disregarding non-combustible requirements, number of building exits, access to open space and the use of sprinkler systems (BCA C1.5) and compartment size (9c only).
- Determine if the construction is Type A, B or C construction (BCA C1.1):
  - Type A provides the highest level of passive protection e.g. structural elements must withstand burnout of the building contents.
  - Type B provides lower passive protection e.g. less of the structure must be able to withstand burnout of the contents.
  - Type C provides the lowest passive fire-resistance e.g. only some elements have specified fire-resistance intended to mainly restrict horizontal spread of fire to adjoining dwellings.

The chart on the next page will help you plot your course.

A chart to assist selection of the appropriate type of construction is shown in Figure 10. It also allows users to determine if a timber-framed building solution is possible under the Deemed to Satisfy Provisions, or if an Alternative Solution will be necessary.

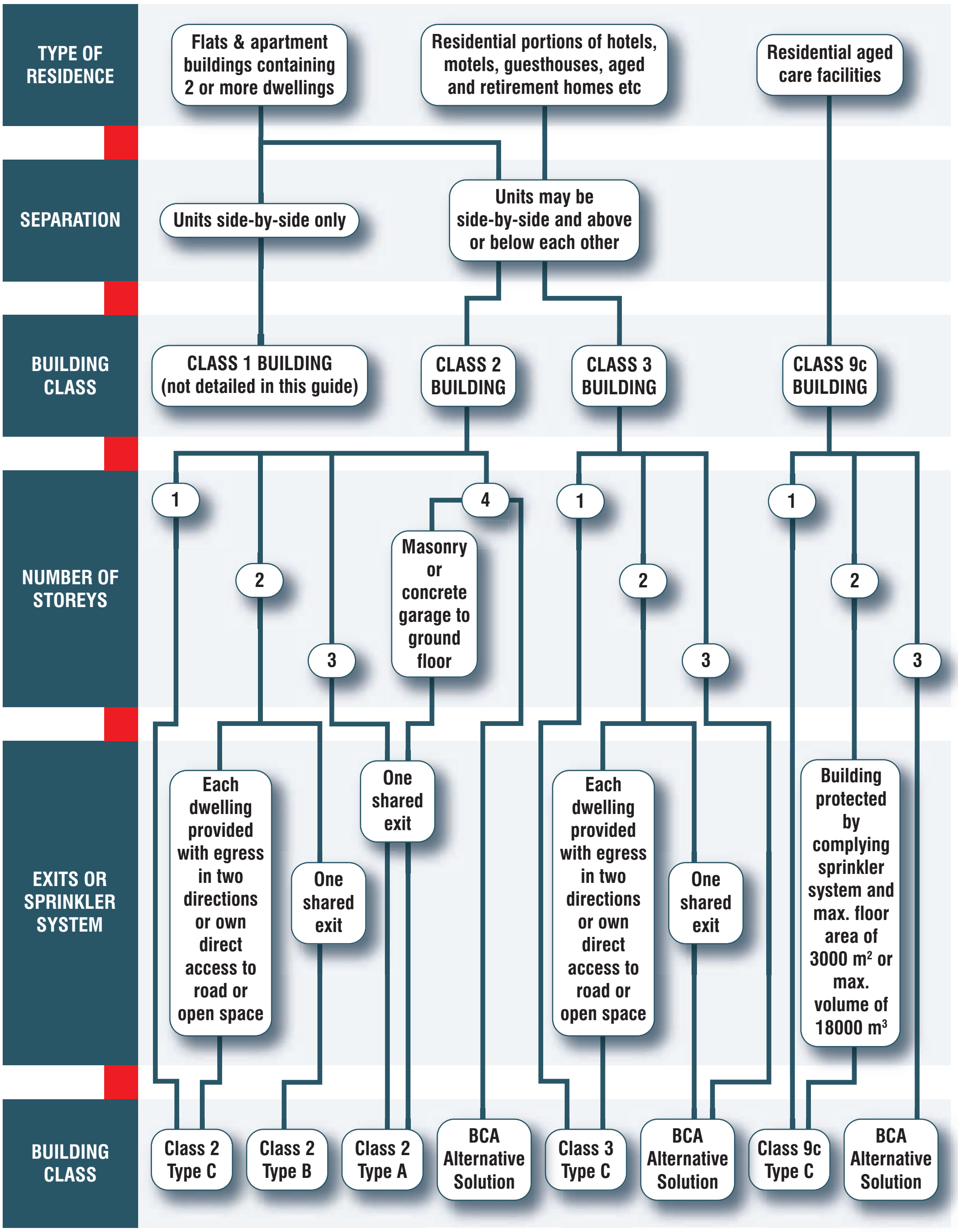


Figure 10: Determining the type of construction and applicability of Deemed to Satisfy Provisions.

Refer to: BCA Spec. C1.1.

4.3 Determining Fire Resistance Levels for Building Elements

Having determined the correct Type of Construction for the building, it is now possible to determine the Fire Resistance Levels required for various wall, floor, ceiling and other building elements (Note: This is possible using specification C1.1 as called up in the BCA's Deemed to Satisfy Provisions).

FRL = Fire Resistance Level.

A Fire Resistance Level (FRL) expresses the minimum amount of time (in minutes) that a building component must resist a fire as defined by three separate elements:

- Structural adequacy – ability to withstand loads.
- Integrity – in terms of containing smoke, flames and gases.
- Insulation – in terms of limiting the temperature on one side of the element getting through to the other side.

An example of the way that a Fire Resistance Level is expressed is: 60/60/60. Another example where a fire rating is not required for all elements is: – /60/ –.

Deemed to Satisfy Fire Resistance Levels for building elements in Class 2 and 3, Type A, B and C construction are provided in Figures 11, 12 and 13 respectively. Class 9c, Type C is found in Figure 14. These figures represent an interpreted version of information contained in BCA Specification C1.1. In interpreting these figures care should be taken to recognise the variety of different wall, floor and ceiling situations involved. Of note, this includes the selective need for roof void walls that restrict the passage of fire from one SOU to another through the roof void. An alternative which is relevant to Type A construction is the use of a Resistant to Incipient Spread of Flame ceiling which aims to prevent the spread of flame before it gets into the roof void.

Once relevant Fire Resistance Levels have been established for all relevant elements it is then possible to select timber-framed construction that will meet the chosen Fire Resistance Levels requirements from Section 5. In addition, it is important to consider more specialised elements as dealt with under the following Section 5.4.

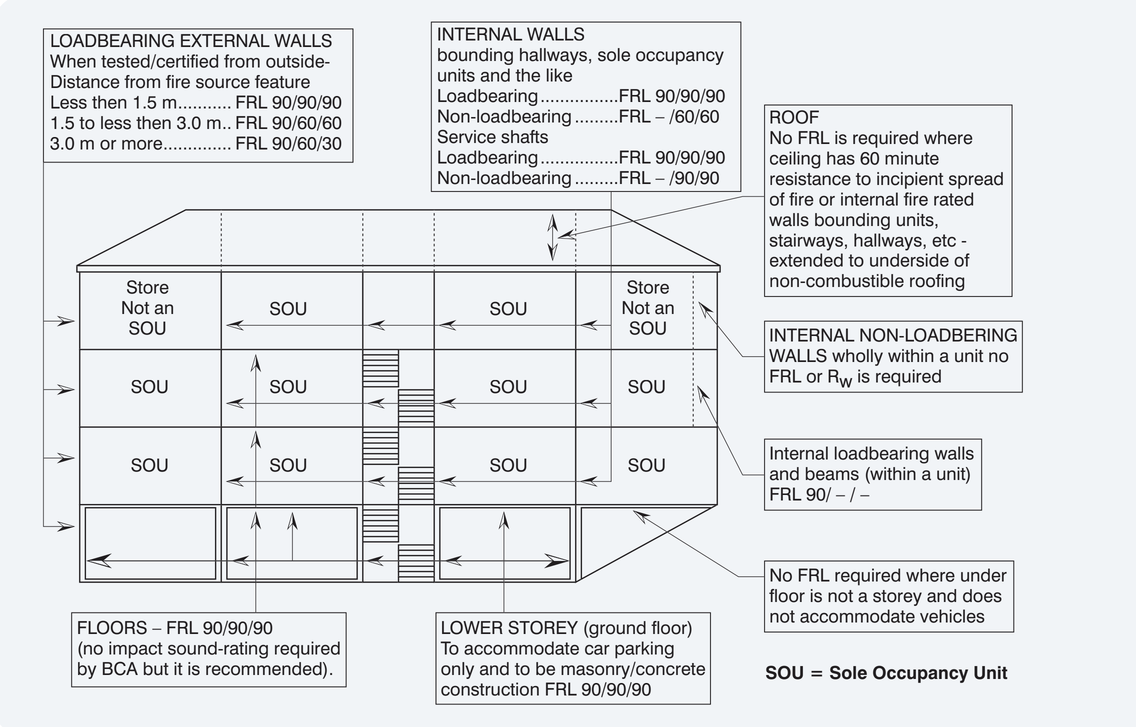


Figure 11a: Type A Construction Deemed to Satisfy Requirements – without sprinklers (must have smoke alarms).

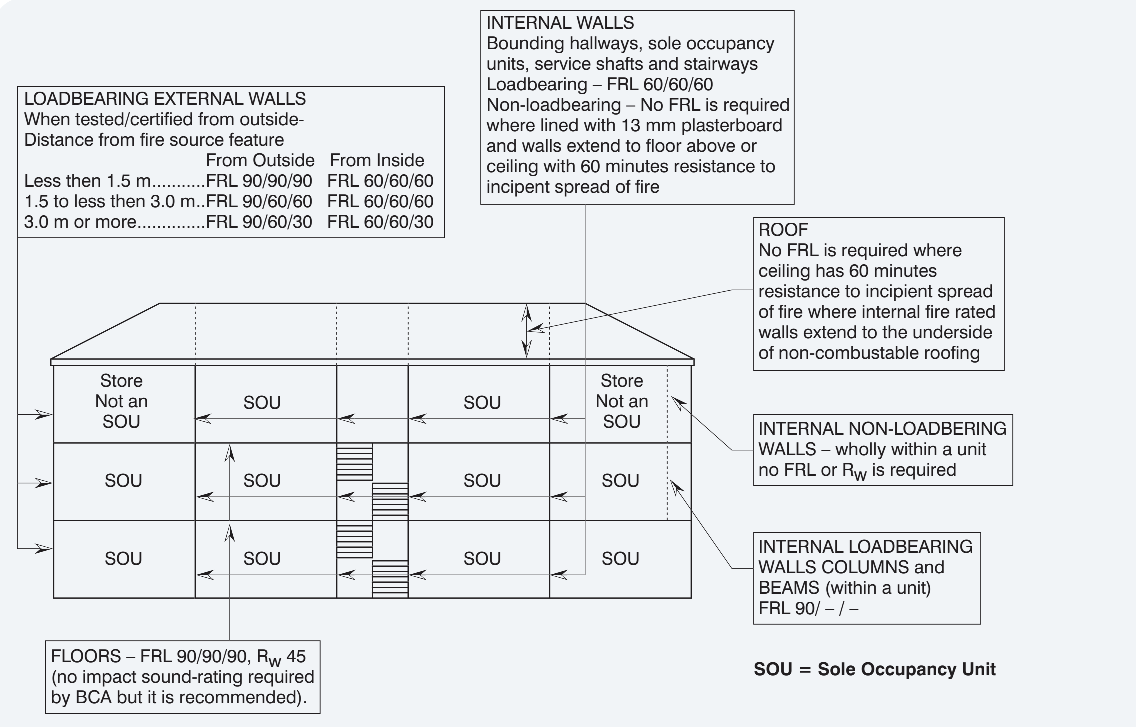


Figure 11b: Type A Construction Deemed to Satisfy Requirements – with sprinklers and smoke alarms.

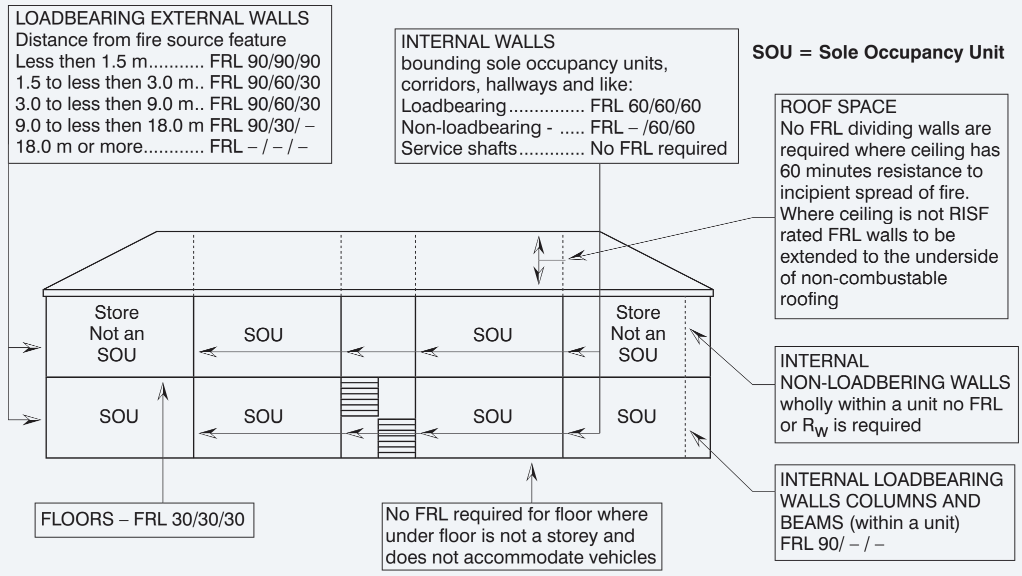


Figure 12a: Type B Construction Deemed to Satisfy Requirements – without sprinklers (must have smoke alarms).

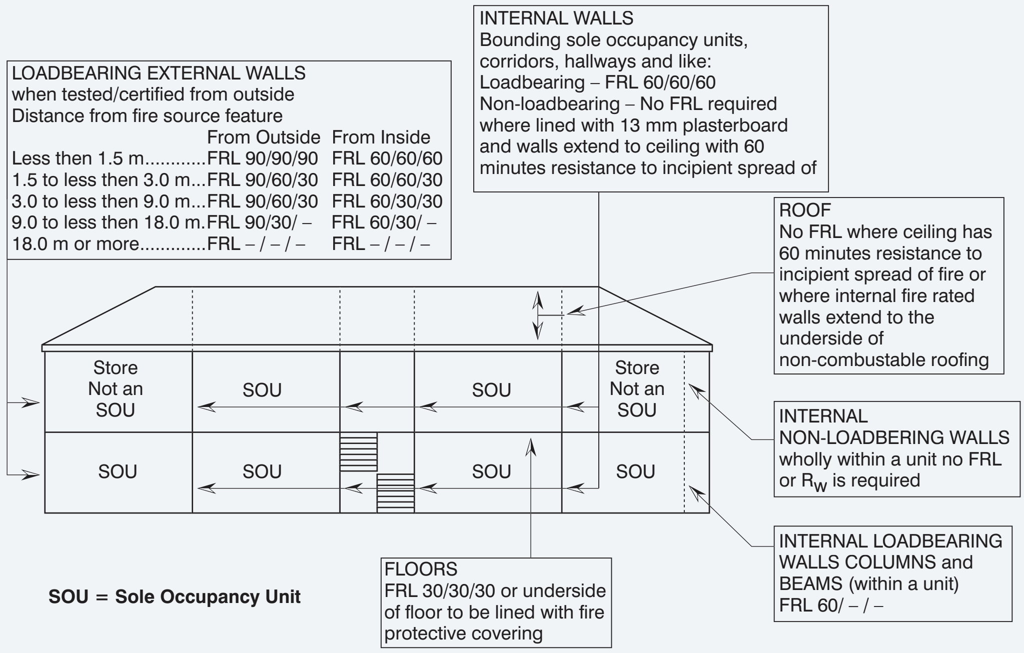


Figure 12b: Type B Construction Deemed to Satisfy Requirements – with sprinklers and smoke alarms.

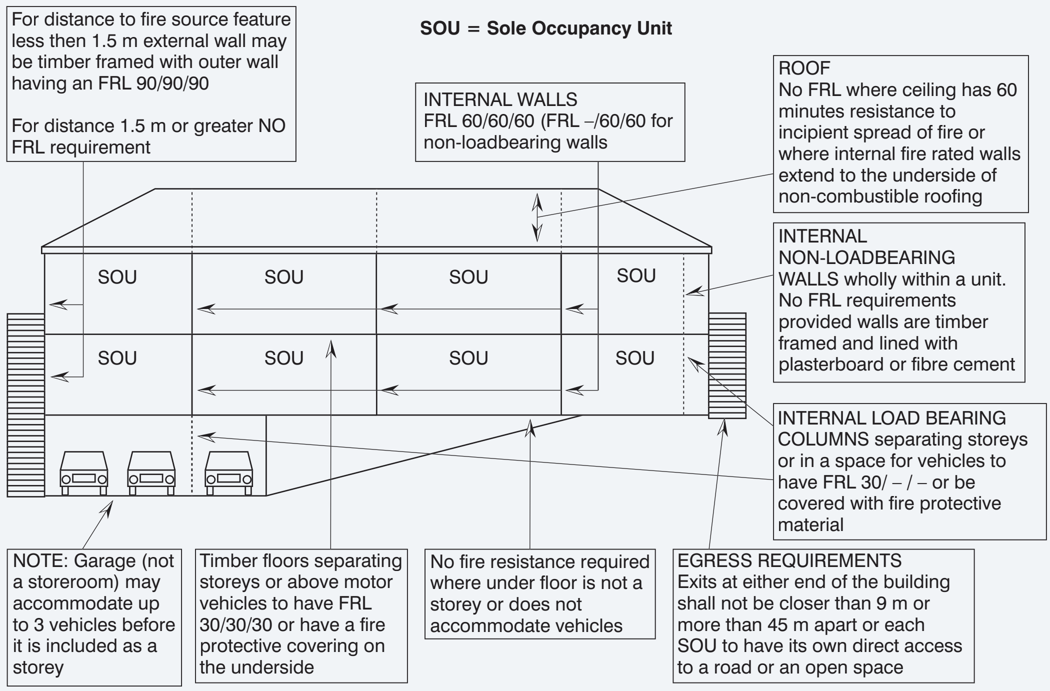


Figure 13: Type C Construction Deemed to Satisfy Requirements.

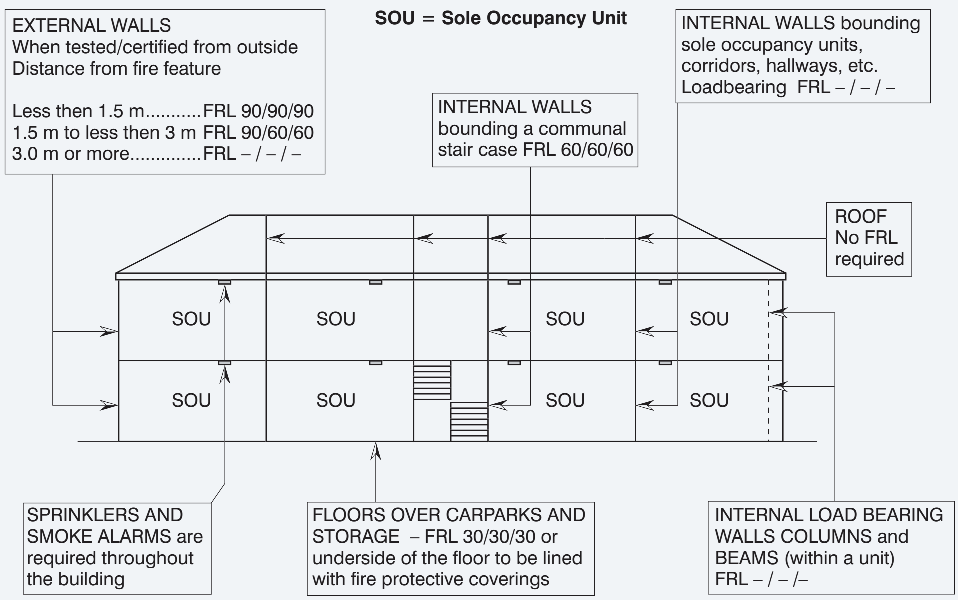


Figure 14: Class 9c, Type C Deemed to Satisfy Requirements.

Refer to: BCA Spec C1.1, 3.10 and 4.3.

4.3.1 Non-Combustibility Concession

The BCA Specification C1.1 for Type A and B construction requires that external walls, common and non-loadbearing fire-resisting wall and shafts to be built from non-combustible material and loadbearing internal and fire walls to be built from concrete or masonry. Specification C1.1 Clause 3.10 and 4.3 provides a concession to these requirements as long as non-combustible insulation is used. Non-combustible insulation products are mainly mineral wool products but confirmation is required from the manufacturer.

Given the recent influx of inferior insulation, it's vital to confirm non-combustibility. Some products create a fire hazard!

4.3.2 Sprinklers

There is no requirement to use sprinklers in Class 2 and 3 buildings as long as the effective height of the building is not more than 25 m. If sprinklers are installed, there is a concessions for Type A and B Fire Resistance Level for certain elements.

For Class 9c building sprinklers are required throughout the building.

4.4 Special Fire Issues

In constructing Class 2, 3 and 9c timber-framed 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-framed construction practices. A summary of fire issues covered in this Guide is found in Appendix B.

4.4.1 Smoke–Proof Walls

Refer to: BCA C2.14 and Spec C2.5 2 & 3.

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

For Class 9c buildings, smoke-proof walls are required to restrict open areas to not more than 500 m^2 and/or surround ancillary use areas such as a kitchen, laundry or storage rooms. The walls are required to be at least sheeted on one side with a non-combustible lining. If plasterboard is used it is to be at least 13 mm thick.

Details showing how to construct smoke-proof walls out of timber-framed construction are shown later in this Guide under Section 5.10.

4.4.2 Shafts

Shafts used in Type A buildings for lifts, ventilation, pipes, garbage or similar purpose are required to be fire-resisting to a Fire Resistance Levels of 90/90/90 or -/90/90. For Type B & C buildings, shafts should have the same Fire Resistance Levels as the element they penetrate.

Refer to: BCA Spec C3.1(c) and C4.1 (d).

Shafts must also be enclosed at the top and the bottom with a floor/ceiling system of the same Fire Resistance Levels as the walls, except where the top of the shaft is extended beyond the roof ,or the bottom of the shaft is laid 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 kitchen or non-habitable room.

