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Timber-framed Construction for Townhouse Buildings Class 1a

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

Technical Design Guide issued by Forest and Wood Products Australia

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Introduction

This Guide covers fire and sound.

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 building occupants' 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 and certifying authorities. It is set-out according to a simple step-by-step process shown in Table 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 detailed below.

Scope

For timber-framed construction, this Guide demonstrates compliance with targeted fire safety and sound-insulation Performance Requirements in the Building Code of Australia for Class 1a attached buildings and associated Class 10a buildings. Specific areas of performance addressed include:

- Providing sound insulation in walls between dwellings.
- Protection against spread of fire both between dwellings and on external walls (where required).

It does not deal with fire detection and early warning in buildings (including smoke alarms), heating appliance issues, bushfires or fire in alpine areas.

This Guide provides certified construction details by utilising the BCA's Deemed to Satisfy Provisions. In addition, guidance beyond BCA minimum requirements is provided for those wanting to improve and upgrade sound performance.

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. Users of this Guide should make themselves aware of these differences and should develop a full understanding of the resulting implications. Only on this basis should this Guide be used.

Taking a step-by-step approach reduces complex designs to manageable elements.

Table 1: 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 separating walls between dwellings

Step 2 – Define BCA Sound Design Requirements

- Utilise the Deemed to Satisfy Provisions for sound design
- Determine sound-insulation requirements for separating

Step 3 – Improve and Upgrade Sound Performance

- Attention to building design (space and
- 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 Fire Resistance Levels of wall

Step 5 – Sound- and Fire-Rated Timber Construction

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

Step 6 – Further Design Assistance (Appendices)

- Structural considerations, other BCA requirements, references,

Taking a step-by-step approach reduces complex designs to manageable elements.

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Step 1 – High-Level BCA Design Issues

This Guide covers BCA Class 1a and 10a buildings. It's also relevant to Class 1b structures.

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 decision making to be made on a building project. A selection of high-level design issues relating to fire-resisting and sound-insulation construction are addressed in this section of the Guide.

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. These classes are determined according to the purpose for which a given building will be used. The classes relevant to this Guide are:

- Class 1a attached dwellings each being a building separated by a fire-resisting wall including row houses, terrace houses, townhouses or villa units.
- Class 10a non-habitable buildings that are attached or in some way associated with the above Class 1a buildings including private garages, carports and sheds.

These classes are dealt with in Volume 2 of the BCA and so all future references to the BCA are made with relevance to this Volume. Other Class 1 buildings not specifically dealt with in this Guide, but which may still benefit from specific information contained within, include:

- Class 1a detached dwellings.
- Class 1b boarding houses, guest houses, hostels and similar buildings (Note: Class 1b buildings are defined as having a total floor area up to 300 m^2 and would not ordinarily have more than 12 people as residents).
- Both these types of building have no specific sound Performance Requirements in the BCA and only require fire-resisting construction where exterior walls have close proximity to an allotment boundary or close proximity to an adjacent building (refer BCA 3.7.1.3).

Care is required to ensure that Class 1a buildings do not inadvertently have their building classification changed. Common causes of this are:

- Two or more dwellings sharing a common garage.
- Two or more dwelling sharing a common entrance.
- One dwelling construction overlapping onto another below.

1.2 BCA Compliance – Deemed to Satisfy Provisions or Alternative Solutions

Refer BCA 1.0.9 and 1.2.2 to 1.2.4.

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

- Deemed to Satisfy Provisions – a specific type of construction which is acknowledged as complying with the BCA's Performance Requirements. This includes Acceptable Construction Practices for fire and sound, as detailed in Volume 2 of the BCA.
- 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 by utilising the Acceptable Construction Practices in Volume 2. This part of the BCA directs the level of fire-resisting and sound-insulation construction that timber-framed construction must achieve in order to meet minimum BCA Performance 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.

1.3 Fire and Sound Separation in Buildings

Two clear BCA conditions make it straightforward to deem external walls.