Details showing how to construct shafts in timber-framed construction are shown later in this Guide under Section 5.6.

4.4.3 Complex Roof Framing Intersecting Fire-Rated Walls

Where a roof void may allow a fire to pass from one SOU to another, the BCA requires that a fire-resisting wall extend to the underside of a non-combustible roof and not to be crossed by combustible construction except for a maximum of 75 x 50 mm roof battens. For many situations this is not practical such as where walls intersect valleys or hips ends. In these cases, a ceiling which is Resistant to Incipient Spread of Fire is often a preferred option, see Section 5.5 of this Guide.

4.4.4 Vertical Separation of Openings in External Walls

Refer to: BCA C2.6.

To reduce the chance of a fire spreading from one floor to the next via the external wall, there is a need in the BCA to address the vertical separation of openings. This only applies to Type A construction, as there is no requirement for Type B and C construction.

In Type A construction, where there is an opening directly or within 450 mm (measured horizontally) of another opening in the storey below, and the building is not fitted with automatic sprinklers, the BCA requires these openings to be protected (Figure 15).

Protection can be achieved by a spandrel which is not less than 900 mm in height between the two openings and not less than 600 mm above the upper floor surface. The spandrel must have a Fire Resistance Level of 60/60/60, which in most cases is the requirement of the external wall.

Alternatively, horizontal construction projecting at least 1,100 mm from the external face of the wall and extending not less than 450 mm beyond the opening, either side of the wall, is required. Again the construction must have an Fire Resistance Levels of 60/60/60.

Details showing how to construct the two options in timber-framed construction are given in this Guide under Section 5.7.

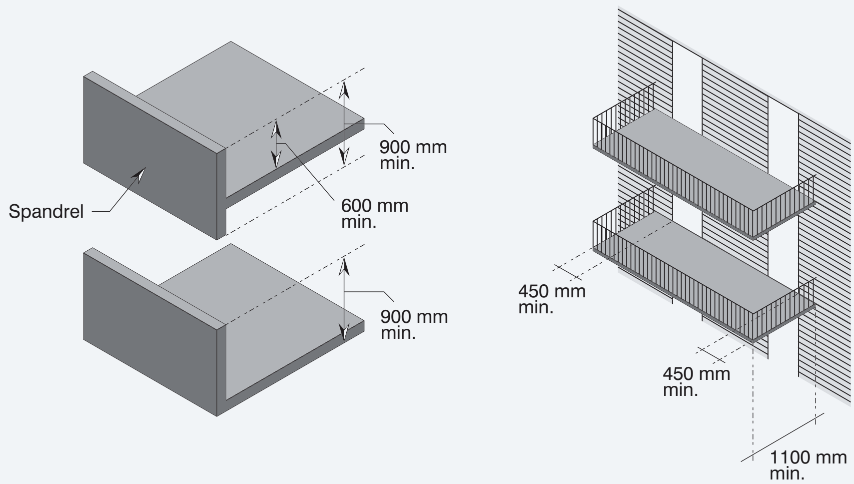


Figure 15: Required dimensions for spandrel panels.

Refer to: BCA D1.3.

4.4.5 Fire- and Non-Fire-Isolated Stairs

Non-fire-isolated stairs are required for the following building classifications:

- Class 2, Type A, B and C – where not more than three consecutive storeys are connected
- Class 3, Type C – where not more than two consecutive storeys are connected.
- Class 9c, Type C – where not more than two consecutive storeys are connected.

One extra storey is allowed for Class 2 and 3 if the extra storey is for use as a garage or has complying sprinklers installed or the egress or access is separated from the extra storey by fire-rated construction applicable for the construction type.

Section 5.6 shows how to ensure penetrations don't compromise fire-rated walls.

As this Guide addresses only BCA Deemed to Satisfy categories of buildings and 'rise in storeys' where timber framing can be used, and this range of buildings does not require Fire-Isolated Stairways and Ramps, construction information on Fire-isolated Stairways and Ramps is not addressed in this Guide.

For the range of 'building types' and 'rise in storey' this Guide considers, stairways or ramps that are required for egress and access to be Non-Fire-Isolated Stairways and Ramps. Stairs contained entirely within the Sole Occupancy Unit, or that do not form a part of the escape path for exiting a unit in an emergency, have no fire rating requirement. Details showing how to construct the Non-Fire-Isolated Stairways and ramps are shown later in this Guide under Section 5.8.

4.4.6 Services Penetrating Fire-Resistant Elements

Refer to: BCA Spec C3.15.

The BCA requires that where services such as pipes, ducts and electrical cables that penetrate a fire-rated wall, floor or ceiling, such penetration does not affect the performance of the building element.

Details showing how to meet this requirement are shown later in Section 5.6.

4.4.7 Lightweight Construction

Refer to: BCA Spec. C1.8.

The BCA requires elements that have a Fire Resistance Levels, 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 and plasterboard. Specification C1.8 is a structural test for lightweight construction, and in most parts is directly related to the performance of the linings used. Manufacturers of lining material should be able to provide appropriate information on compliance to this requirement.

4.5 The Next Step

Having used this information to obtain a strong understanding of fire-resistant construction, the next step is to go to Step 5 – Selecting Timber-Framed Construction that will comply with minimum BCA fire-resisting construction requirements.

5

Step 5 – Select Sound- and Fire-Rated Timber Construction Systems

This Step focuses on matching Deemed to Satisfy sound-insulation levels ($R_W + C_{tr}$, $L_{n,w} + C_I$), Fire Resistance Levels (FRLs) and other necessary requirements with appropriate timber-framed construction. The commentary begins by explaining key principles used in timber-framed construction to address sound insulation and fire safety needs. These principles are then presented in the form of integrated systems, e.g. timber-framed wall, floor and ceiling systems. Importantly, construction details are provided for each system in terms of fire/sound rated junctions between elements, penetrations in elements, stair construction details, treatment of service shafts, balconies and similar situations.

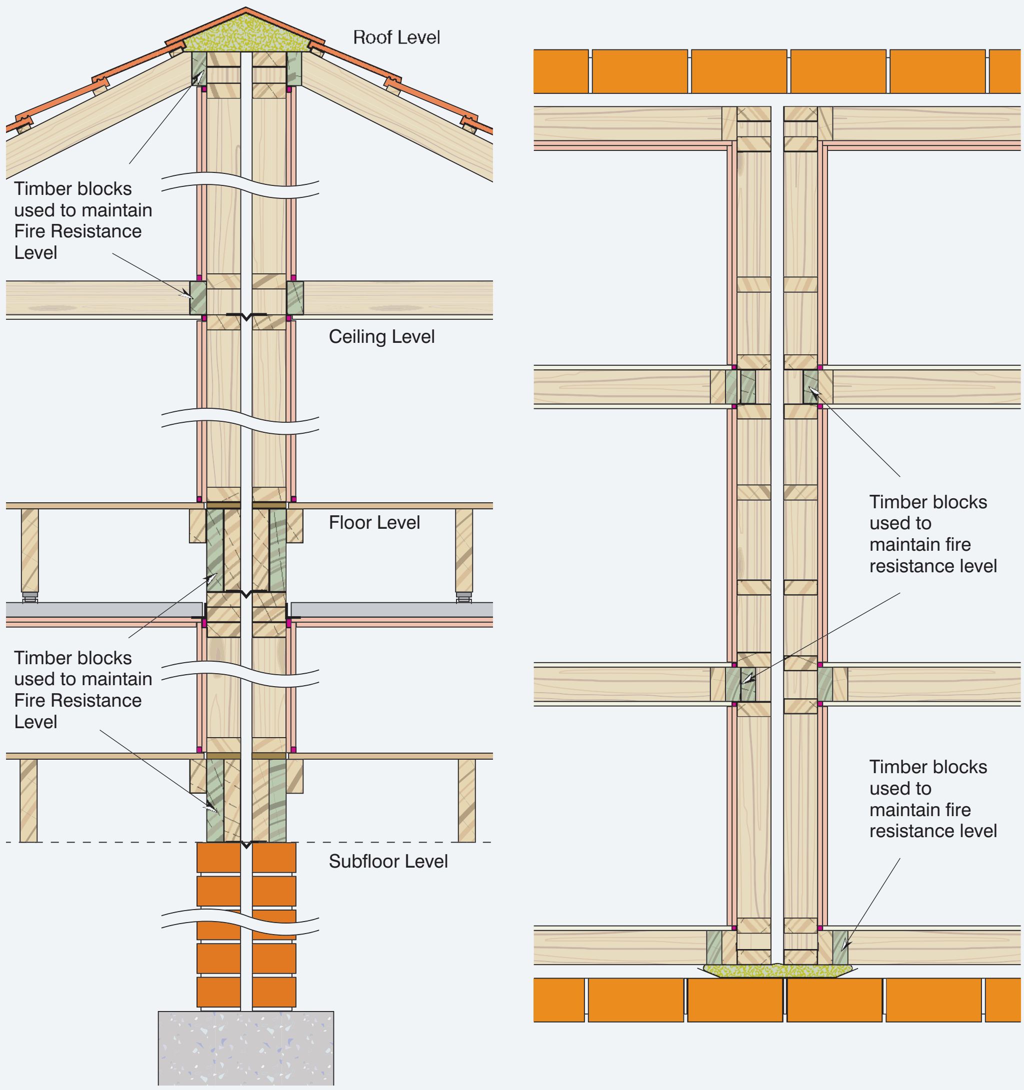
5.1 Principles for Achieving Fire Resistance Levels in Timber-Framed Construction

Fire-grade linings (see Appendix D for definition) provide the primary source of protection to timber framing, and generally the greater the number of layers, the greater the resistance to fire. Additional measures, as discussed in the following paragraphs, are required at weak spots or breaks in the fire-grade linings that occur at intersections between wall, floor and ceiling elements. Corner laps and exposed edges in lining sheets present areas where attention is needed. Extra consideration is also needed at penetrations, openings and protrusions.

In some situations, solid timber can equate to fire-grade linings.

Due to the sequencing of trades in lightweight buildings, it is not always possible to provide complete covering with the fire-grade linings as framing elements often get in the way. Solid timber can be used as an equivalent to fire-grade linings in these situations and this is mainly used where linings stop at junctions between wall and/or floor elements. At these junctions, the width of the timber framework is unprotected by the linings and so extra studs, plates or joists are used to provide fire-resistance. This is possible because timber of a certain thickness forms an insulating char layer as it burns. This helps protect and slow the burning process for the remaining timber thickness. As a result, it is possible to predictably calculate and determine how long the timber joint will last in a fire. Though this varies according to timber density, in general, the more pieces of solid timber added to the joint, the longer the joint will last. For higher fire-resistance, the joint is reinforced with a light-gauge metal angle.

Common locations where solid-timber blocks are used include wall, floor, ceilings and roof junctions. Figure 16 shows generally locations where timber blocks can be used. It is important that the extra timber block should not also have a structural propose unless shown otherwise. If the element is required to support load then these timber blocks are in addition to timber work required for structural adequacy.



Elevation view ***Plan View***

Figure 16: Common locations where solid-timber blocks are used to maintain fire-resistance.

Fire stops are fire-grade materials used to close gaps in the construction that occur between fire-grade materials and at service penetrations. They restrict heat, smoke and gases from moving beyond a certain point in the construction. There are various situations where such gaps occur, and so various options can be used to act as fire stop materials, including:

- fire-resisting mineral wool (Figure 17); and
- fire-resisting sealant (Figure 18).

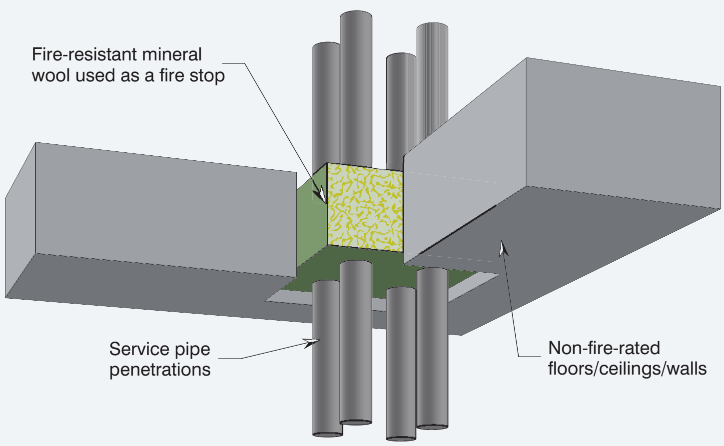


Figure 17: Fire-resistant mineral wool used as a fire stop.

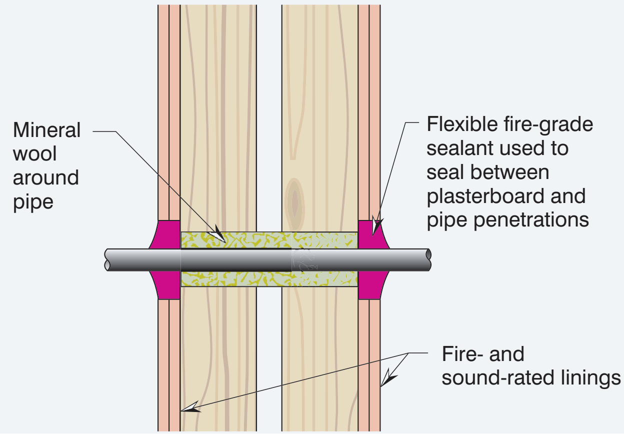


Figure 18: Fire-resistant sealant used to seal around pipe.

Though optional, cavity barriers offer many worthwhile benefits.

Cavity barriers help restrict the passage of heat, smoke and gasses where a cavity in the construction creates an unintentional passage for fire to bypass fire-rated wall or floor elements bounding Sole Occupancy Units. Cavity barriers are non-mandatory construction in so far as not directly achieving Fire Resistance Levels in wall, floor and ceiling elements. Even so, these barriers have a clear and worthwhile purpose as they also assist in reducing flanking noise as their position in wall cavities also reduces air borne noise travelling along these cavities.

Key locations are shown in Figure 19 and are described further below:

- Situation 1: A barrier is required where the cavity in a brick veneer wall creates the means for a fire to bypass the fire-resisting wall bounding a SOU, refer to Section 5.11 for construction information.
- Situation 2: A barrier is required where the cavity in a multi-storey wall creates the means for a fire to bypass the fire-resisting floor bounding a SOU, refer to Section 5.11 for construction information.

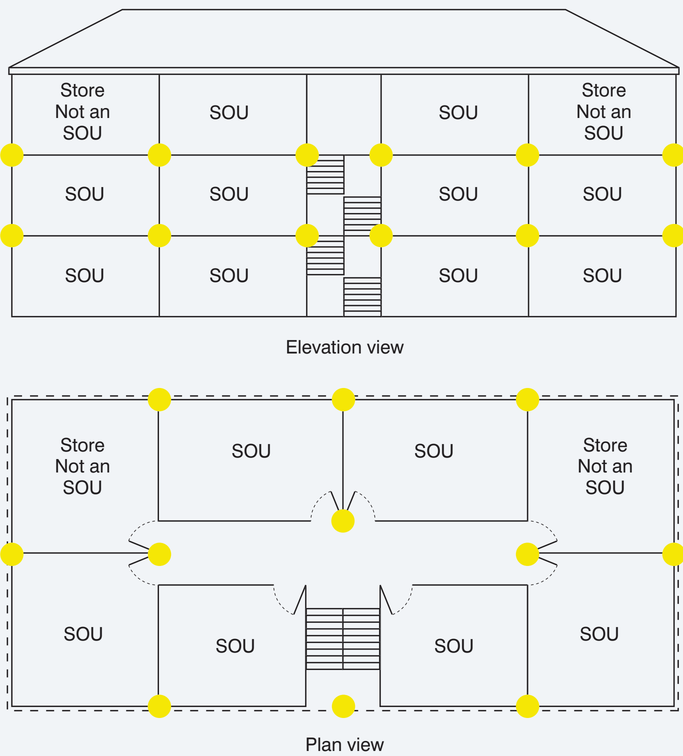


Figure 19: Key locations for cavity barriers.

5.2 Principles for Achieving Sound Insulation in Timber-Framed Construction

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

- **Increasing mass such as 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 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 changes in floor level.
- **Using absorptive materials to fill wall and floor cavities** (cellulose fibre, glass fibre or mineral wall) 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.
- **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 dealing with this is to batten out the wall (after fire/sound resisting linings have been applied) and then provide an additional lining over the top. 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.

Battening wet areas protects fire- and sound-rated walls from compromise due to bath and shower installation.

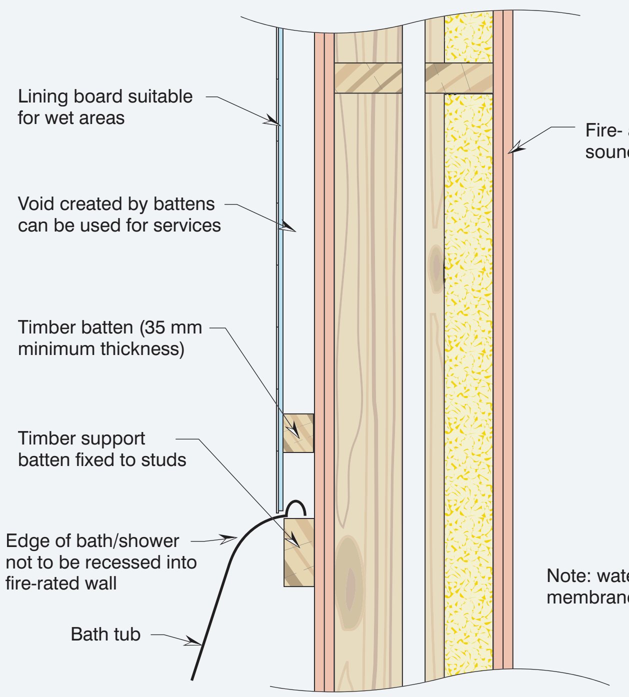


Figure 20: Batten detail for wet area walls – elevation view.

5.2.1 Floors 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 less (Figure 21).

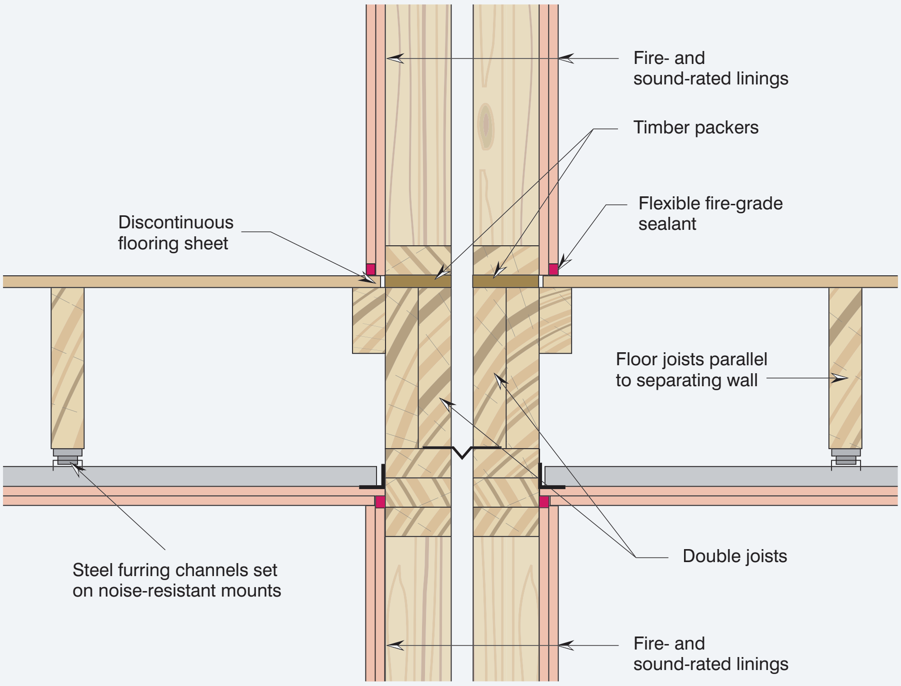


Figure 21: Joists running parallel to bounding wall – elevation view.

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

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. They typically force the sound energy through a rubber component which deforms slightly under load, as the sound passes from the joist to ceiling sheet. Therefore, sound-resilient mounts are not all the same, different systems have different performance and investigation is recommended (Figures 21 and 22).

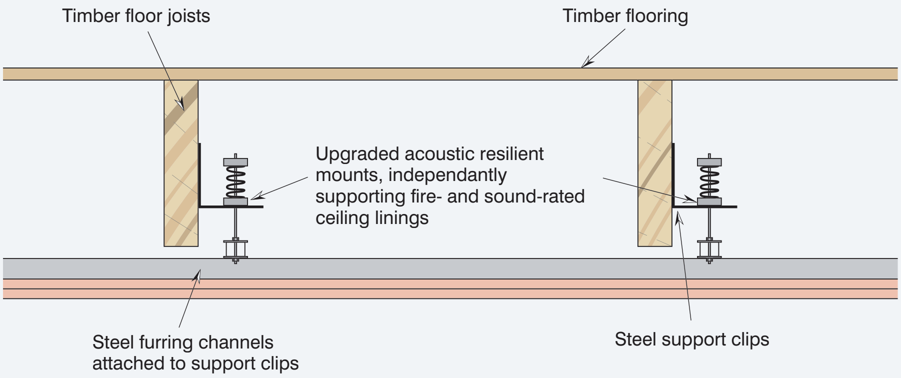


Figure 22: Upgraded sound-resilient ceiling mounts – elevation view.

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 BCA's sound requirements, and the additional floor mass is extra.

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

Few SOU residents would suspect sand in their timber floors.

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 to reduce the vibration and energy created by impact sound from footfall.

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 leveled just below the surface of the final floor sheet. The final floor sheet is fixed in the normal manner, and floor covering placed on this (Figure 23).