In order to prevent the spread of fire and provide sound insulation between buildings, there are key concepts used in the BCA's Acceptable Construction Practices including:

Separating Walls – Such walls separate the effects of fire and sound on adjoining Class 1a buildings by virtue of a common wall. The wall commences at the lowest floor level (or possibly ground level where a raised floor is involved) and finishes at either the underside of the roofing material or in some instances a set distance above the roof line (Figures 1 and 2). More specific conditions concerning separating walls are discussed later in this Guide.

External Walls – Such walls are important in protecting a building against spread of fire from external fire sources (Figures 1 and 2). These walls are deemed to occur where:

- 900 mm or less from an allotment boundary other than the boundary adjoining a road alignment or other public space; or
- 1.8 m or less from another building on the same allotment other than a Class 10 building or a detached part of the same Class 1 building.

More specific conditions concerning external walls are discussed later in this Guide.

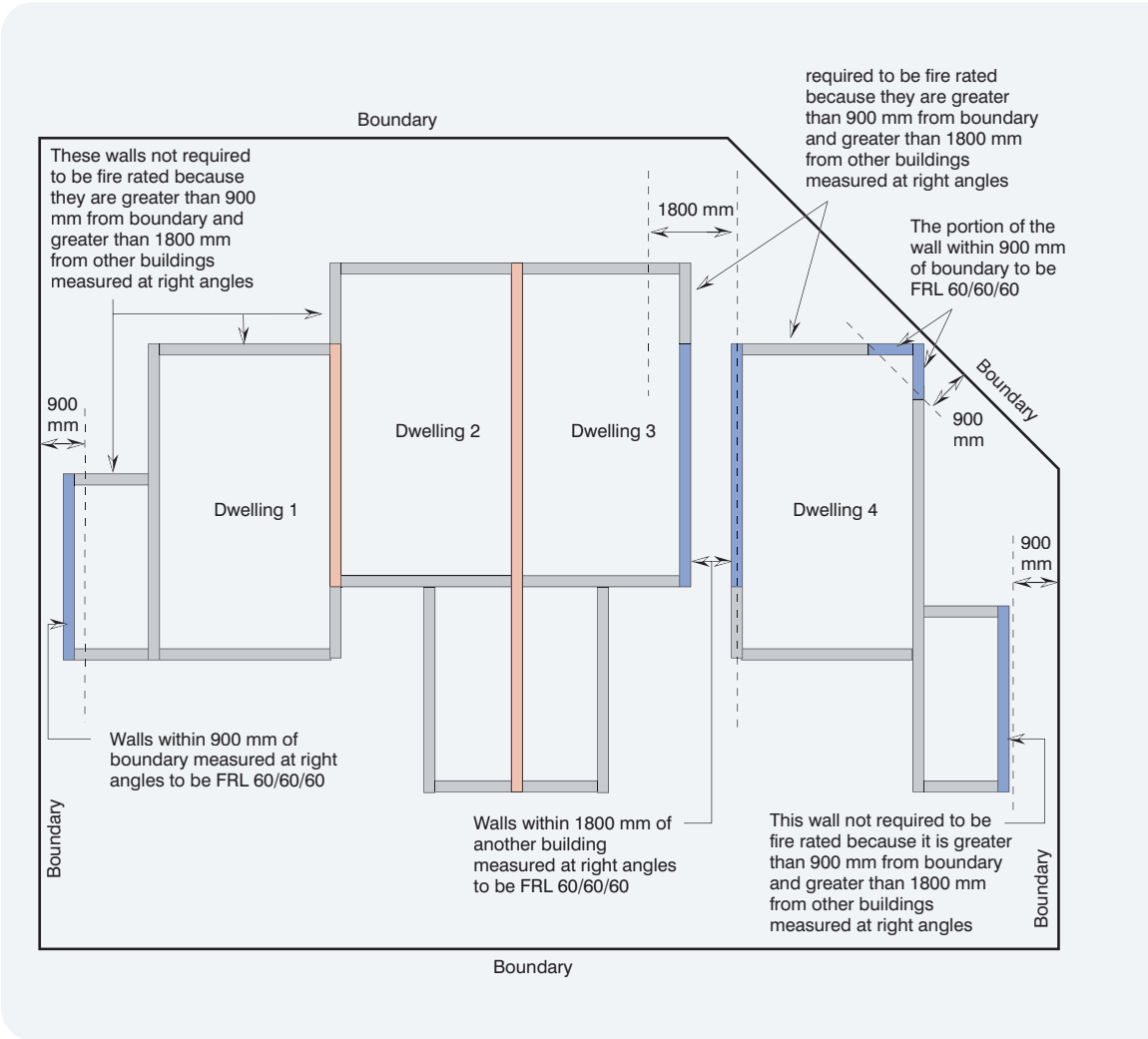

Figure 1: Examples of a separating walls and external walls – plan view.