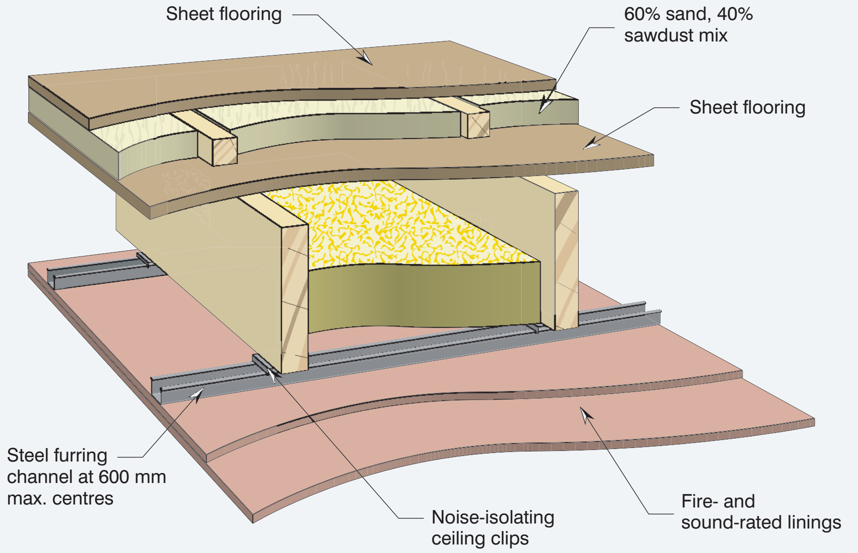


Figure 23: Adding mass to floor system through the use of sand top layer.

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-up the isolating acoustic mat at the perimeter of the topping adjacent to the wall, otherwise the affect of the topping is negated (Figure 24).

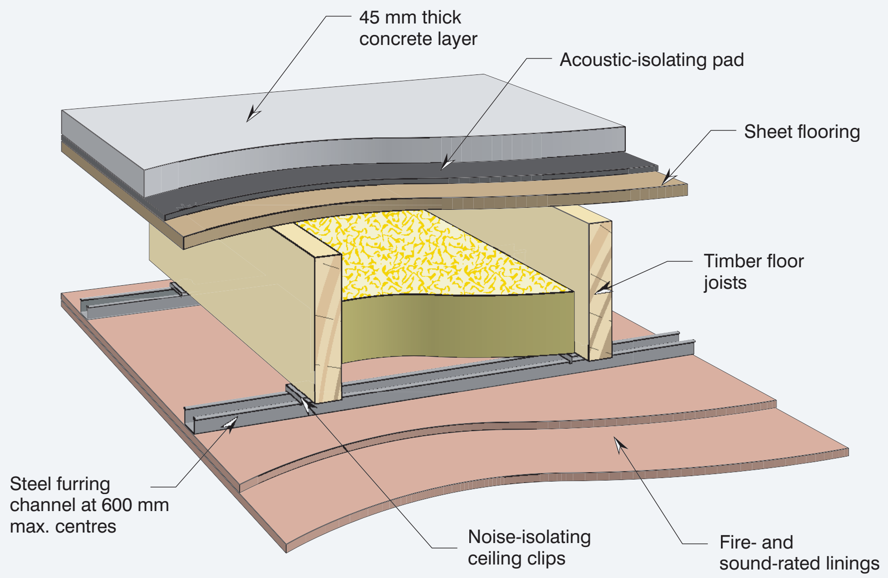


Figure 24: Adding mass to floor system through the use of concrete topping.

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 25).

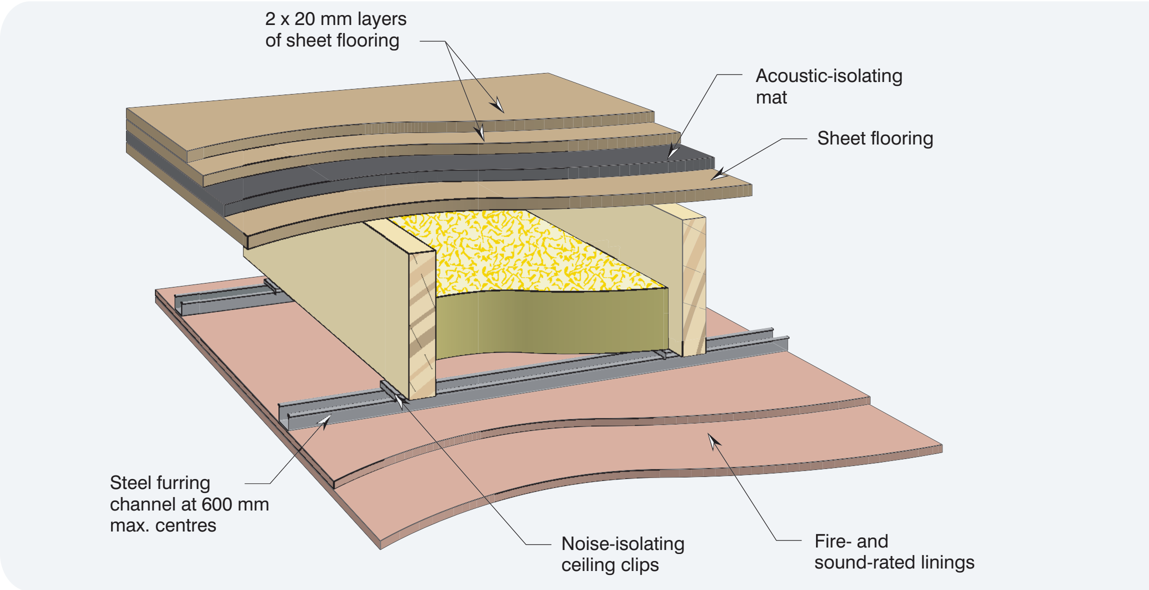


Figure 25: Adding mass to floor system through the use of additional floor sheets.

Separate floor and ceiling frame. By having two sets of joists (separate floor and ceiling joists) which 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. Even so, 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 isolating mat (Figure 26).

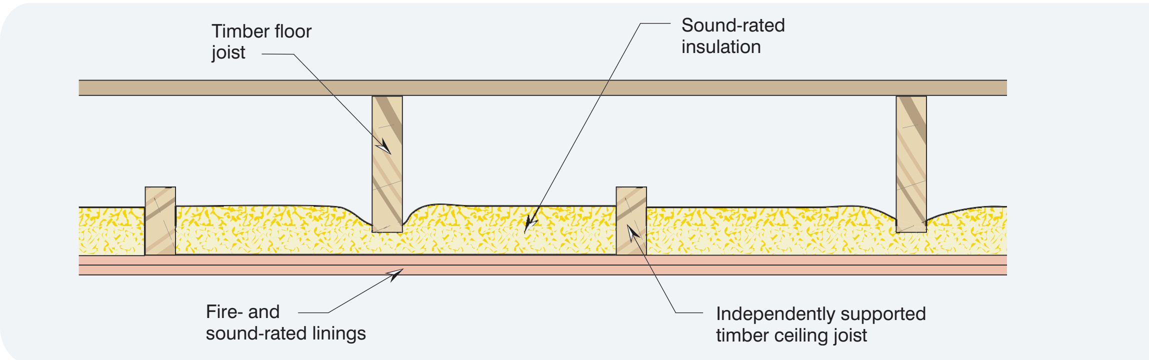


Figure 26: Separate ceiling and floor joist structures.

Stringers are an elegant way to isolate stairs from dividing walls (see next page).

Isolated support for stairs. Impact sound from stair usage typically vibrates its way into walls dividing SOUs, thus creating a greater likelihood of sound passing across the walls and into adjacent SOUs. The best way to prevent this is by isolating the support for the stair structure. Options include:

- Using the stringers to support the stairs (top and bottom) rather than the wall between dwellings (Figure 27).
- Using newell posts to support the stair structure rather than the wall between dwellings.

Stringers lift and separate!

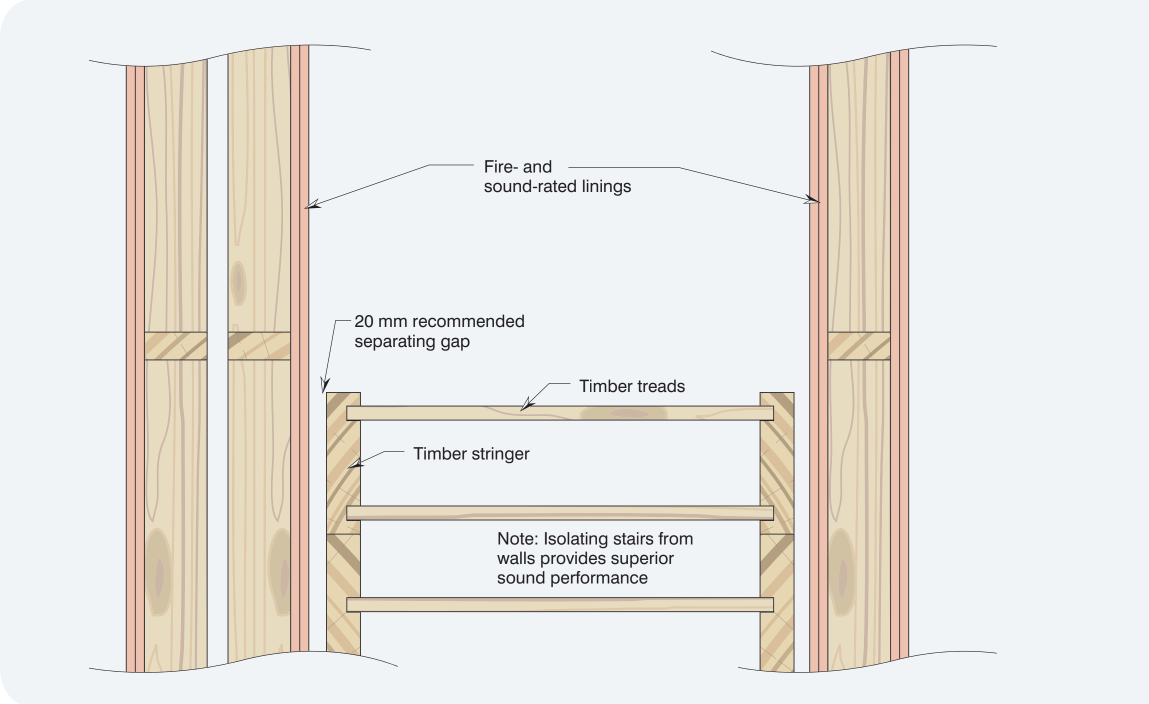
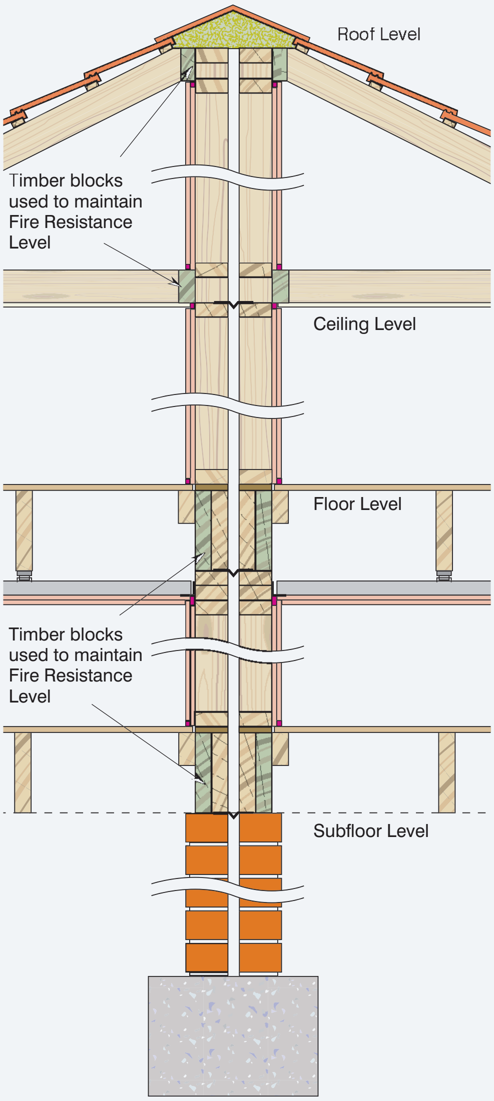


Figure 27: Isolated support for stairs – elevation view.

5.3 Sound- and Fire-Rated Wall Construction Systems

Timber framed construction can be described in terms of the systems as depicted by the main wall, floor and ceiling elements (Figure 28).



Elevation view

Figure 28: Main elements that make up a fire- and sound-rated timber-framed building.

As explained previously, all the elements shown in Figure 28 rely on multiple layers of linings to attain to fire-resistance and sound-insulation levels. Bulk insulation is also critical in the achievement of sound insulation. Further detail on each individual element in the system is discussed below.

Situation 1: Sound- and fire-resistant double stud wall (Figure 29) mainly used between Sole Occupancy Units (SOUs).

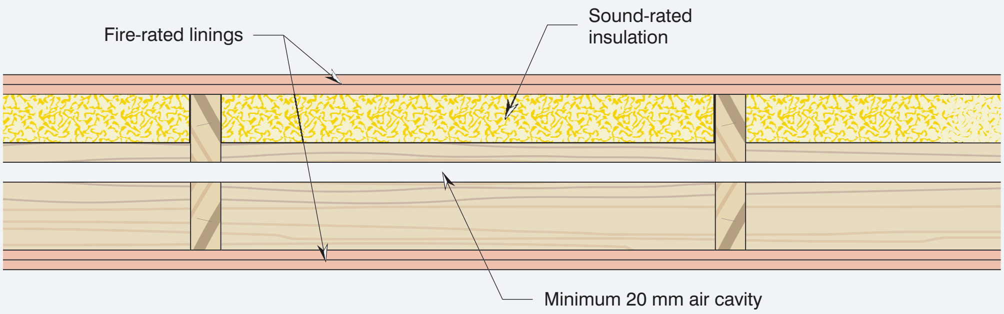


Figure 29: Fire- and sound-rated double stud timber wall – plan view.

Situation 2: Fire-resistant internal single stud wall (Figure 30) mainly used for supporting fire-rated floors.

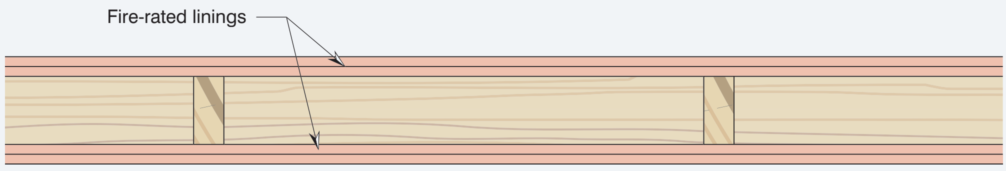


Figure 30: Fire-rated internal timber stud wall – plan view.

Situation 3: Fire-resistant external single stud clad wall (Figure 31) used where required to protect against an external fire source, using lightweight wall cladding.

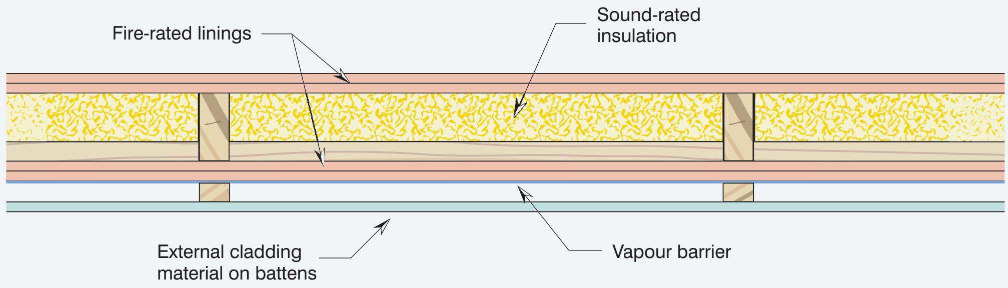


Figure 31: Fire-rated external timber stud wall – plan view.

Multiple layers + bulk insulation = good sound and fire performance.

Situation 4: Fire-resistant brick veneer external wall (Figure 32) used where required to protect against an external fire source.

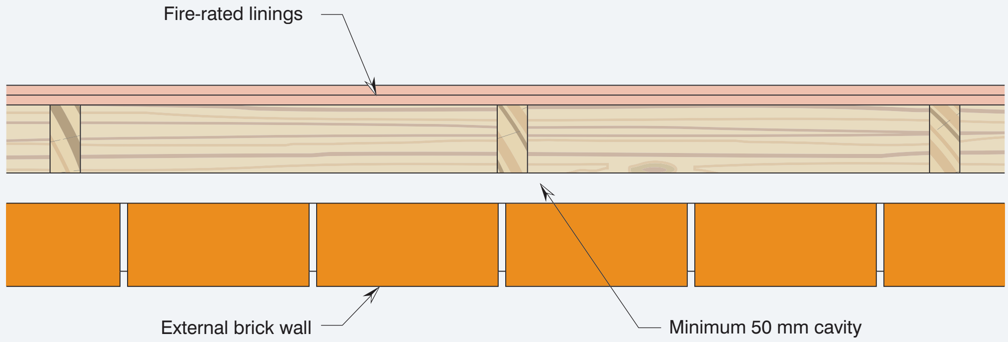


Figure 32: Fire-rated brick veneer wall – plan view.

Situation 5: Sound- and fire-resistant deep joisted floor (Figure 33) mainly used between SOUs stacked on top of each other.

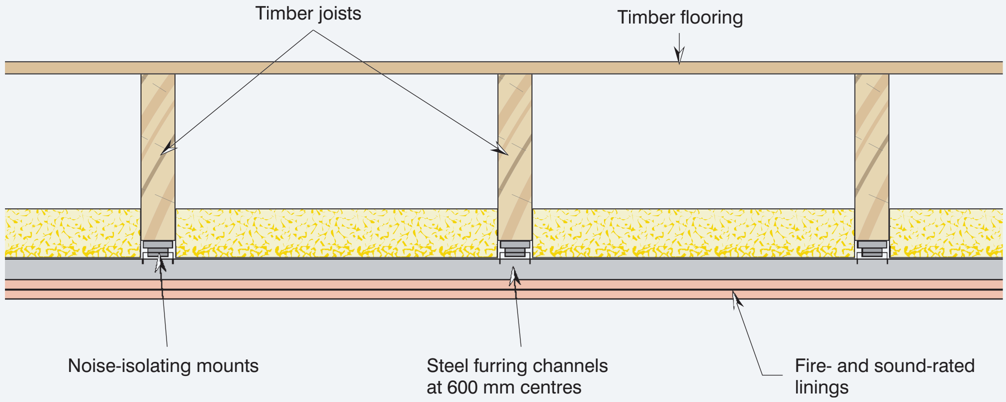


Figure 33: Fire- and sound-rated timber-framed floor – elevation view.

Situation 6: Smoke walls (Figure 34) mainly used for long public corridors in Class 2 & 3 buildings or walls bounding large open spaces in Class 9c buildings.

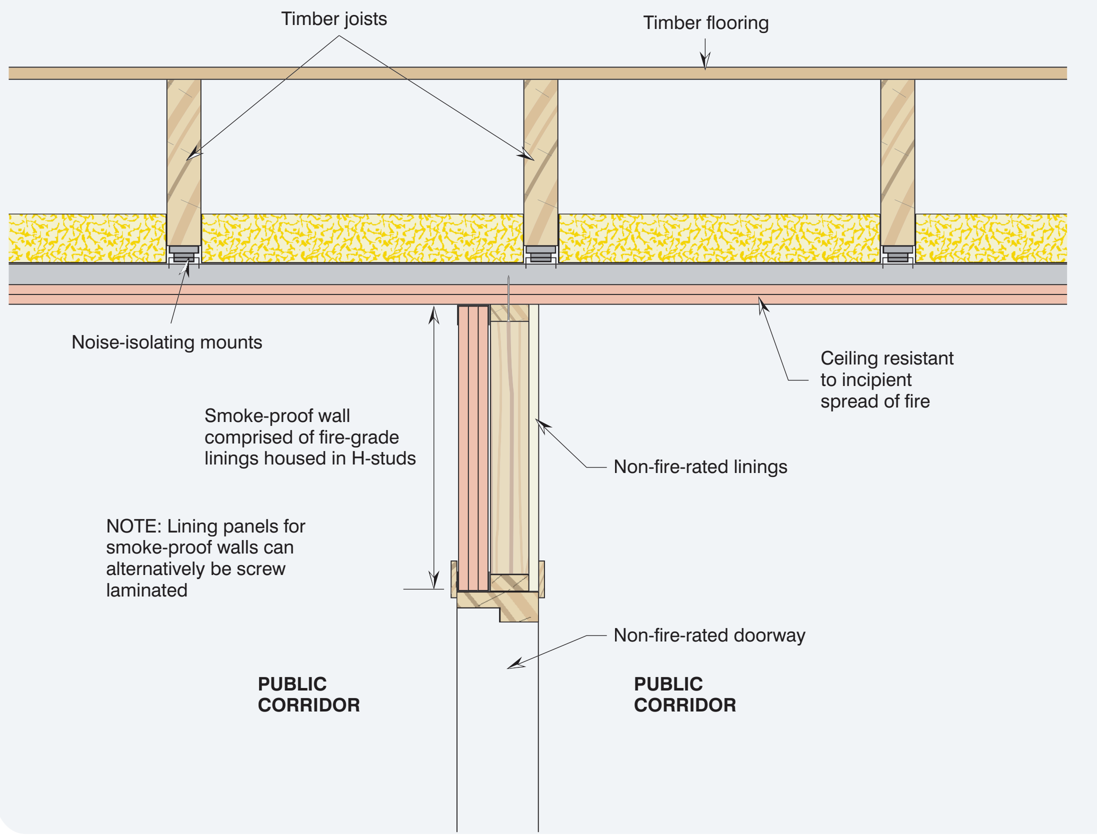


Figure 34: Smoke walls constructed out of fire-grade linings (only) – elevation view.

5.4 Construction Joints

Refer to: BCA C3.16.

'Gaps' in the system must perform as well as the system.

The BCA C3.16 requires construction joints, spaces and the like in between building elements required to be fire-resisting, to have the same Fire Resistance Level as the system it is in. These gaps often occur between fire-grade materials due to sequencing of trades as well as locations of service penetrations. A number of solutions are available, including:

- Fire-resisting mineral wool (Figure 35)
- Solid-timber blocking (Figure 35)
- Fire-grade sealant (Figure 36).

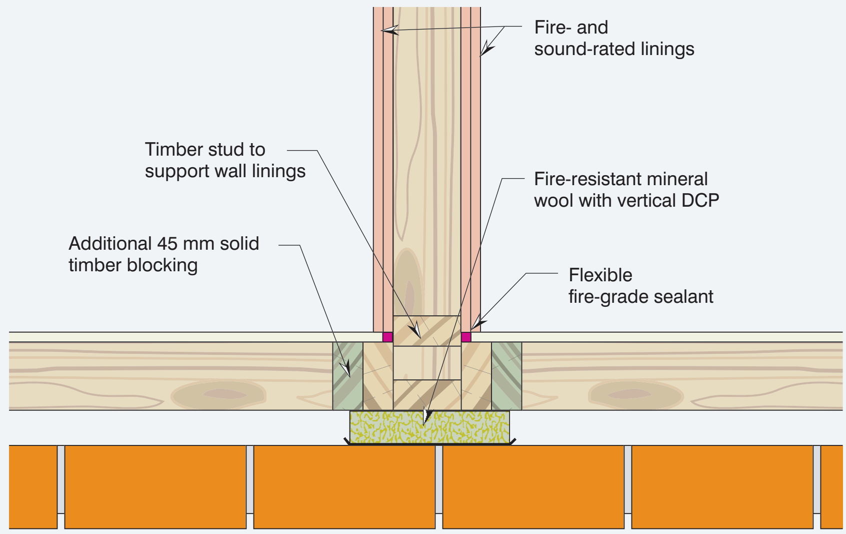


Figure 35: Fire-resistant mineral wool used to close a gap – plan view.

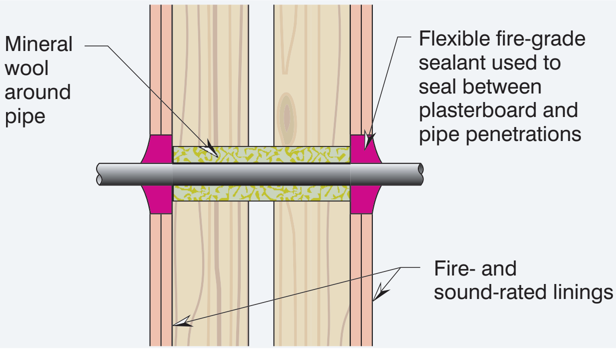


Figure 36: Fire-resistant sealant used to close a gap.

5.4.1 Solid Timber Construction Joints

By forming a char layer, some timber elements gain fire resistance as they burn.

Solid timber can be used as an equivalent to fire-grade linings mainly where linings stop at junctions between wall and/or floor elements. At these junctions, the width of the timber framework is unprotected by the linings and so extra studs, plates or joists are used to provide the required fire-resistance. This is possible because timber of a certain thickness forms an insulating char layer as it burns. This helps protect and slows the burning process for the remaining timber thickness. As a result, it is possible to predictably calculate and determine how long the timber joint will last in a fire. Though, this varies according to timber density and species, in general, the more pieces of solid timber added to the joint, the longer the joint will last. Refer to Figure 37 for a general illustration of a 60 minutes fire-resisting system. The example shown is a non-fire-rated wall abutting a fire-rated wall. Other applications are discussed later in the Guide.

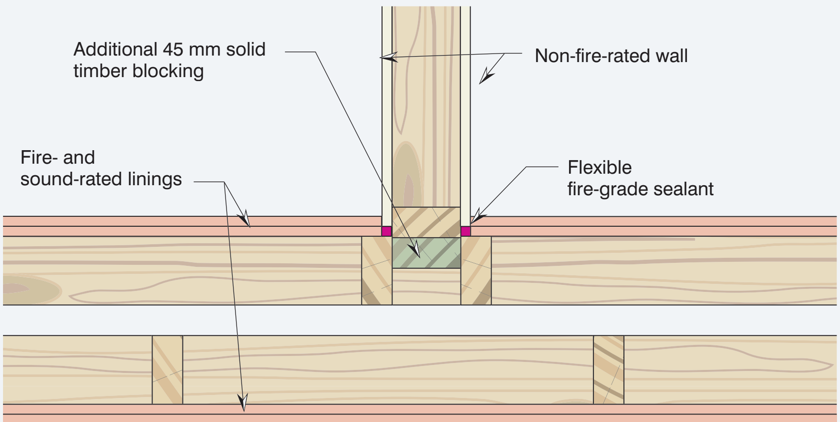


Figure 37: Non-fire-rated wall abutting 60 minute fire-rated walls using timber blocks – plan view.

For 90 minutes fire-resisting systems the fire-grade plasterboard adjacent to the timber blocks is required to be support by thin gauge metal angles, 35 x 35 x 0.7 mm BMT (Figure 38).

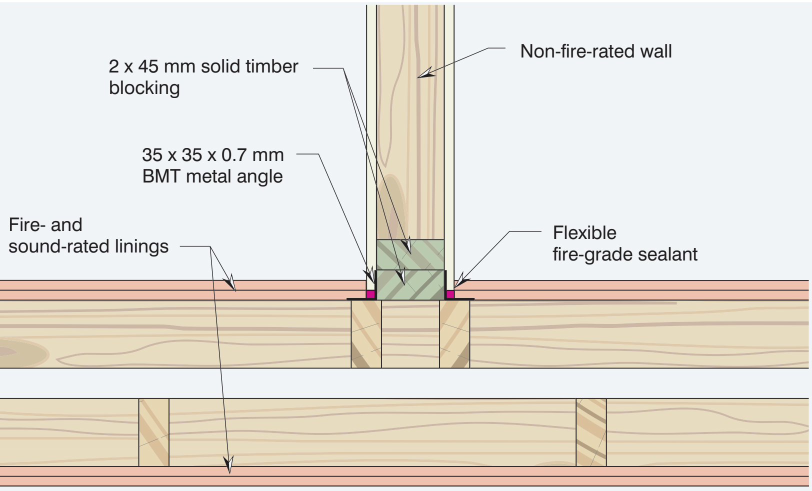


Figure 38: Timber sacrificial blocks used to close a gap for a 90 minute system – plan view.

The system is limited to fire-resistance of 90 minutes. Where fire-resistance greater than 90 minutes is required, continuous fire-rated linings through the wall junction is recommended.

5.4.2 Common Locations for Construction Joints

Due to the number of building classifications and types of construction covered by this Guide, there are a variety of situations when wall and floor elements may require the maintenance of the fire and sound rating. It can be simplified to the following three situations where:

- Non-fire-rated wall or floor element abuts a fire-rated wall or floor element, refer Section 5.4.3 in this Guide.
- Fire-rated walls and floor elements abut, both have Fire Resistance Levels but one is lower than the other, refer to Section 5.4.4 in this Guide.
- Fire-rated wall and floor elements abut but have the same Fire Resistance Level, refer to Section 5.4.5 in the Guide.

As explained in Section 5.1, solid timber is used as an equivalent to fire-grade linings, the more blocks the greater the Fire Resistance Level achieved. This is an important means of making fire-resisting joints between wall, floor and ceiling elements in timber-framed construction and is a principle that can be used for situations not covered by this Guide.

Such joints are generally only required where there is a break in the fire-grade lining and this generally excludes situations where two same Fire Resistance Level elements intersect. Instead, the emphasis is on junctions between non-fire-rated elements meeting fire-rated elements, or, lower fire-rated elements meeting more highly fire-rated elements. The systems described later do vary depending on the fire-resistance required. Generally this difference is that timber blocks alone only work for 60 minutes While 90 minutes system requires 2 x 45 mm thick timber blocks as well as reinforcing with a metal angle or flashing.

5.4.3 Junctions Between Non-Rated and Fire-Rated Elements

As previously mentioned, the fire-grade linings provide much of the fire resistance developed in timber-framed fire-rated building systems. Due to the construction sequencing of a typical timber-framed building the fire-grade linings are normally affixed well into the building's construction schedule. Therefore this leaves many possibilities for elements within a building to interfere with the placement of the fire-grade linings. Locations where this could occur are:

- Non-fire-rated walls abutting fire- and sound-rated walls, Section 5.4.3.1.
- Non-fire-rated walls abutting a fire-rated wall, Section 5.4.3.2.
- Non-fire-rated internal walls meeting a fire-rated ceiling or floor, Section 5.4.3.3.
- Roof framing elements supported off fire-rated walls, Section 5.4.3.4.
- Internal non-fire-rated floors abutting fire-rated walls, Section 5.4.3.5.

Non-Fire-Rated Walls Abutting Fire- and Sound-Rated Walls

There are two ways to provide fire safety (Figures 39 and 40). The system shown in Figure 39 is dependent on solid-timber blocks replacing the fire-resistant linings. The important point is that the addition of the timber blocks is supplementary to the framing required for structural purposes. This system is limited to FRL 60 minutes, and requires the addition of 1 x 45 mm block or 2 x 35 mm blocks.

While solid wood blocks can add fire safety, they must be supplementary to structural framing.

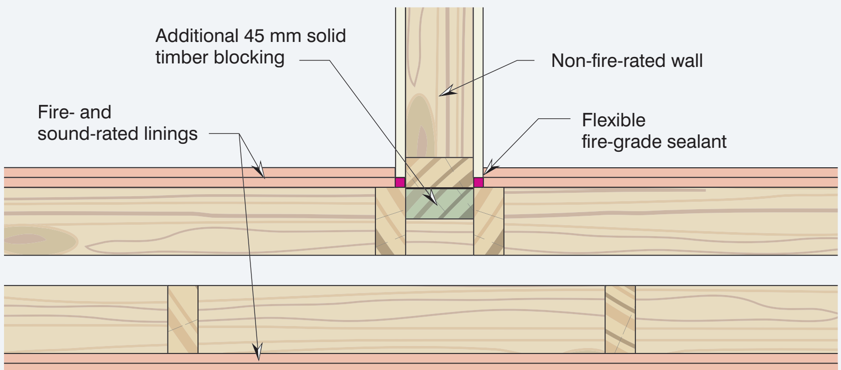


Figure 39: Non-fire-rated walls abutting fire- and sound-rated walls using timber blocks – FRL 60 minutes.

Light gauge metal angles do more than reinforce joints.

Systems with an FRL of 90 minutes require the use of 0.7 mm BMT light-gauge metal angle to reinforce the joint (Figure 40). This is in addition to the 2 x 45 mm solid-timber blocks which are also required.

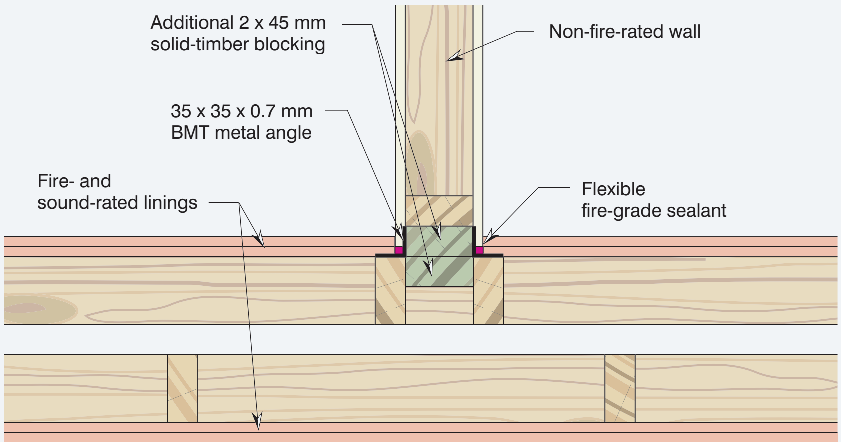


Figure 40: Non-rated wall abutting a fire- and sound-rated wall using metal angles – FRL 90 minutes – plan view.

Non-Fire-Rated Walls Abutting Fire-Rated Walls

This situation occurs normally within a unit or where there is no sound rating required. Again the principle is the same, where the fire-resistant linings cannot be placed, solid-timber blocks can substitute for the linings. The technique to deal with them is similar to section 5.4.3.1 (Figure 41). This system is limited to 60 minutes and requires 1 x 45 mm or 2 x 35 mm timber blocks.

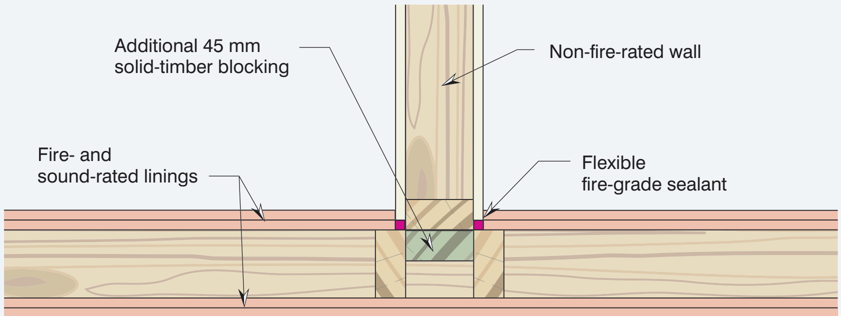


Figure 41: Non-rated wall abutting fire-rated wall using timber blocks – FRL 60 minutes – plan view.

Again for an FRL of 90 minutes, light gauge metal angles and 2 x 45 mm timber blocks are required (Figure 42).

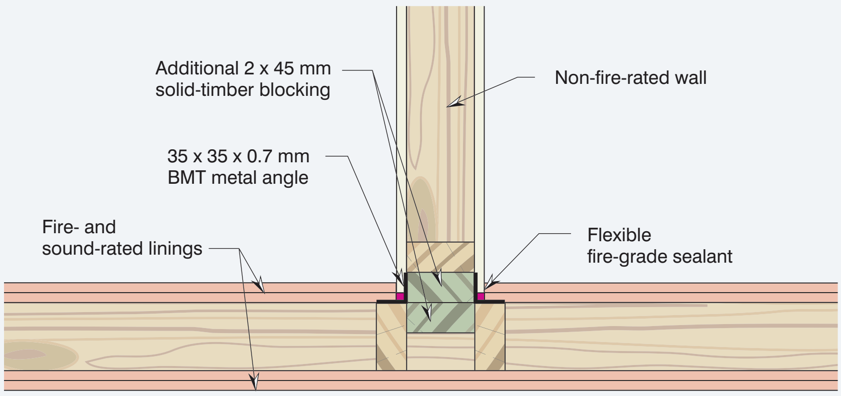


Figure 42: Non-rated wall abutting fire-rated wall using timber blocks and 35 mm metal angle – FRL 90 minute – plan view.

Non-Fire-Rated Internal Walls Meeting Fire-Rated Ceiling or Floor

Where internal non-loadbearing walls meet fire-rated floor/ceiling systems, timber blocks cannot be used to maintain fire-resistance as they interfere with the sound performance of the floor. The only solution available is to have continuous the ceiling linings (Figure 43).

This detail is also applicable for Resistant to the Incipient Spread of Fire ceilings, refer to Section 7.5.

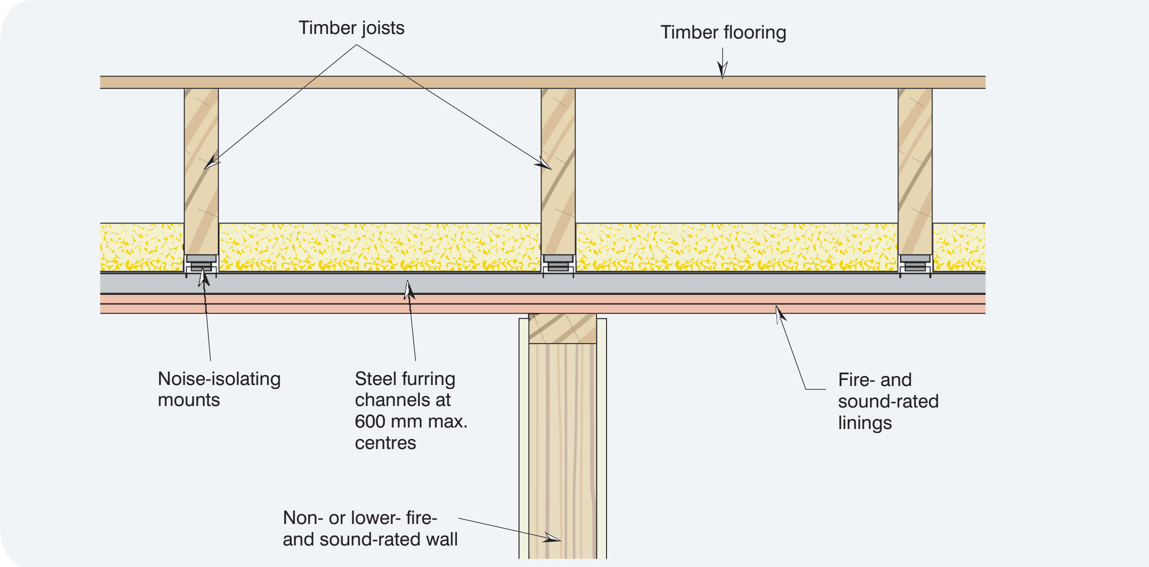


Figure 43: Internal non-rated wall intersecting a fire-rated floor/ceiling systems.

Mineral wool fills many needs and spaces.

Roof Framing Elements Supported Off Fire-Rated Walls

Where roof framing elements abut fire-rated walls, they create openings that can be sealed by the use of solid-timber blocks. Refer to Figures 44 and 47 for fire-resistance of 60 minutes and Figures 45 and 48 for fire-resistance of 90 minutes.

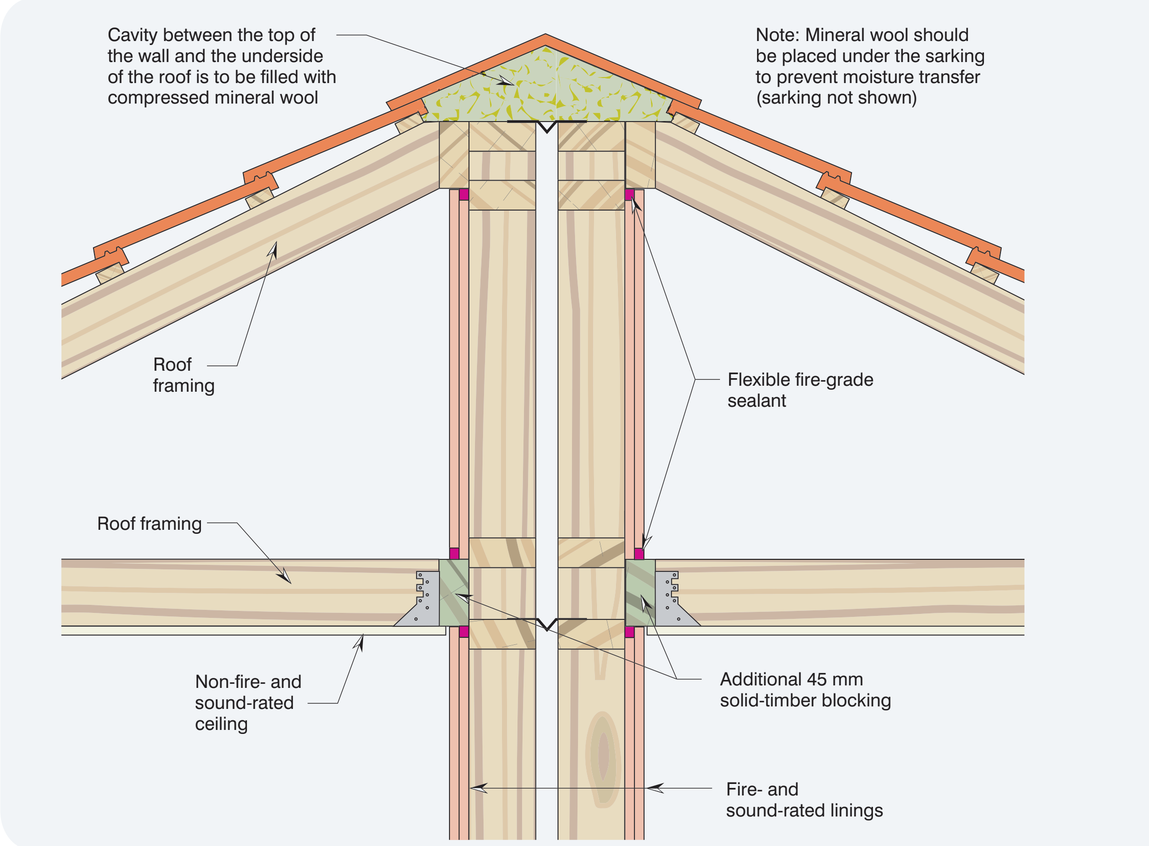


Figure 44: Timber blocks used to maintain fire-resistance – FRL 60 minutes in roof void – elevation view.

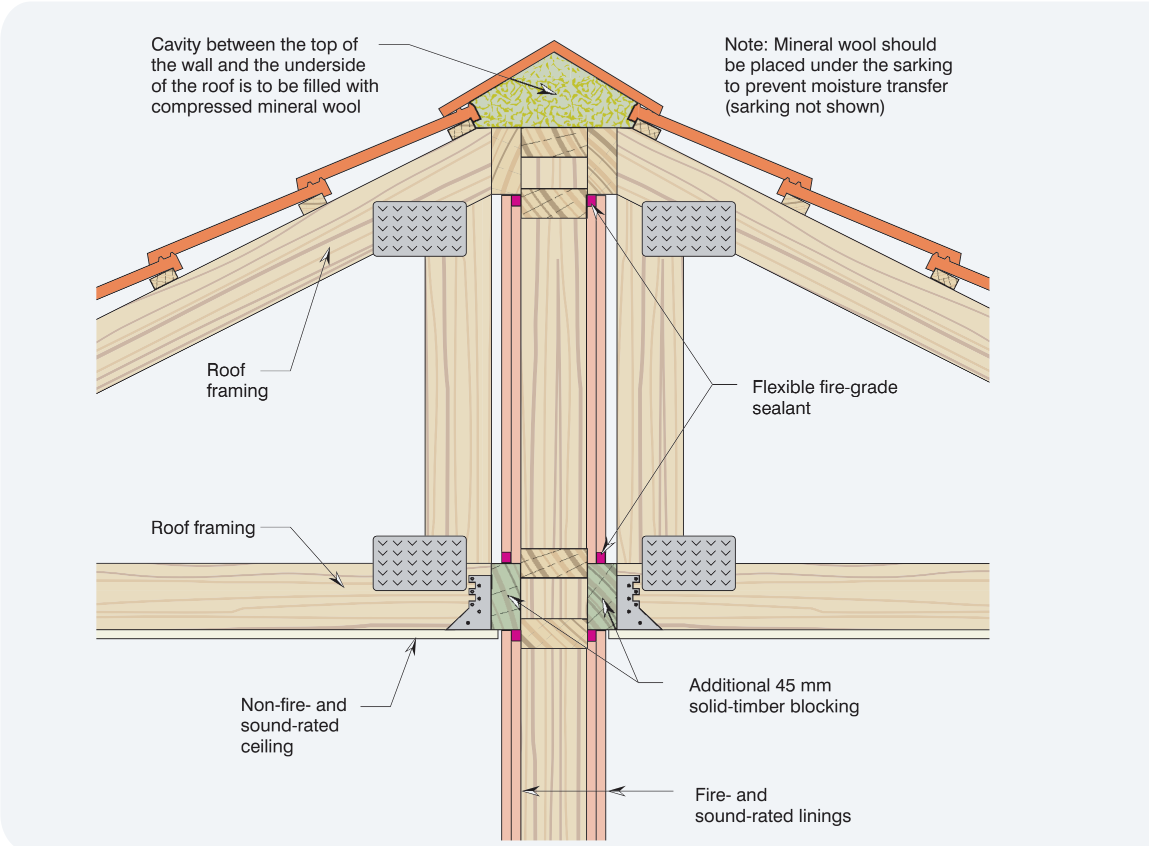


Figure 45: Timber blocks used to maintain fire-resistance – FRL 60 minutes in roof void – elevation view.