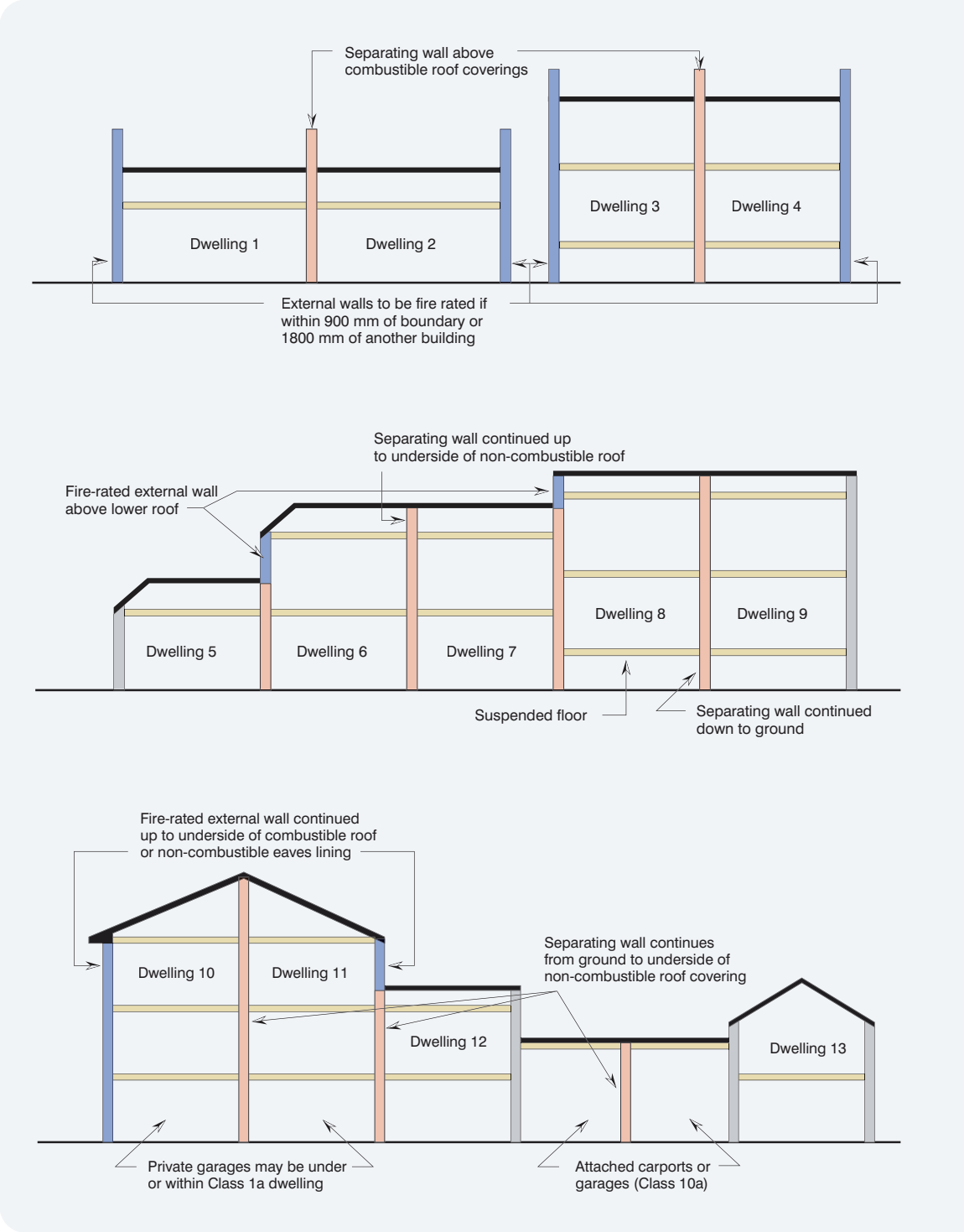

Figure 2: Examples of a separating walls and external walls – elevation view.

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Addressing multiple sound sources is even more important in light of today's trend towards medium density housing.

Step 2 – Define BCA Sound-Design Requirements

Designing sound-insulated construction involves a process of understanding how the BCA's Performance Requirements translate into objective design parameters, as contained in the BCA's Deemed to Satisfy Provisions (i.e. acceptable construction practice). This is then used as the basis