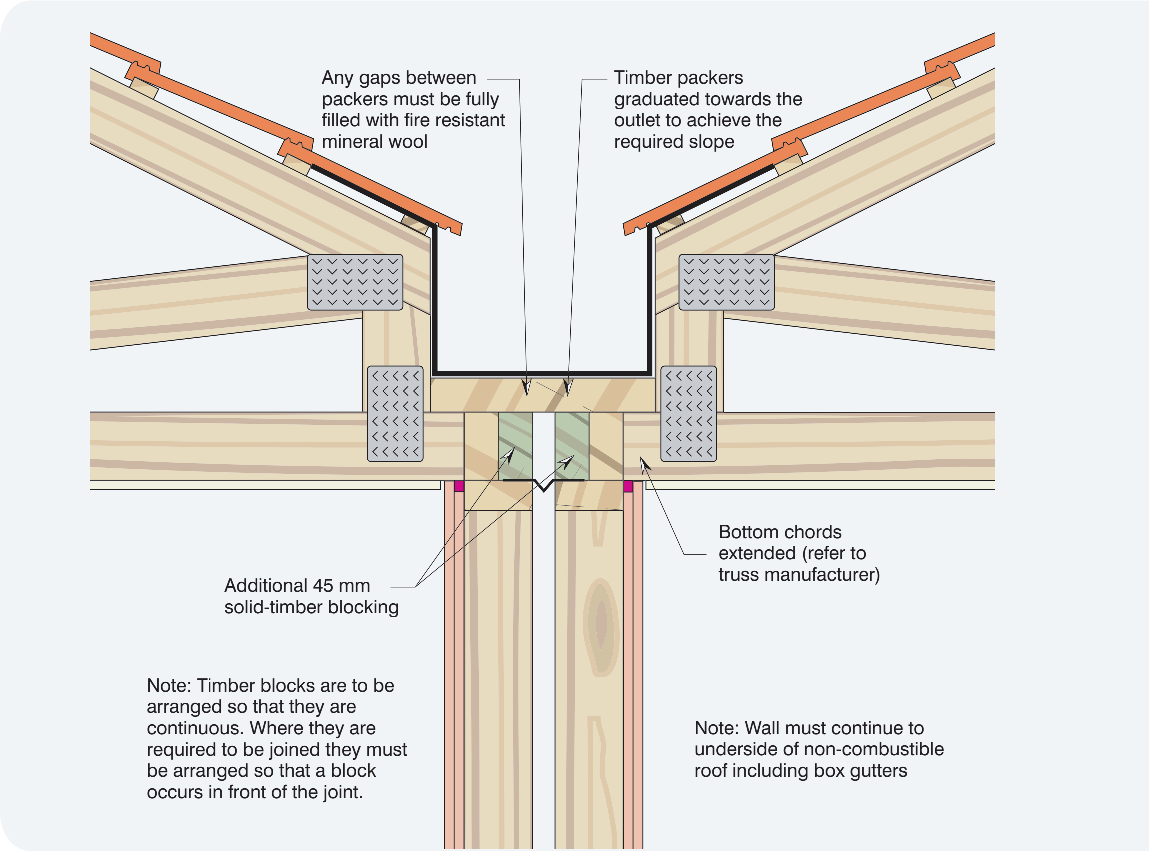


Figure 46: Timber blocks used to maintain fire-resistance – FRL 60 minutes under box gutter – elevation view.

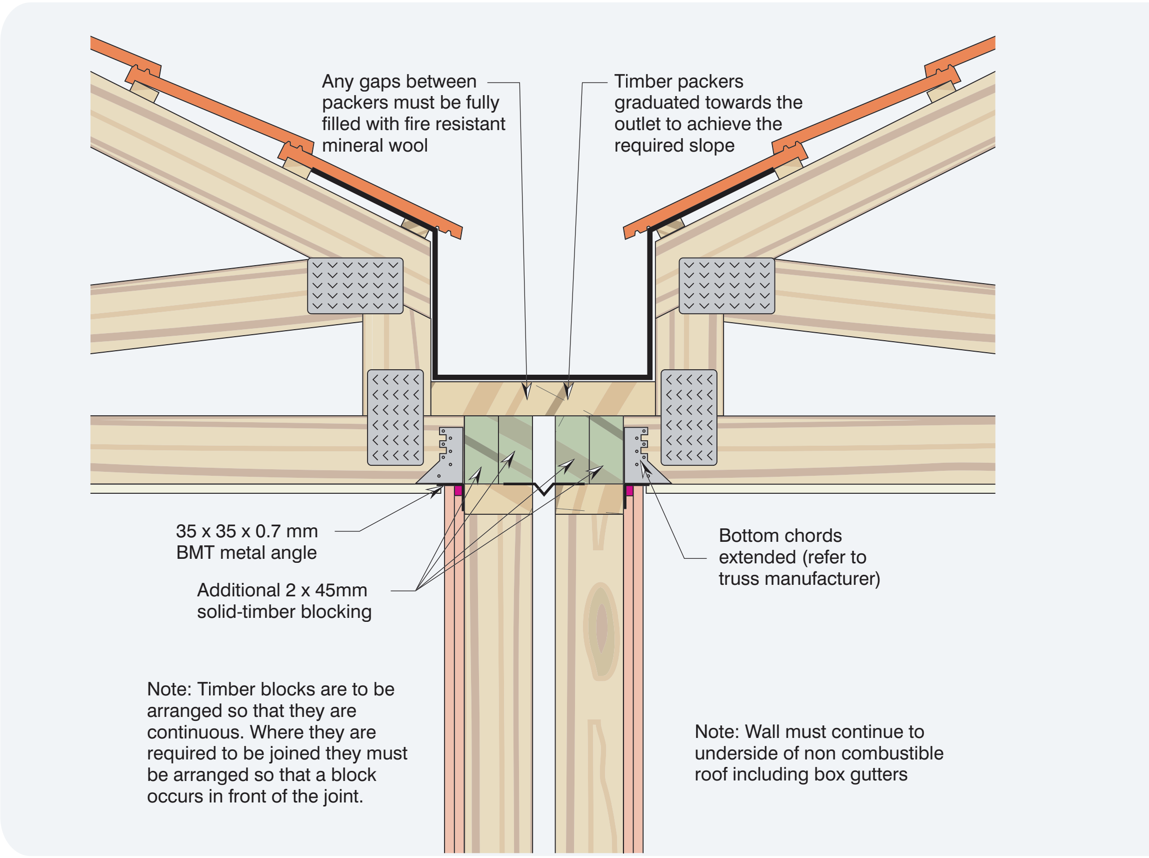


Figure 47: Timber blocks used to maintain fire-resistance – FRL 90 minutes under box gutter – elevation view.

Internal Non-Fire-Rated Floors Abutting Fire-Rated Walls

There are times when floors maybe abutting a fire-rated wall but are not fire rated, such as an internal floor to a unit, or for Type C construction, when a 'fire-protective covering' is used instead of a fire-rated floor. In these cases, the same principle is used, with timber blocks replacing fire-resistant linings, refer to Figures 48a, 48b and 49.

If fire strikes, collapsing floors must leave separating walls intact.

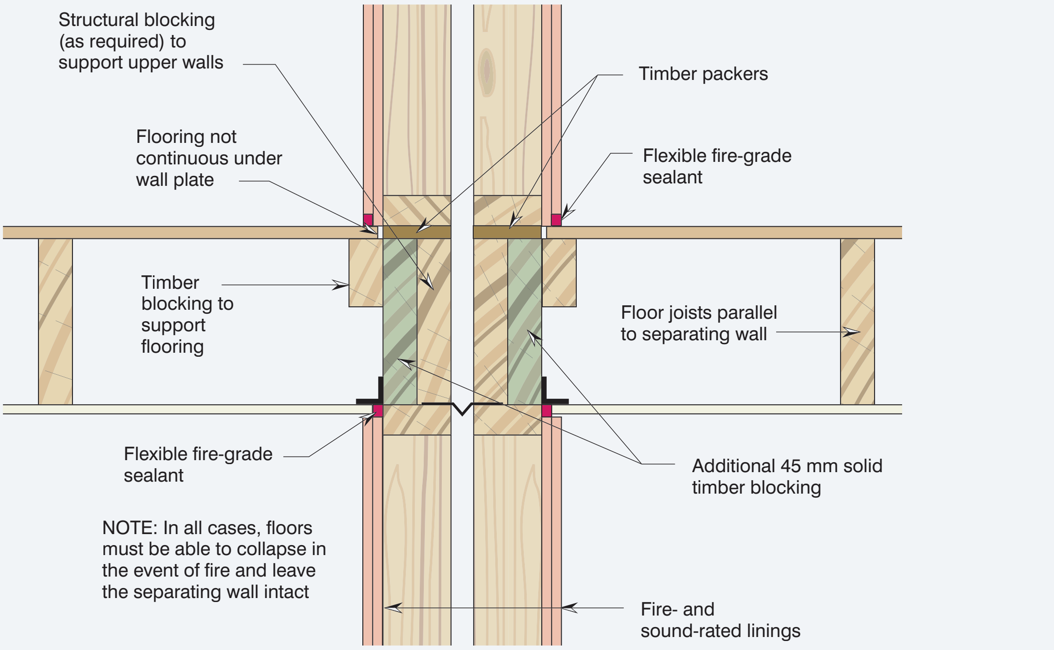


Figure 48a: Joist parallel to wall, wall stud not continuous through junction – FRL 60 minutes – elevation view.

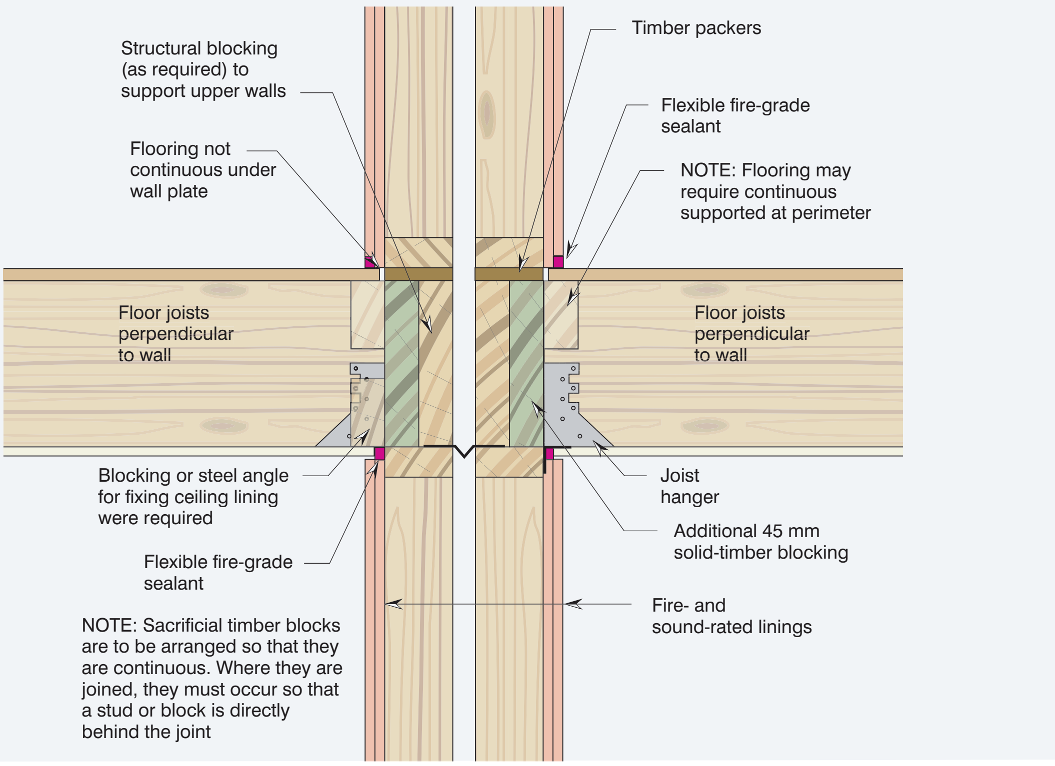


Figure 48b: Joist perpendicular to wall, wall stud not continuous through junction – FRL 60 minutes – elevation view.

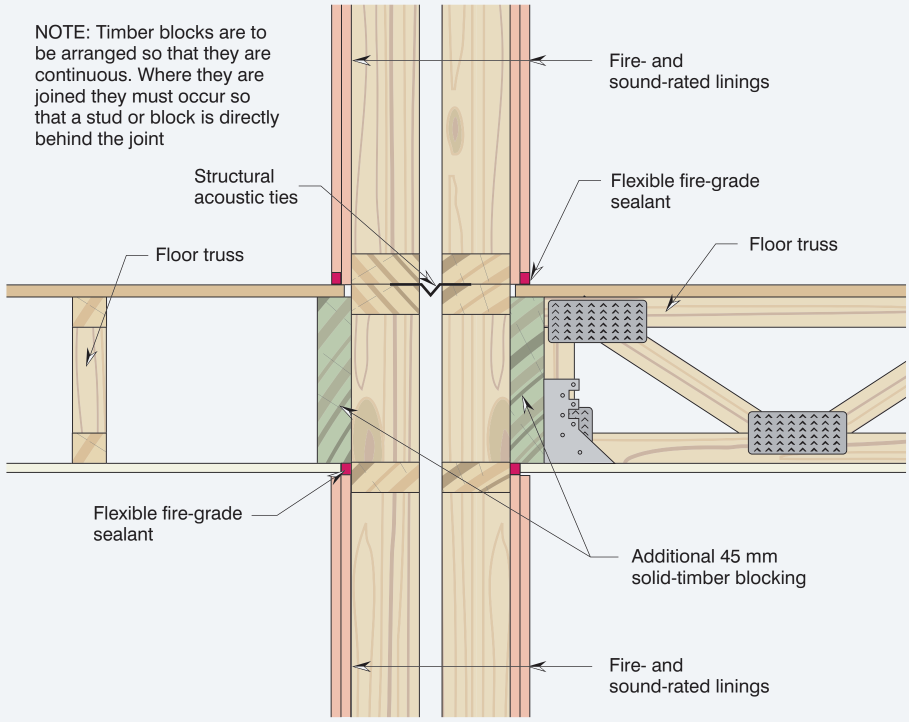


Figure 49: Joist parallel and perpendicular to wall, wall stud continuous through junction – FRL 60 minutes only – elevation view.

Fire Pockets in Fire-Rated Walls

Another method is to create pockets within the fire-rated wall that allow the joists to bear on the wall. This detail can be achieved by utilising similar techniques discussed previously for double joists. Solid-timber blocking, the same depth as the main joists, forms the inner of the two blocking joists. Where this blocking joist is required to be joined, it must be butted closely and the joint must be at least 100 mm from any pocket created.

Floor joists such as solid timber, I-beams or floor trusses, perpendicular to the wall, can be supported on the wall and in the pocket formed, with a minimum bearing depth of 35 mm. Additional solid-timber blocks, the same depth and thickness as the inner packing block, are to be tightly cut-in between the joist. The main floor joists are not to be nailed to blocking, and any locating nailing is to occur at the base of the joist into the lower wall plate only (Figure 50a and 50b).

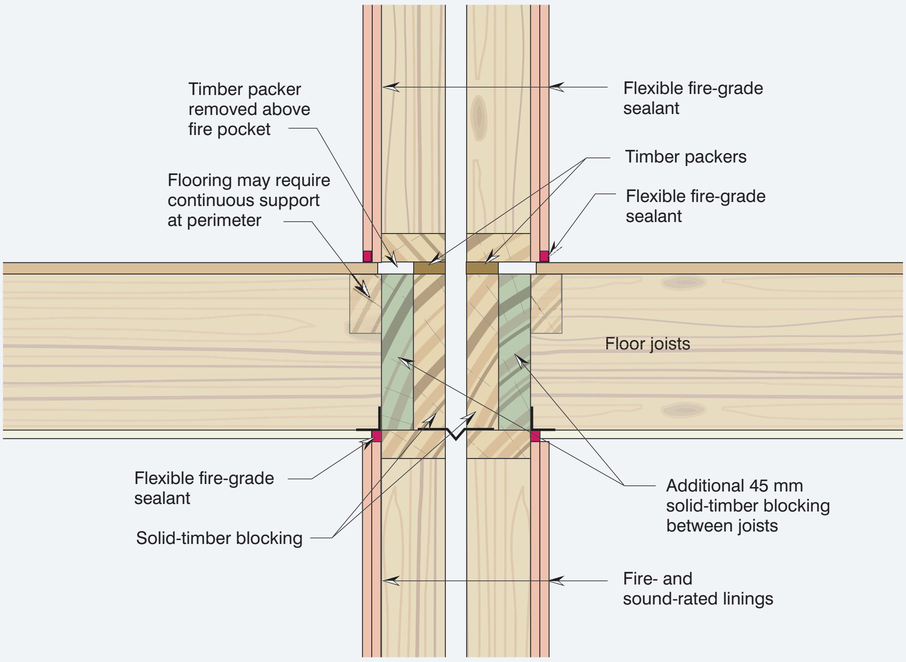


Figure 50a: Pockets created in separating wall to accommodate floor joists – FRL 60 minutes only – elevation view.

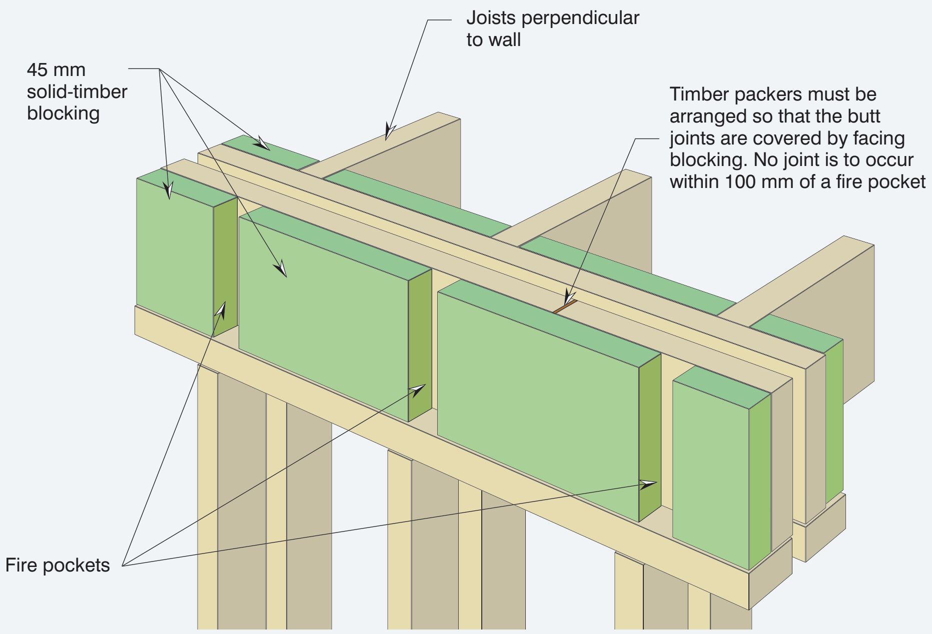


Figure 50b: Pockets created in separating wall to accommodate floor joists – FRL 60 minutes only – perspective view.

Top Chord Support Detail for Floor Trusses

Floor trusses are commonly used as floor joists. This form of floor joist has the unique ability to be supported by the top chord. A similar support mechanism as the pocket described above can be used. Here only the top chord needs to be located in a fire pocket. Refer to Figures 51 and 52 for two variations on the same solution for an FRL of 60 minutes.

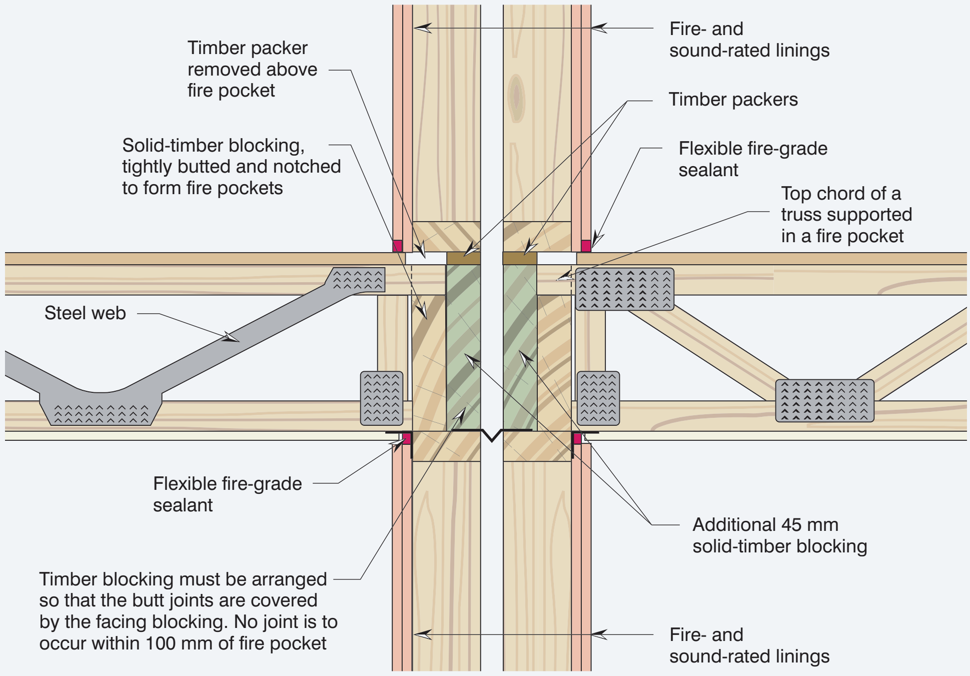


Figure 51a: Floor-truss top chord supported in pocket – FRL 60 minutes – elevation view.

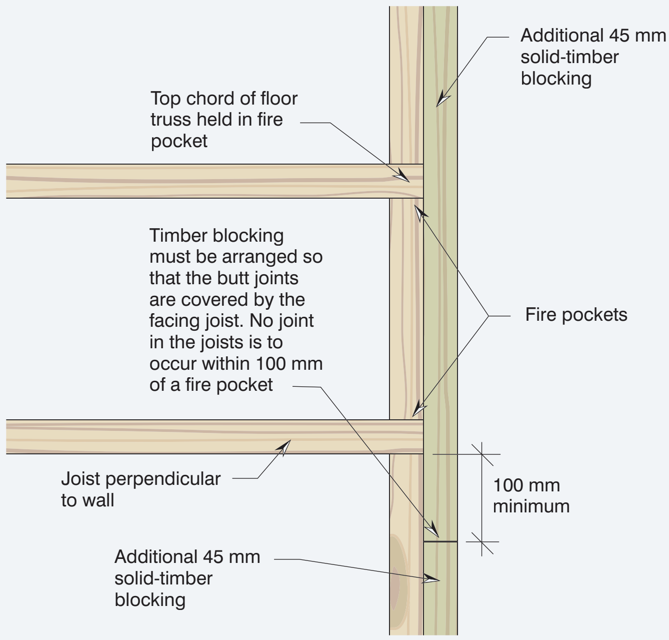


Figure 51b: Floor-truss top chord supported in pocket – FRL 60 minutes – plan view.

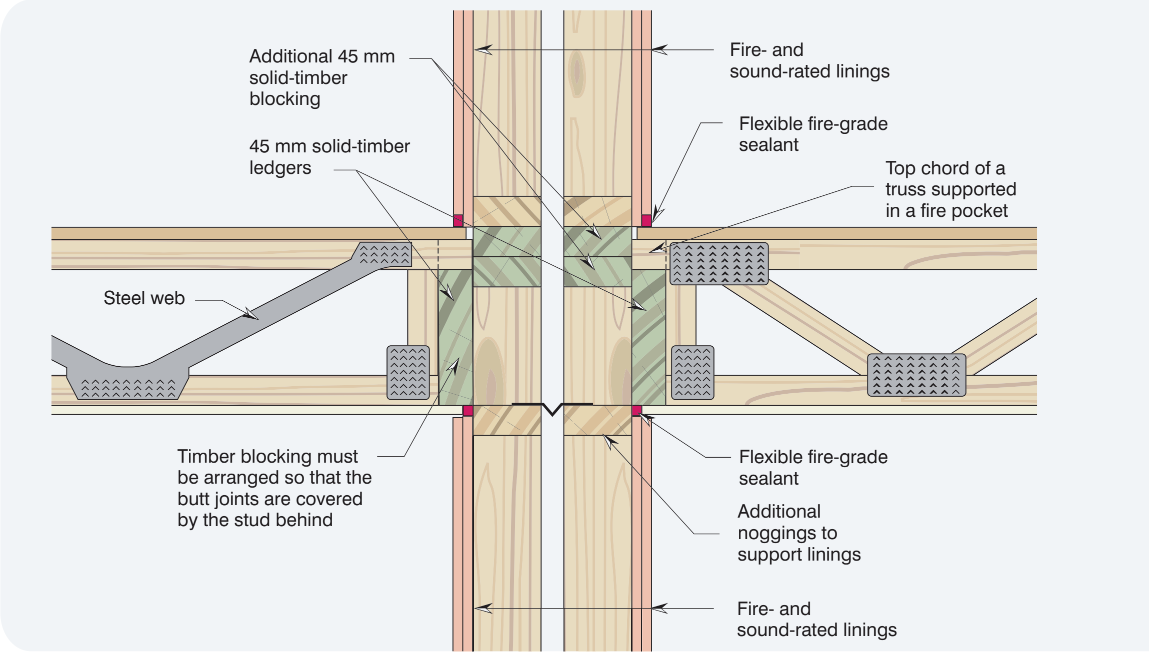


Figure 52: Alternative floor-truss top chord support – FRL 60 minutes – elevation view.

5.4.4 Junction Between Dissimilar Fire-Rated Elements

Fire can traverse higher-rated elements via lower-rated elements. The answer? Aim high.

There are many instances where lower-rated elements abut higher-rated elements, such as a non-loadbearing SOU bounding walls abutting loadbearing SOU bounding walls. The BCA allows different Fire Resistance Levels for these elements, and therefore, the lower-rated element may be a fire path through the higher-rated element.

The recommended way to treat this is to design both elements to the highest fire rating. This removes the need to use timber blocking. In most cases the sound performance requires more plasterboard sheets than is required for fire resistance, and making use of the lower rating may not necessarily provide project savings or the desired performance.

Where the occurrence of mismatched fire rated elements is unavoidable, the principles of sacrificial timber blocking discussed in Section 5.4.1 can be used. In this case, it is recommended to treat the lower fire-rated element as non-rated, and utilise timber blocks or timber blocks and angles as shown in this Guide.

5.4.5 Junction Between Elements with the Same Fire Ratings

When elements have the same fire-resistance, there is little required except to ensure that the fire-grade linings are supported and the board edges interweave with each other. Details for this are dependent on the lining material used, and reference to lining manufacturers is recommended. Typical junctions are shown in Figure 53.

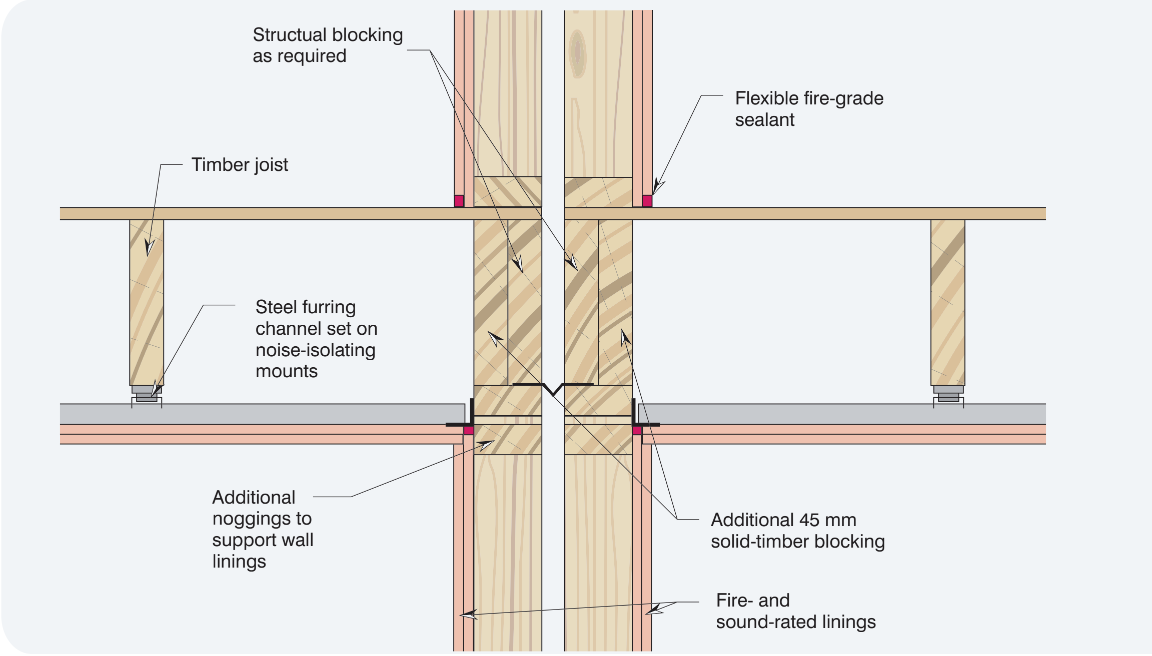


Figure 53a: Typical junction of elements with the same FRL – fire-rated floors abutting fire-rated walls – elevation view.

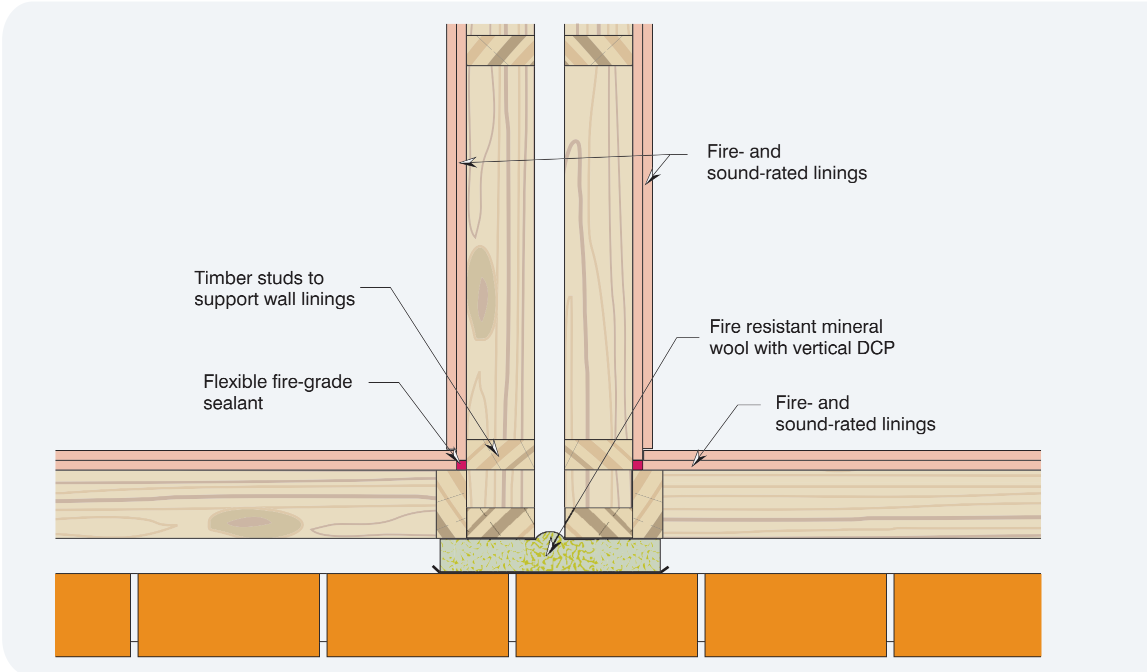


Figure 53b: Typical junction of elements with the same FRL – fire-rated bounding wall abutting fire-rated external wall – plan view.

5.5 Treatment of Roof/Ceiling and Eaves Voids

5.5.1 Roof and Ceiling Voids

The roof void must not let fire jump between SOUs.

In Class 2, 3 and 9c buildings there is the opportunity of fire and sound jumping from one SOU to another through the roof void. Timber-framed construction needs to prevent this happening. Three options exist, including:

- Continuation of the fire/sound wall through the roof void to the roof covering (Figure 54)
- Continuation of the fire/sound wall through the roof to a parapet wall (Figure 55)
- Stopping the flame passage at ceiling level using a Resistant to Incipient Spread of Fire ceiling (Figure 56).

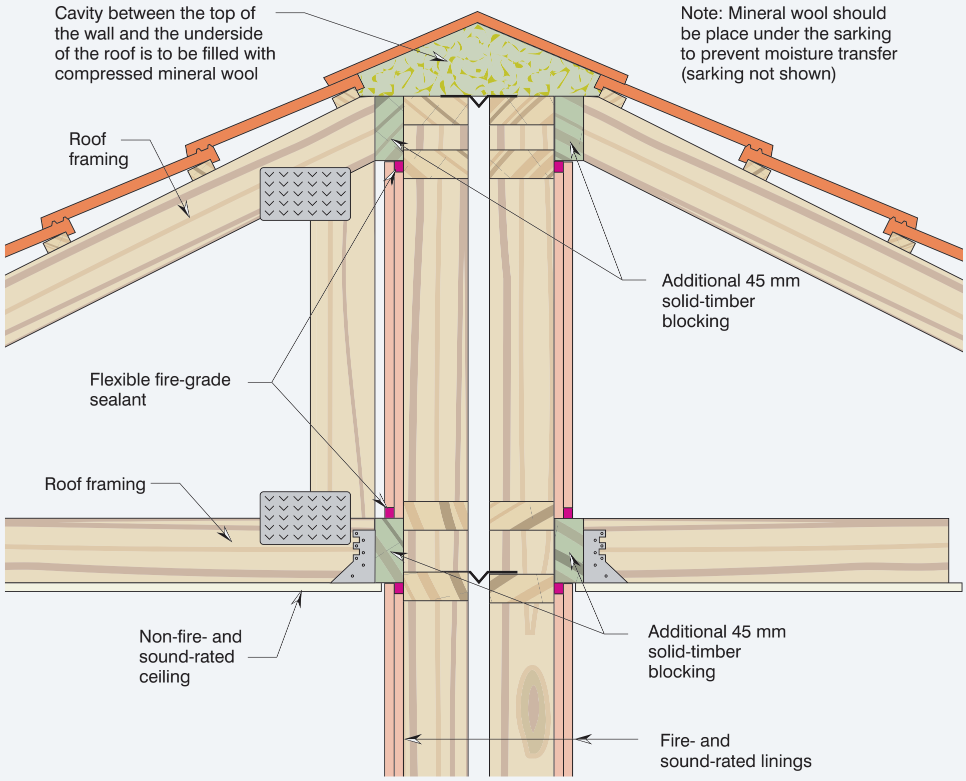


Figure 54: Fire- and sound-rated wall through to underside of roof – FRL 60 minutes – elevation view.

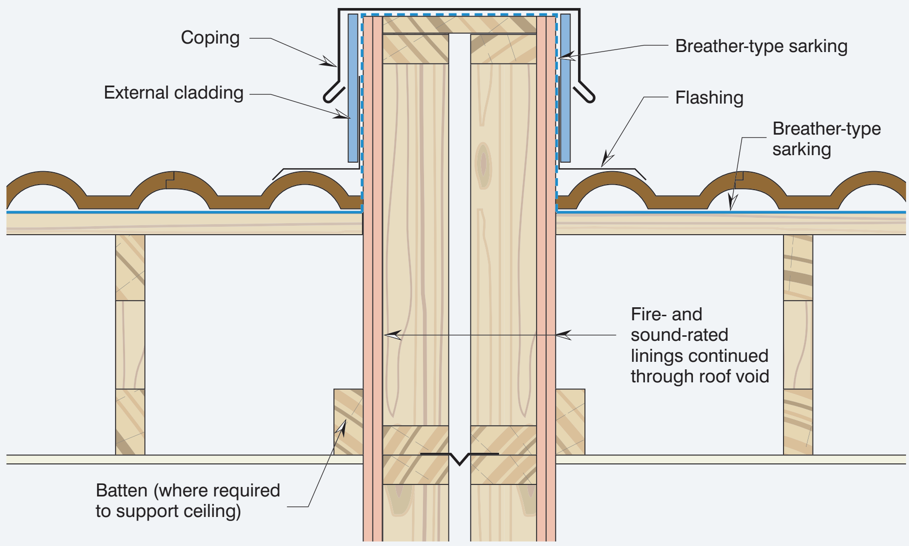


Figure 55: Double stud fire- and sound-rated wall in roof void to form parapet – FRL 60 minutes – elevation view.

5.5.2 Resistant to Incipient Spread of Fire Ceiling

This special ceiling is used directly below the roof framing instead of using bounding walls travelling to the underside of the roof. This ceiling is useful with complex roof framing elements, as the BCA does not allow any timber element to cross the bounding wall, except for 75 x 50 mm roof battens.

The ceiling is required to be continuous, and walls below this ceiling must affix to it. Timber block substitution is not allowed in this case (Figure 56).

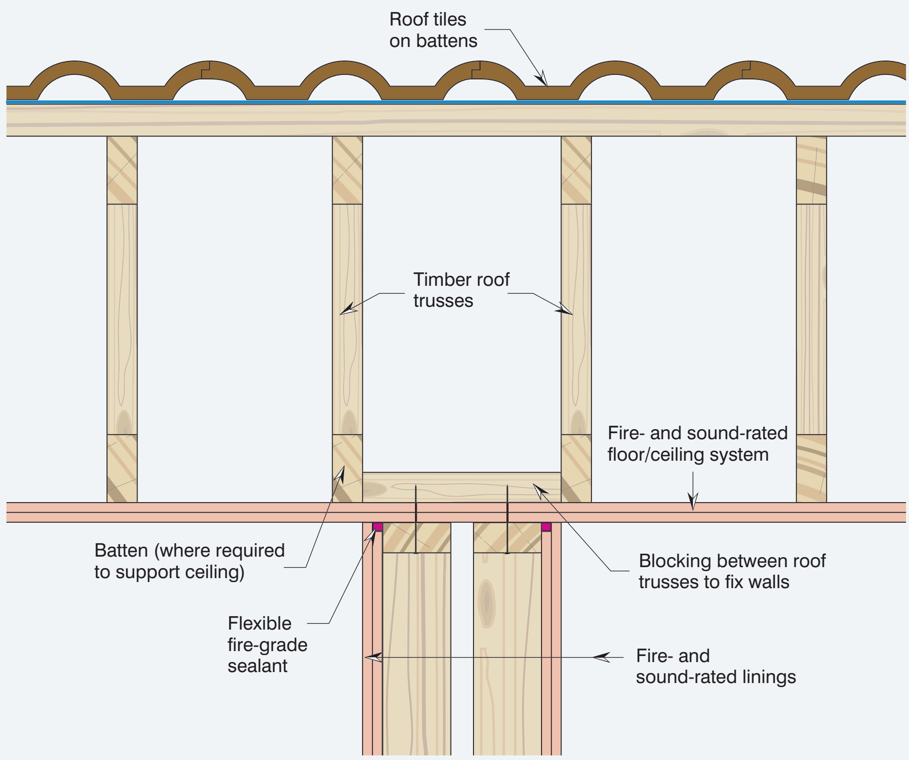


Figure 56: SOU wall abutting a Resistant to Incipient Spread of Fire ceiling.

5.5.3 Eaves Voids

In addition to the mandatory requirements, there is a non-mandatory but logical need to address the cavity created by a boxed eave (or similar) that creates the means for a fire to by-pass a fire-resisting wall bounding an SOU.

This situation often occurs when an external wall is not rated, nor has a rating less than the bounding walls of the SOU. In this case it is recommended that the eaves be blocked off to limit fire spread along this path. A construction detail to address this problem is shown in Figure 57. It is same approach to the requirement for Class 1 buildings for separating walls.

As they lack mandatory requirements, eaves require common sense handling.

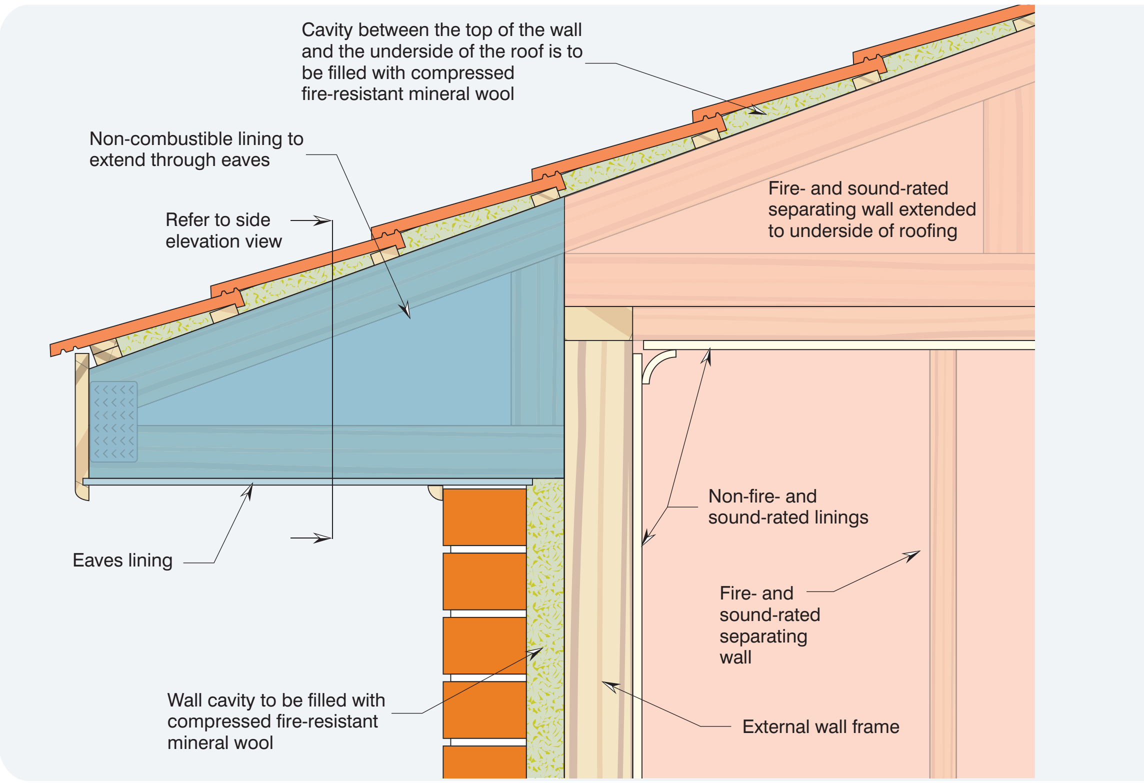


Figure 57a: Non-combustible linings blocking off eaves void – front elevation view.

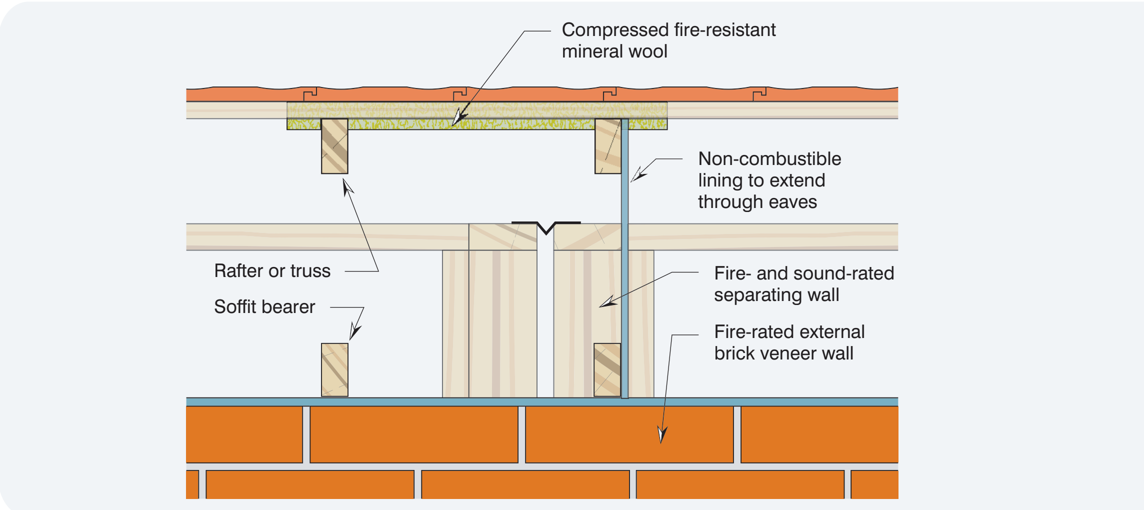


Figure 57b: Non-combustible linings blocking off eaves void – side elevation view.