for selecting appropriate timber-framed construction. Key issues determining sound design requirements are discussed in this Section of the Guide.

2.1 Utilising the Deemed to Satisfy Provisions for Sound Design

The BCA's Performance Requirements for sound insulation concern the use of separating walls between dwellings to sufficiently insulate against airborne sound transmission and impact noise. In order to understand these requirements it is important to differentiate between airborne and impact sound as shown in Figure 3.

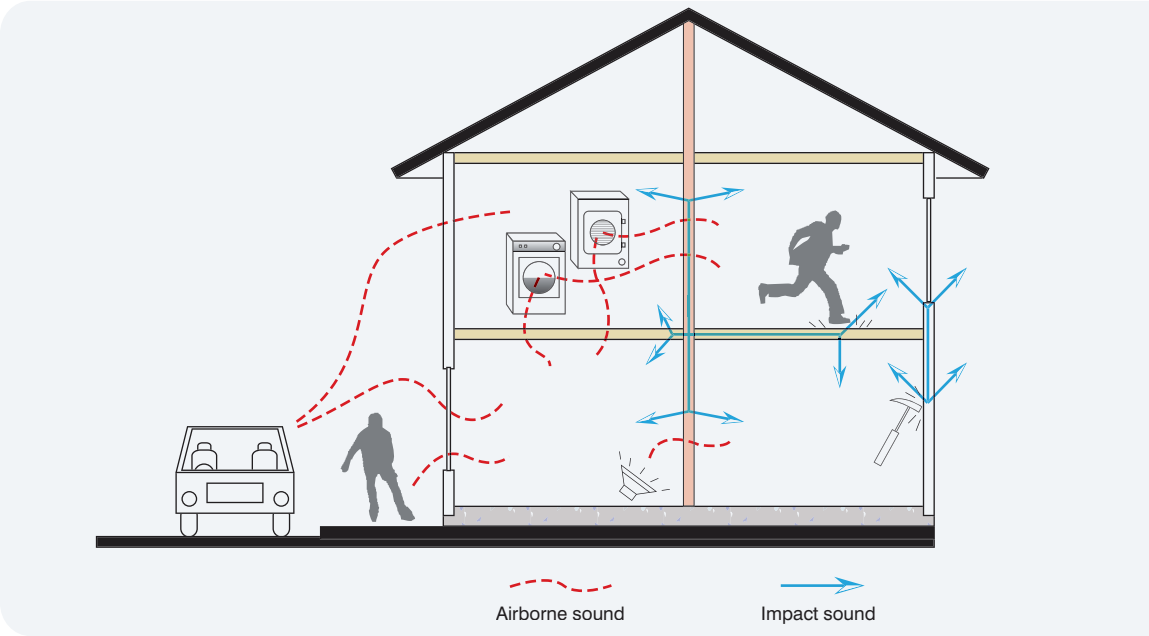

Figure 3: Examples of impact and airborne sound.

2.1.1 Airborne Sound Transmission

Airborne sound transmission refers to sound waves that travel through the air and cause a building element to vibrate, radiating out on the other side of the wall. Methods used to reduce transmitted airborne sound generally use cavity (isolated) construction with bulk insulations to absorb the vibration.

Deemed to Satisfy construction that meets the above Performance Requirements is provided in the Acceptable Construction Practices part of the BCA (BCA 3.8.6).

2.1.2 Impact Sound Transmission

Impact sound refers to the sound arising from the impact of an object on a building element causing both sides of the building element to vibrate and generates sound waves. The primary method used to reduce impact noise is isolation from any adjoining building elements.

Generally, the BCA considers impact sound for walls separating a bathroom, sanitary compartment, laundry or kitchen in one dwelling from a habitable room (other than a kitchen) in an adjoining dwelling. Sound leakage at penetrations from service elements may compromise the performance of

Proper sound insulation isn't 'bolted on'. It starts at the bottom and permeates every level of construction.

walls. This requirement is generally achieved with discontinuous construction. Refer to Appendix C for a definition of discontinuous construction.

It is also important to understand how each type of sound is measured in order to select sound-insulated separating walls. The nomenclature used in the BCA's Acceptable Construction Practice is explained in Figure 4.

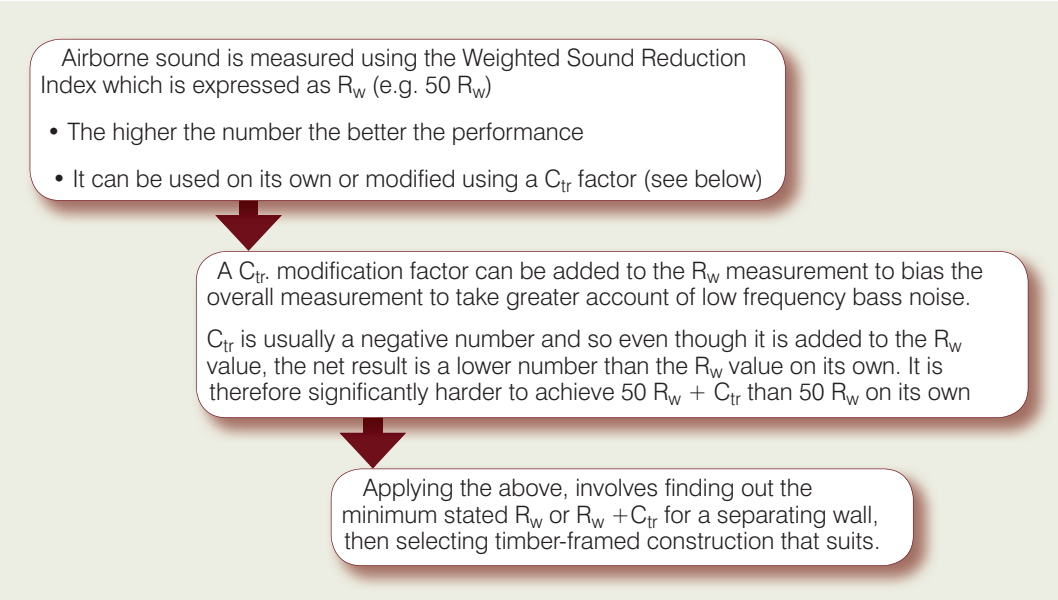

Figure 4: Methods of measuring airborne sound.