5.6 Shafts and Service Penetrations

5.6.1 Fire-Rated Shafts

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 58). Care is required to ensure that the sound rating is achieved, as many wall systems are not adequate on their own.

Many wall systems can't handle shafts unaided.

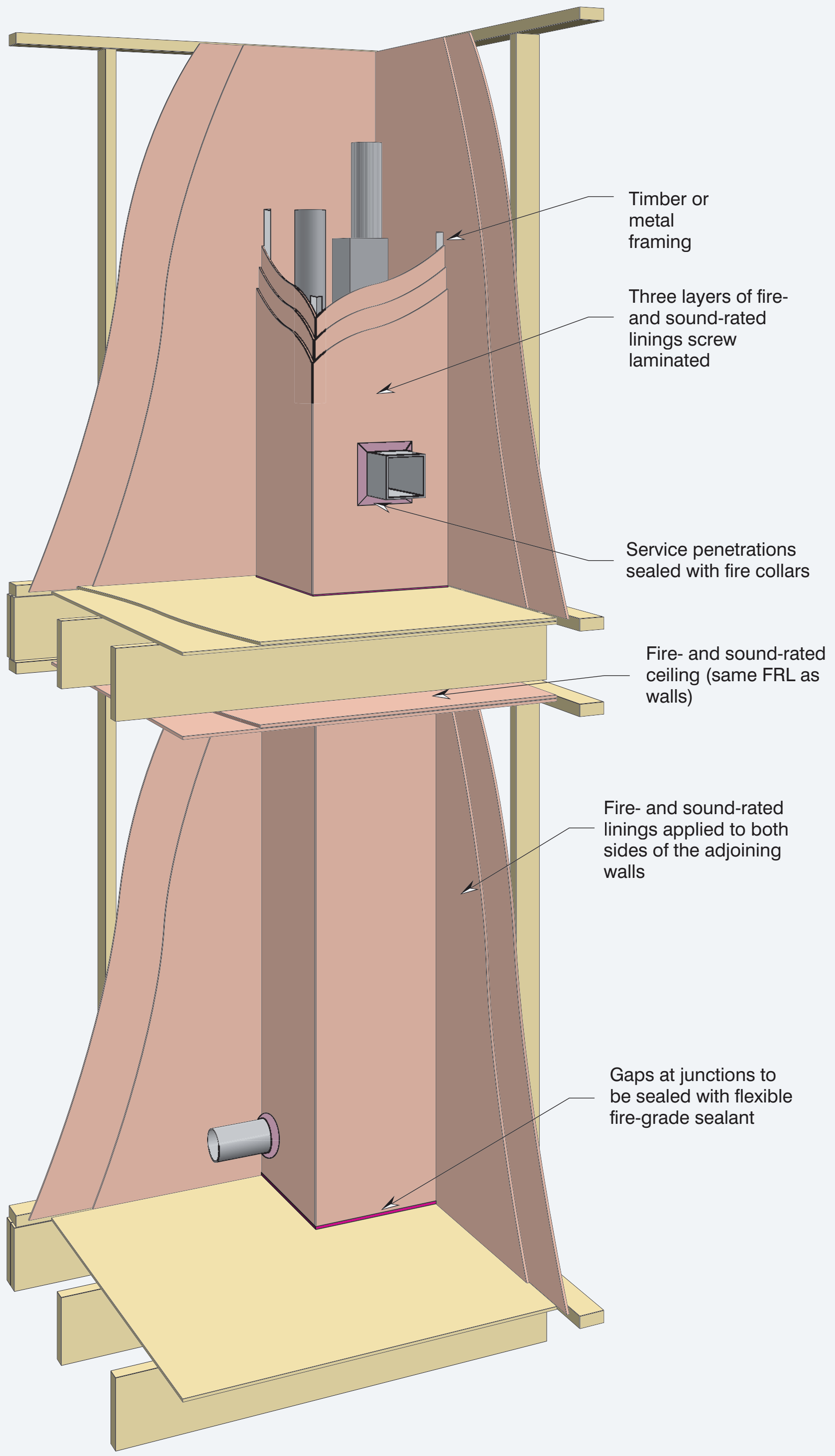


Figure 58: Fire-rated service duct.

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 system. These systems are proprietary developed by lining manufacturers,a and reference to their details is required. Refer to Figure 59 for an illustration of a typical system.

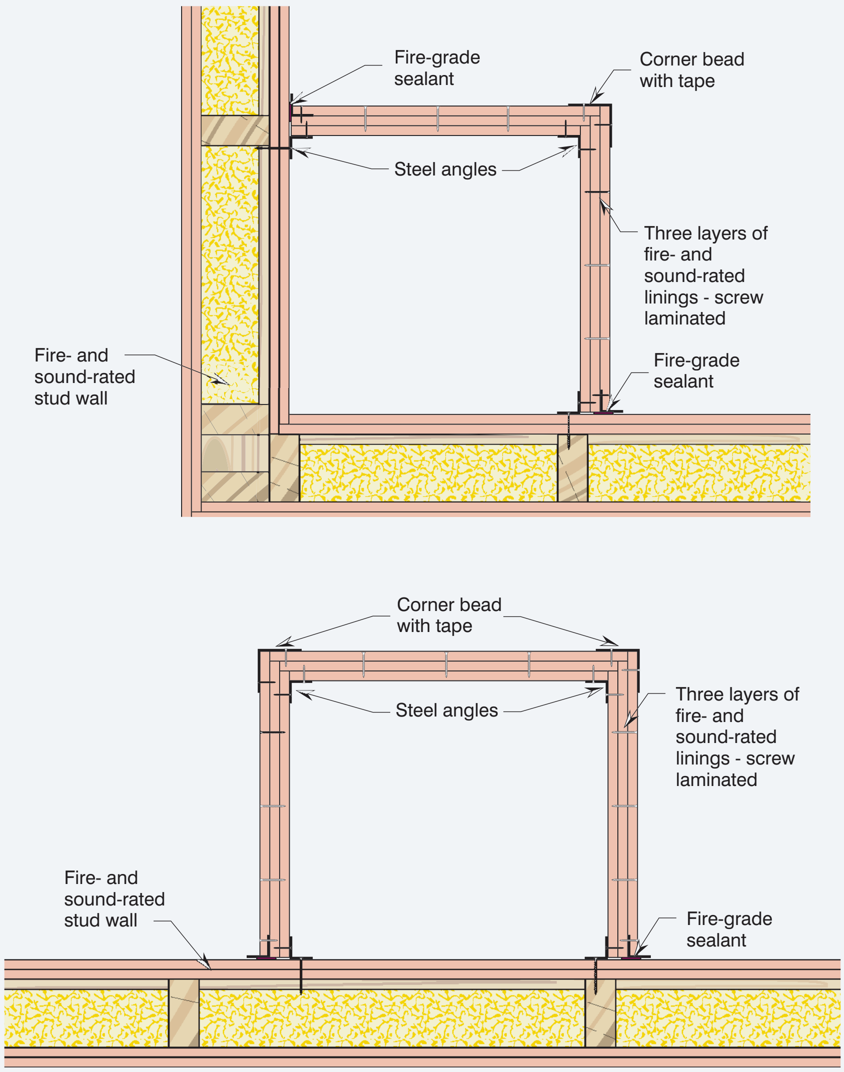


Figure 59: Laminated fire-rated plasterboard used to create shafts.

Another approach for Class B and C buildings is to seal the penetration at the point where it penetrates the floor or wall element with a fire collar but in many cases the service will still require a sound rating, refer to Section 5.6.2 for further details.

As 'chinks in the armour' of a fire-rated element, penetrations require careful and comprehensive treatment.

5.6.2 Plumbing, Electrical and Ventilation Services Penetrating a Fire-Rated Wall

Where services penetrate a fire-resistant element, the BCA requires gaps with the surrounding construction be sealed, and for some elements, that the element seals off during a fire event.

There are two approaches to satisfy the BCA. The first is to follow the requirements in Specification C3.15 in the BCA. This method details a number of elements such as pipes, and cables and gives solutions for sealing these penetrations, (Figures 60 and 61).

The other method is to use a manufacturer's tested system. This involves selecting a system that meets the fire-resistance as well as the acoustic level required. As these systems are proprietary no further details are provided here.

In general, all penetration in fire-rated elements should be fire stopped, kept to a minimum, kept as small as possible and designed in a way that will allow thermal movement as well as shrinkage.

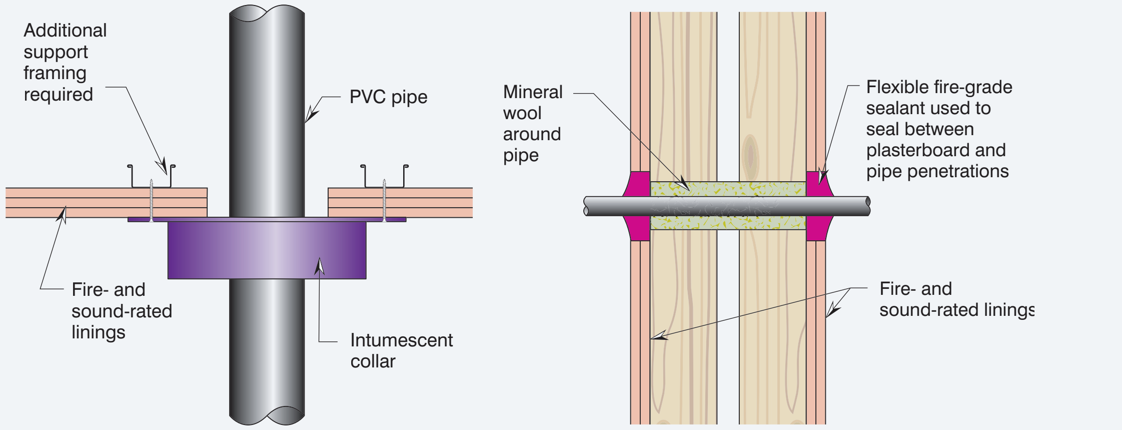


Figure 60: Plumbing service penetration in fire- and sound-rated wall and floor/ceiling – elevation view.

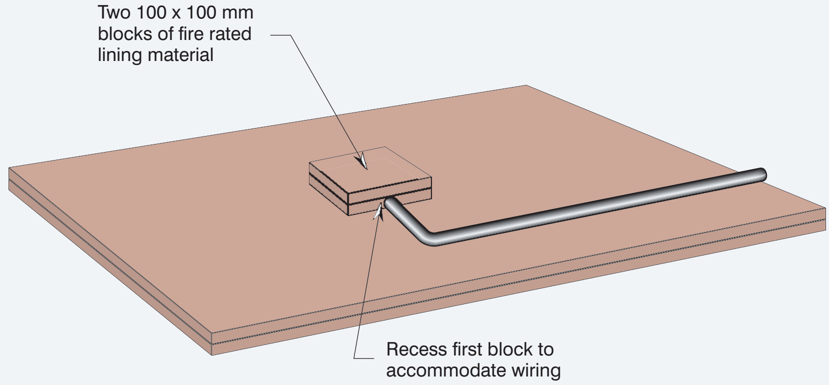


Figure 61: Electrical service penetration in fire- and sound-rated wall and floor/ceiling.

Going around can be simpler (and safer) than going through.

In many cases, dealing with penetrations in fire-rated elements can be avoided by placing penetrations in external non-rated systems, or by building false walls or boxes/bulkheads, creating pockets in the fire-rated element (Figure 62 and 63).

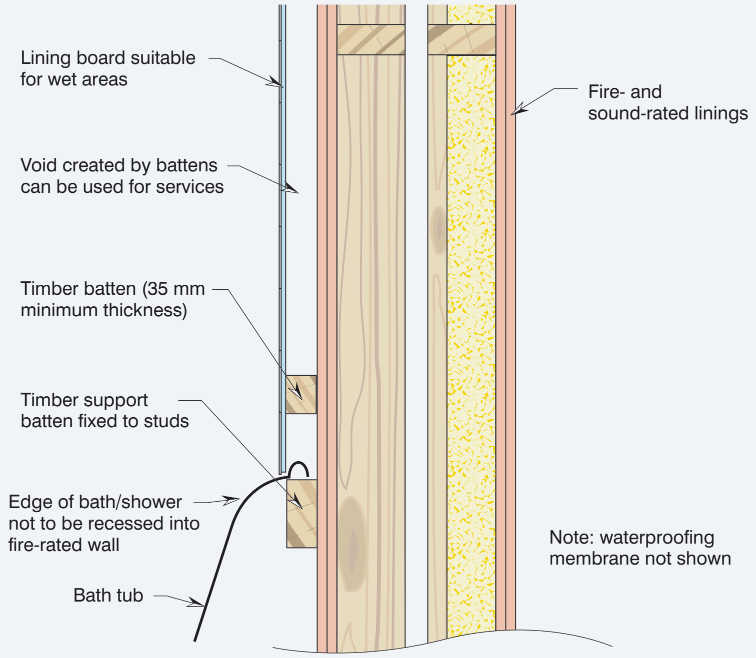


Figure 62: False wall for services (bathroom detail) – elevation view.

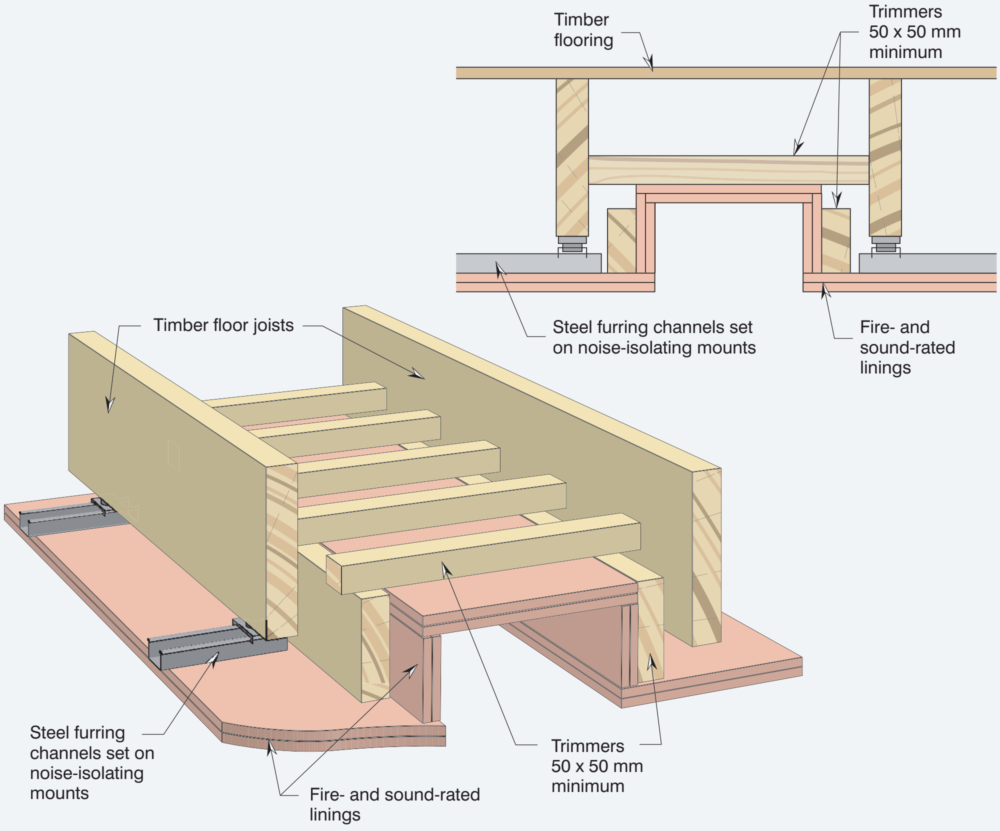


Figure 63: Framing details for recessed light in fire-rated floor/ceiling.

5.7 Vertical Separation in External Walls to Protect Openings from Fire

When using timber-framed construction to create vertical separation on external walls, it is important to have a clear understanding of the BCA requirements. For instance, there is a requirement for non-combustibility in Clause C2.6 of the BCA but this is exempted by a concession in Specification C1.1 Clause 3.10 which deletes the non-combustibility requirement.

Therefore situations such as the protection of balcony doors can be achieved by fire rating the underside of the balcony floor. Care is required to ensure that the method of fire rating is not affected by moisture or the outdoor environment. In many cases a water proof deck structure is required including a covering over the fire rating for its weather protection (Figure 64).

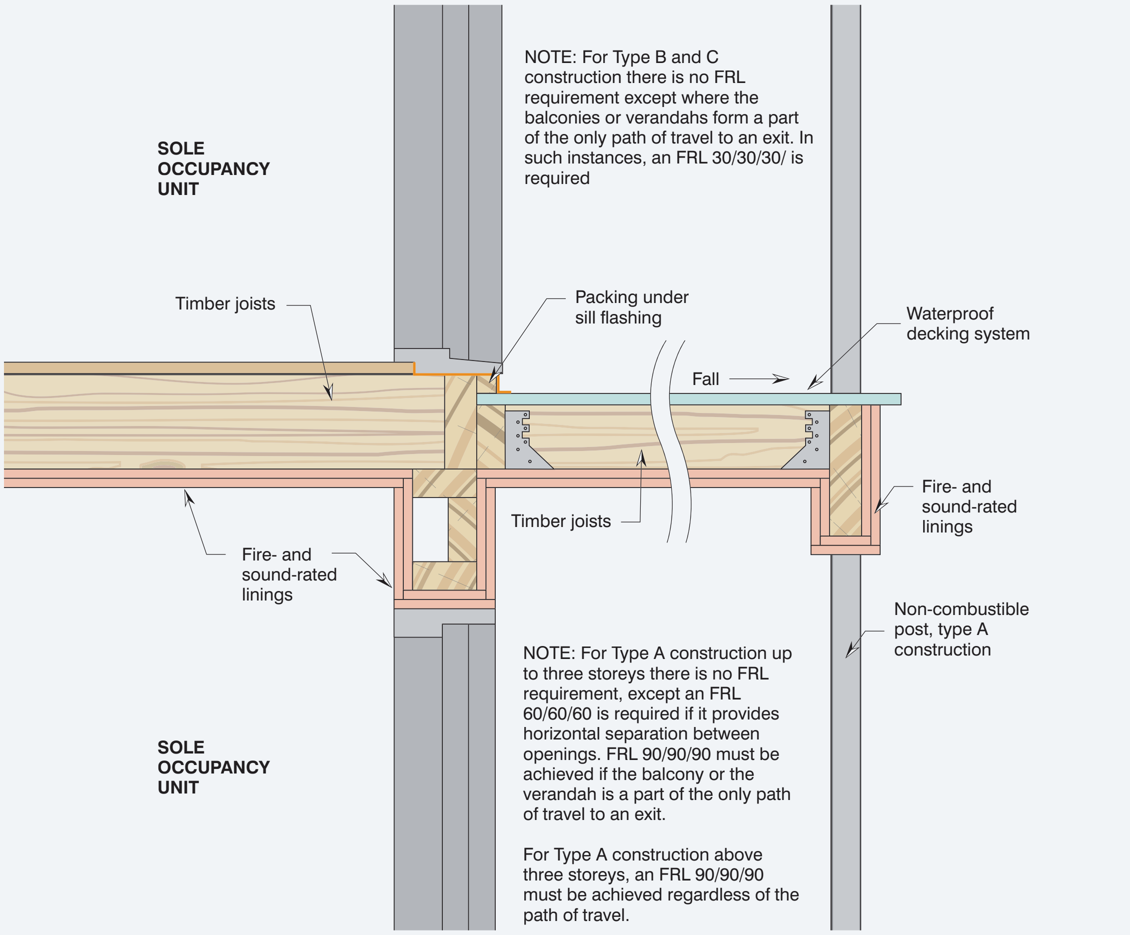


Figure 64: Protection of openings in external walls – elevation view.

5.8 Non-Fire-Isolated Stairways

Where timber is used for the construction of a Non-Fire-Isolated Stairway and ramps it must have;

- a finished thickness of not less than 44 mm;
- an average density of 800 kg/m^3 at 12 % MC; and
- if laminated, adhesives must be resorcinol formaldehyde or resorcinol phenol formaldehyde.

Thinner timber, lower density or laminated products using different glues may be used via the Alternative Solution path. Some successful Alternative Solution applications in the past have used fire-grade linings, as required for the floor systems, under the stairs as an offset for the less fire-resistant Deemed to Satisfy construction solution (Figure 65).

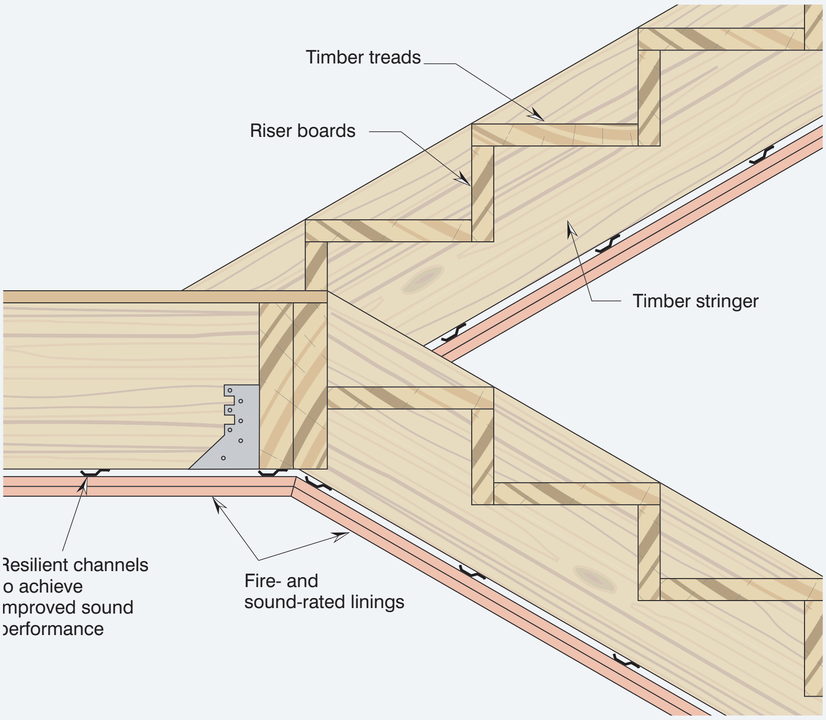


Figure 65: Fire-resistant linings used as Alternative Solution for stairs.