2.2 Determine Sound-Insulation Requirements In Separating Walls

Given the previous definitions, the required airborne and impact sound insulation levels, as interpreted from the BCA for Class 1a buildings, are provided in Table 2. In addition to these requirements, there are general installation requirements in the BCA (refer BCA 3.8.6.3). A key issue here is that to achieve the required sound levels, walls must be sealed at junctions between the sound-insulated separating wall and any perimeter walls or roof covering. In addition, timber studs and perimeter members must be installed as follows:

- Studs must be fixed to top and bottom plates of sufficient depth to permit secure fixing of the plasterboard.
- Noggings and like members must not bridge between studs supporting different wall leaves.
- All timber members at the perimeter of the wall must be securely fixed to the adjoining structure and bedded in resilient compound or the joints must be caulked so there are no voids between the timber members and the wall, refer to lining manufacturer's installation recommendations.

Note: BCA requirements for timber-compatible material such as plasterboard should be viewed separately in the BCA (refer BCA 3.8.6.3) and/or proprietary installation manuals.

Table 2: Minimum sound insulation requirements for separating walls.

SEPARATING WALL – Location and Penetrations	**Discontinuous Construction Required**	**R_w + C_{tr}**
Between a bathroom, sanitary compartment, laundry or kitchen and a habitable room (other than a kitchen) in an adjoining Class 1 building	YES	50
In all other cases, includes roof void and subfloor areas	NO	50
Duct, soil, waste and water supply pipes and storm water pipes that pass through a separating wall between Class 1 buildings:		
• if the adjacent room is habitable (other than kitchen)	NO	40
• if the room is a kitchen or any other room.	NO	25

2.3 Treatment of Services Relevant to Timber-Framed Construction

If a duct, soil, waste, water supply or storm water pipe serves or passes through a separating wall or is located in a separating wall, then the following conditions apply:

- A door or panel providing access to a duct or pipe required to be separated must not open into any habitable room other than a kitchen. In any other part, the door or panel must be firmly fixed so as to overlap the frame or rebate of the frame by not less than 10 mm and be constructed of:
  - wood, plasterboard or blockboard not less than 33 mm thick; or
  - compressed fibre-cement sheeting not less than 9 mm thick; or
  - other suitable material with a mass per unit area not less than 24.4 kg/m^2.
- If it is a water supply pipe, it must:
  - only be installed in discontinuous construction (double stud walls); and
  - in the case of a water supply pipe that serves one dwelling, not be fixed to the wall leaf on the side of any other dwelling and have a clearance not less than 10 mm to the other wall leaf.

Electrical outlets must be offset from each other in timber framing not less than 300 mm.

2.4 The Next Step

Having used the previous information to obtain a strong understanding of the minimum sound insulation requirements for separating walls, the next step is to either:

- Go to Step 3 to improve and/or upgrade sound performance, or
- Go to Step 4 find out about the BCA fire-resisting construction requirements.

3

Step 3 – Improve and Upgrade Sound Performance

Sound performance can often be improved by simple attention to the form and spatial arrangement of the building design. In addition, many end users of dwellings often want higher sound performance than the minimum levels required in the BCA. As a result, this Step of the Guide focuses on ways of improving and upgrading sound performance.

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

3.1 Checking and Adjusting the Building Design to Reduce Sound Transmission

There are many aspects of Class 1a buildings that can reduce sound transmission by simply paying attention to thoughtful sound design (Figure 5).

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 rooms in an adjoining dwelling and should not back onto habitable rooms. Also, try to ensure entrances to dwellings are an appropriate distance from attached or adjacent dwellings.

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

3.1.2 Windows

Windows normally have lower sound insulation than the walls they are located within. As a result, high sound rated wall systems may become ineffective by virtue of poorly sound-insulated windows. Where noise is unavoidable, 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 dwellings.
- 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 the openable sashes and the window frame.

3.1.3 Doors

As with windows, doors tend to be the weak link in sound rated walls. Where sound-control is desired, solid core doors should be used. The top and sides of doors should have soft acoustic gaskets. Threshold closers at the bottom of the door or air seals will also reduce sound transmission. 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 separating walls 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.

Combined sound insulation strategies generally yield better results than stand-alone measures.

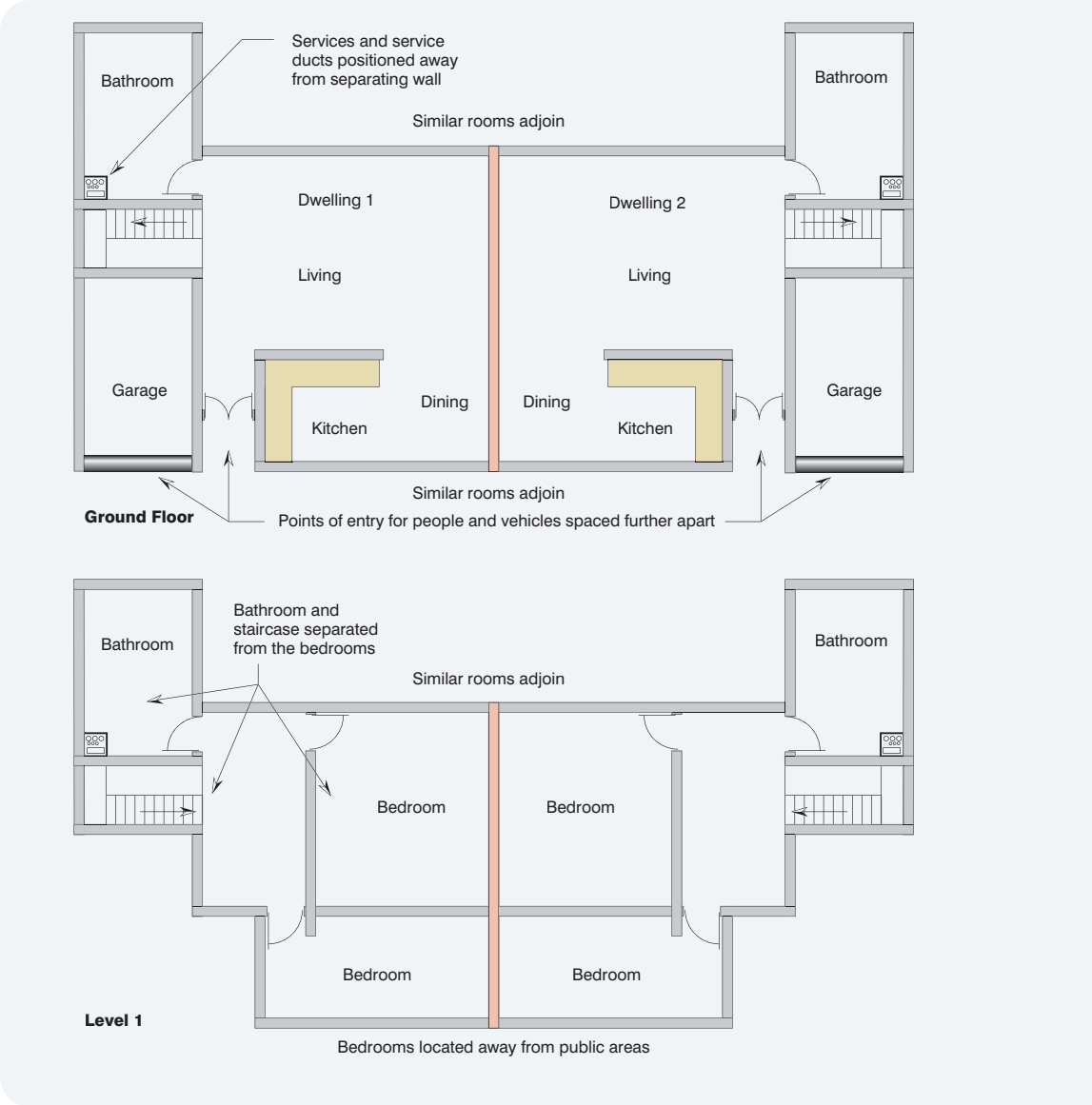

Figure 5: Sound design practices in building layout.

3.1.5 Flanking Noise

Flanking noise is best addressed by:

- isolating of forming discontinuous elements from each other, i.e. resilient acoustic ties and discontinuous flooring, and
- placing absorptive material within sound rated cavities, or near floor/ceiling and wall junctions.