5.9 Archways, Windows and Doors

There are many instances where a window, door or similar construction may penetrate through fire- and sound-rated walls. Examples of this include windows or doors or through external walls, entrance doors, or a door or opening in a fire-rated internal wall.

5.9.1 Fire-Rated Window and Doors in External Walls

Where window and door in external fire-rated walls are required to be fire rated, then the fire-rated window or door is required to be a tested or assessed system. The test or assessed system requires consideration of the type of wall that it is in is a part and that information should be available. In these cases, follow the manufacturer's recommendation.

5.9.2 Non-Fire-Rated Window or Door in Fire-Rated Internal and External Walls

This situation often occurs in Type B and C buildings where there is no fire-resistance requirement for the actual window and door. In these situations, it is recommended that the wall linings used to protect the fire-rated wall be used to enclose the opening (Figure 66).

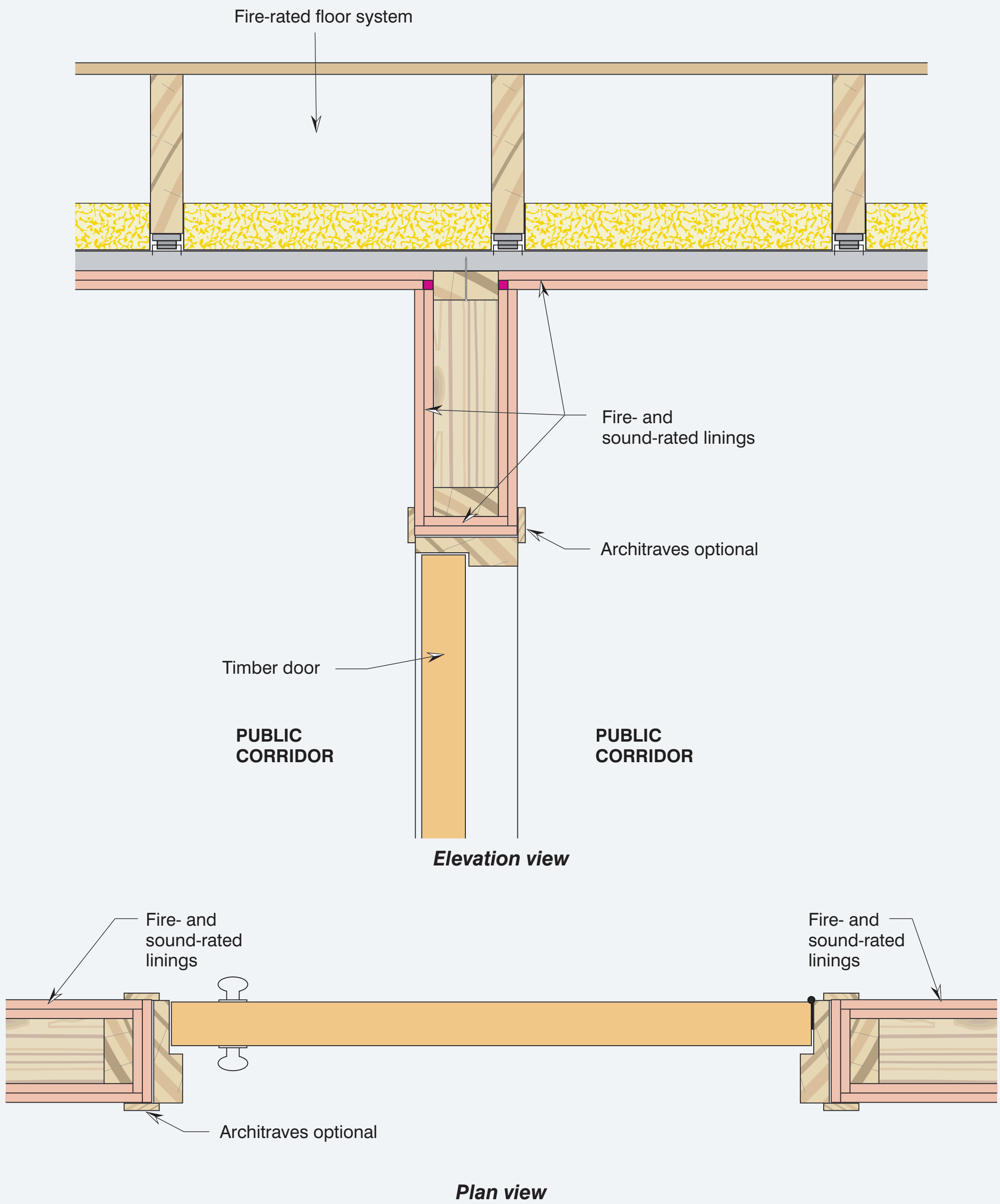


Figure 66: Door openings in fire-rated walls.

5.10 Smoke-Proof Walls

Section 4.4.1 described requirements for the construction of smoke-proof walls for Class 2, 3 and 9c buildings. The following section will describe how timber framing could be used for each building Class.

Proprietary systems, if correctly specified, can save building from scratch.

5.10.1 Class 2 and 3 Buildings

The BCA requires that smoke-proof walls be constructed from non-combustible material. As the smoke-proof wall is only required in long corridors, the wall is very short and most likely incorporates a door. For these situations, the easiest option is a proprietary system from a lining manufacturer, such as laminated plasterboard (Figure 67) or shaft wall (Figure 68).

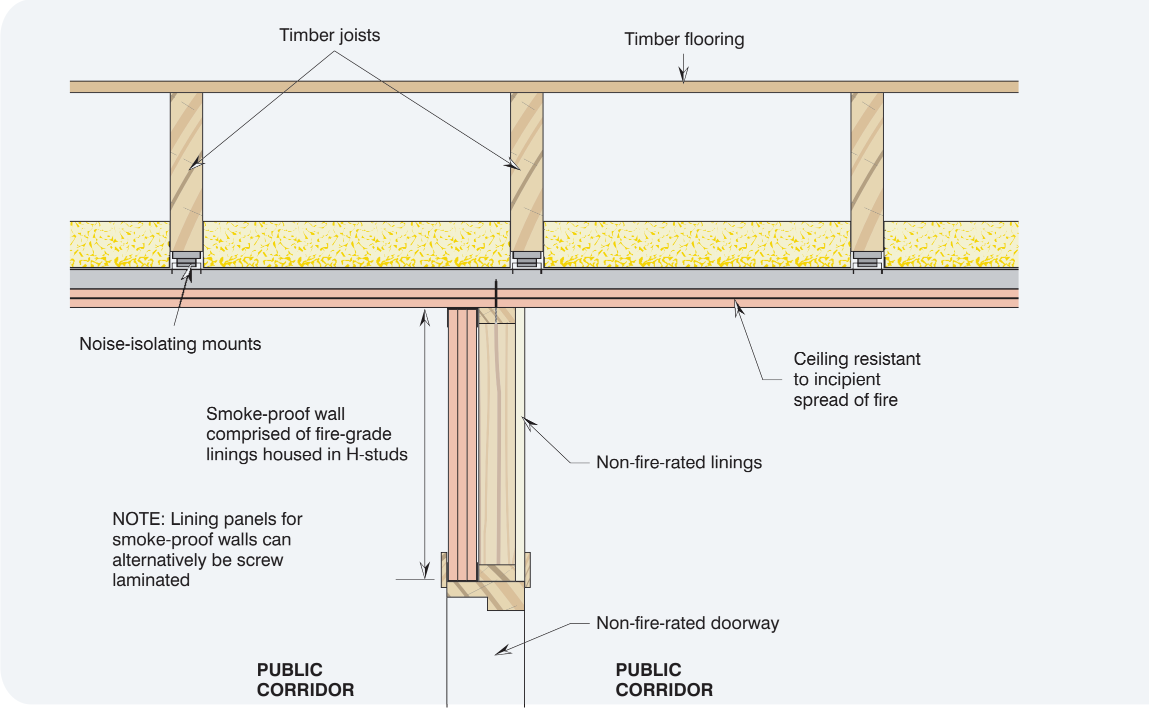


Figure 67: Laminated plasterboard smoke-proof wall – elevation view.

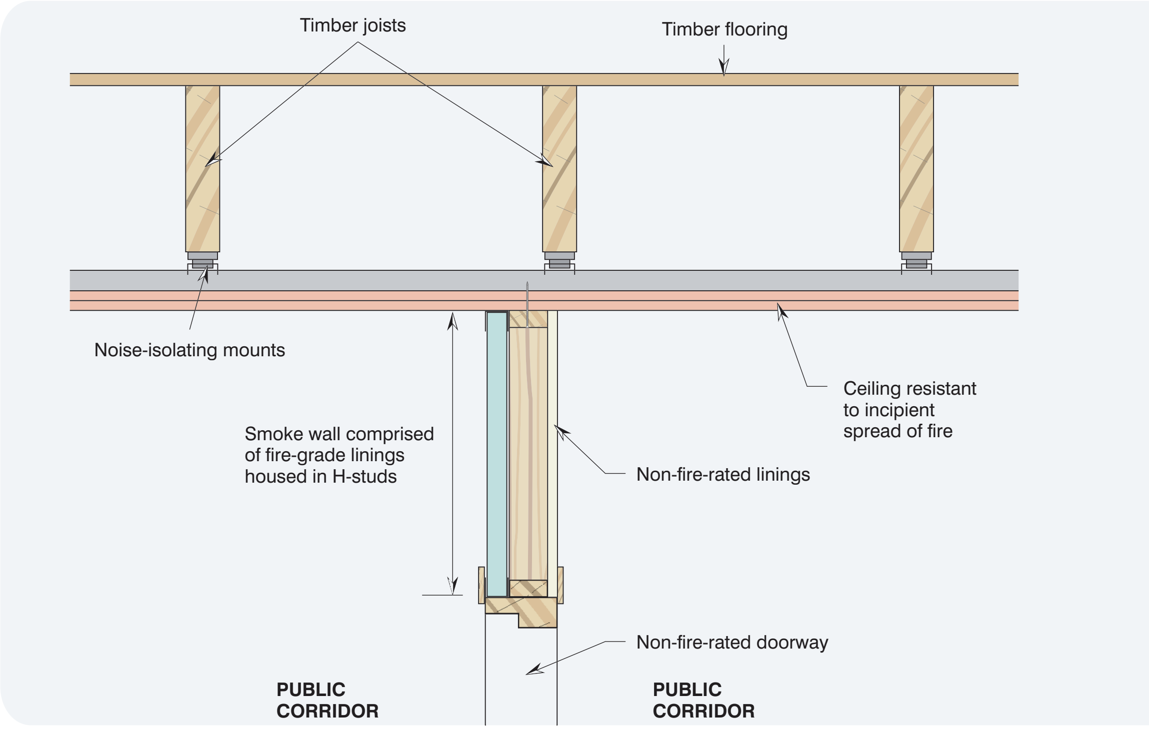


Figure 68: Shaft liner smoke-proof wall – elevation view.

5.10.2 Class 9c Buildings

For Class 9c buildings, the BCA requires that smoke-proof walls are lined on at least one side with a non-combustible lining, and if plasterboard is used, it is to be at least 13 mm thickness. Refer to Figure 69 for typical framing solution.

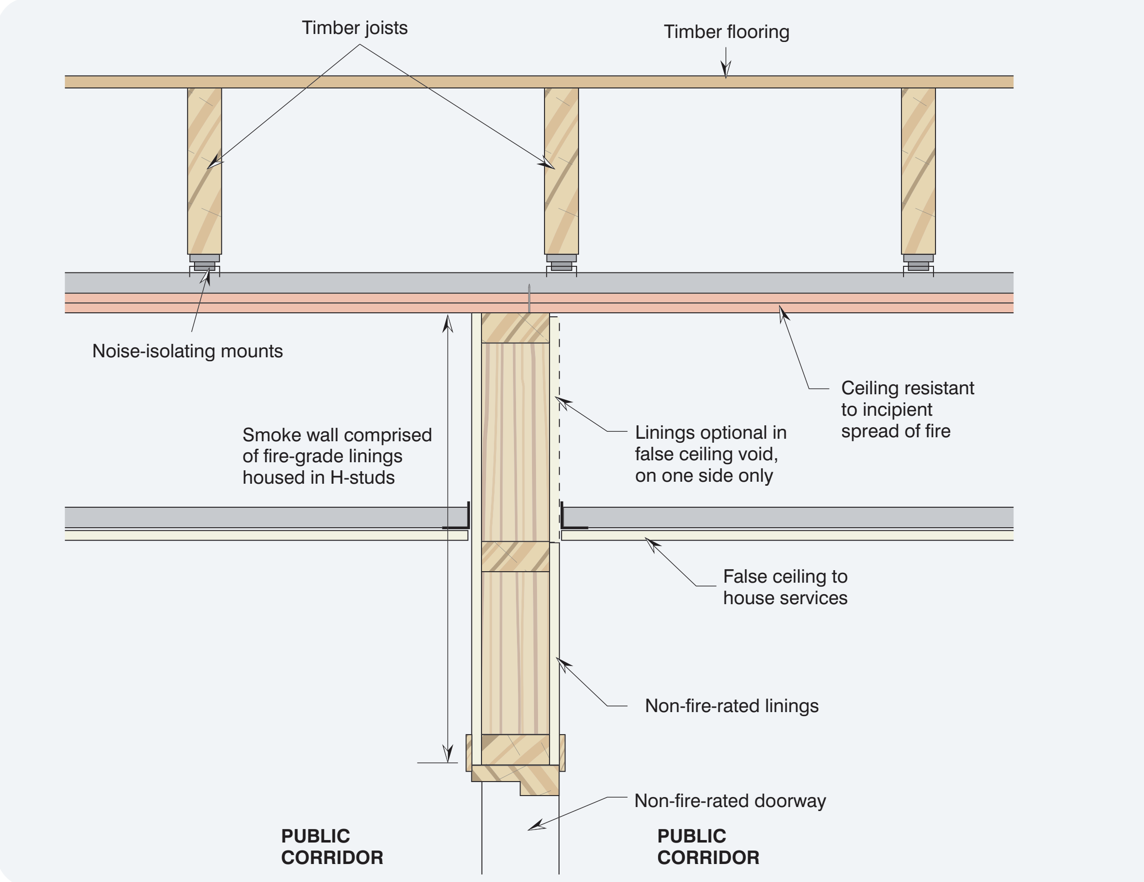


Figure 69: Smoke-proof walls for Class 9c building.

5.11 Cavity Barriers

Cavity barriers are obstructions placed in concealed air spaces in fire-rated systems, that in the event of a fire, limit the spread of smoke and hot gases to other parts of the building, and reduce airborne flanking noise. They are not mandatory under the BCA, but are recommended practice.

Cavity barriers can be made out of many building products used in fire- and sound-rated timber-framed construction, and in many cases are extensions of materials already being used. Solid timber, plywood, particleboard, plasterboard, mineral wools or metal flashing can be used. The cavity barrier must extend continuously along the voids.

5.11.1 Cavity Barrier Location

Generally, cavity barriers should be placed at the corners of each compartment, i.e. at the intersection of floors and bounding walls, and bounding walls to bounding walls. The following are typical locations where cavity barriers should be installed:

- Junction between fire-rated floor and fire-rated internal bounding wall (Figure 70).
- Junction between fire-rated floor and fire-rated external walls. Note there are two option, one using mineral wool and the other a metal flashing (Figure 71).
- Junction between internal fire-rated bounding wall and external wall (Figure 72).

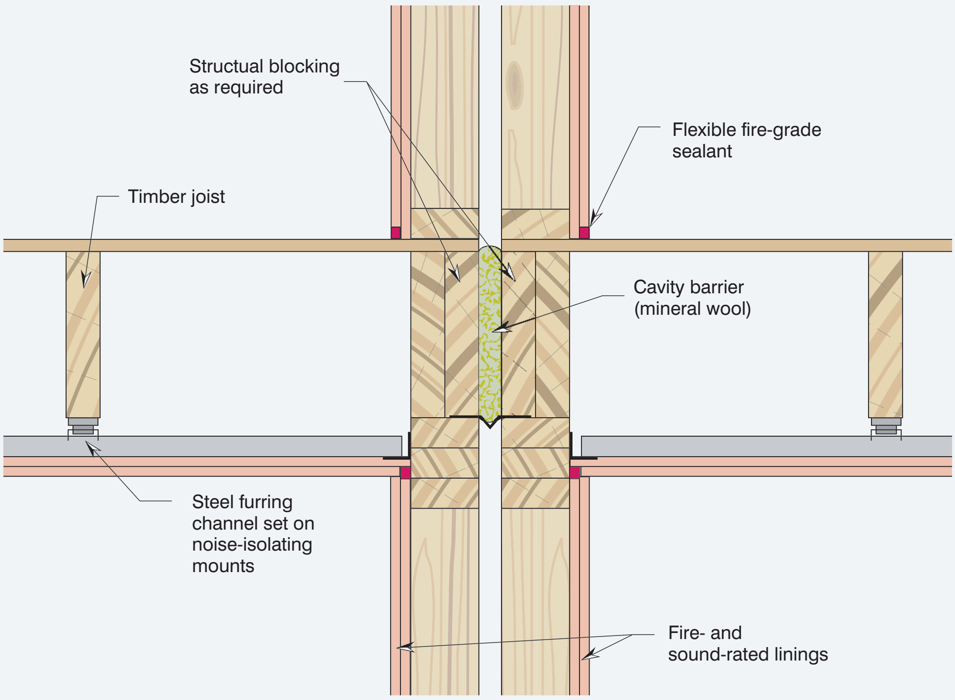


Figure 70: Cavity barrier at the junction of fire-rated floor and fire-rated wall – elevation view.

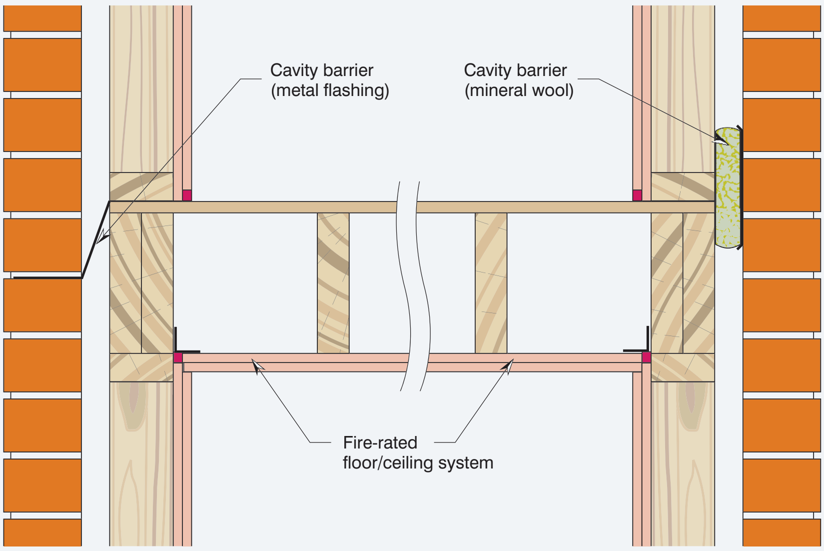


Figure 71: Junction between fire-rated floor and fire-rated external walls – elevation view.

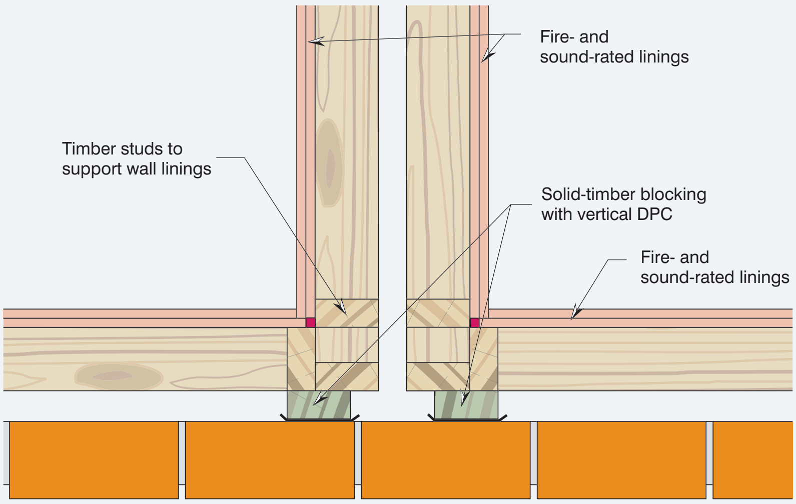


Figure 72a: Cavity barrier (using timber blocking) at junction of fire-rated bounding wall and external wall – plan view.

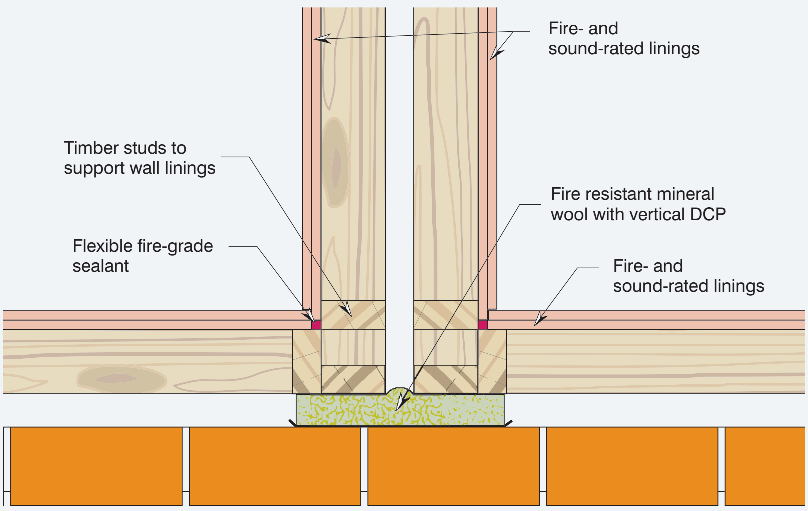


Figure 72b: Cavity barrier (using mineral wool) at junction of fire-rated bounding wall and external wall – plan view.