3.2 Strategies for Improving Sound Performance in Construction

The following strategies can be used to improve the sound insulation. Generally, it is not the use of one but a combination of strategies that gives the most economical solution.

Extra mass on the wall – the addition of mass is a simple yet important means of improving sound performance in timber-framed construction. At its simplest, this involves adding extra layers of material such as plasterboard or fibre-cement sheet to the separating wall system.

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

Upgrade batts in the wall – There are many different types and grades of insulation batts available. Sound-insulation specific batts are best, and in addition, higher density materials tend to outperform low density materials but as a minimum, batts with densities of 10 kg/m^3 or greater are recommended.

Floor joists parallel to separating walls – By running floor joists parallel rather than transverse to the separating wall, less impact sound from the floor will go into the separating wall and subsequently less impact sound will transfer across the wall to the attached building (Figure 6).

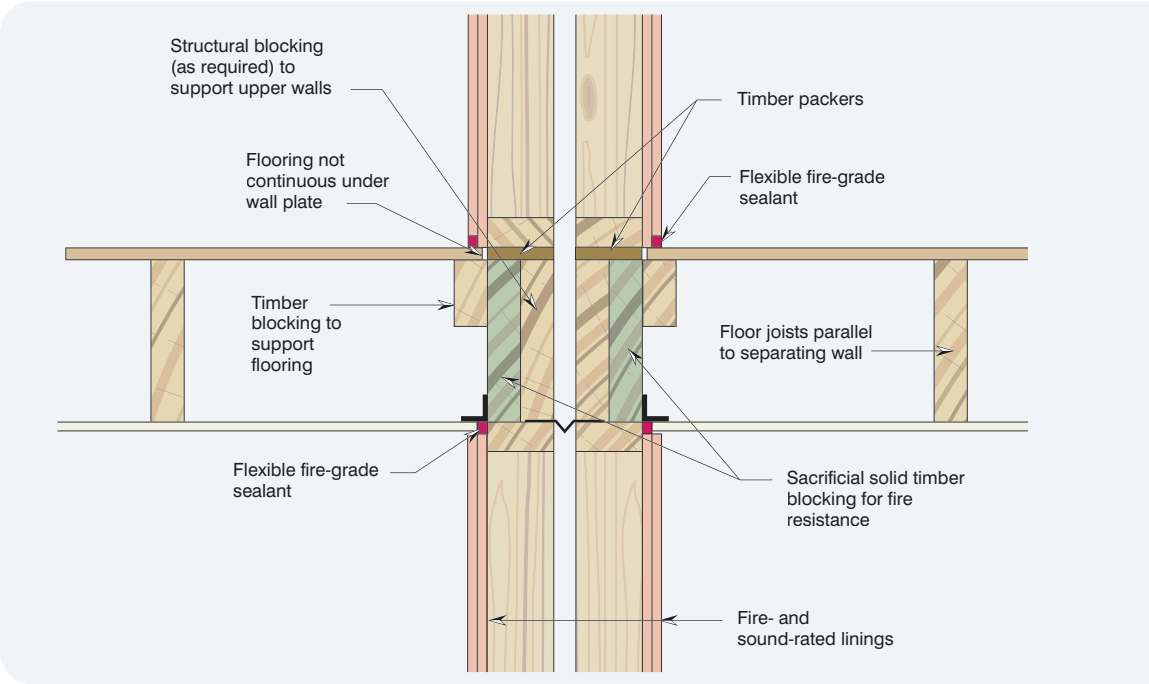

Figure 6: Joists parallel to separating wall – elevation view.

Batts do much more than save energy.

Batts in the floor at the wall/floor junction – Where the parallel joist layout (Figure 6) cannot be achieved, it is good practice to place extra sound-insulation batts between joists running along the separating wall (Figure 7). Much the same can be done at wall and ceiling intersections, but is only required where such insulation is not already provided across the entire ceiling area, such as for energy efficiency.

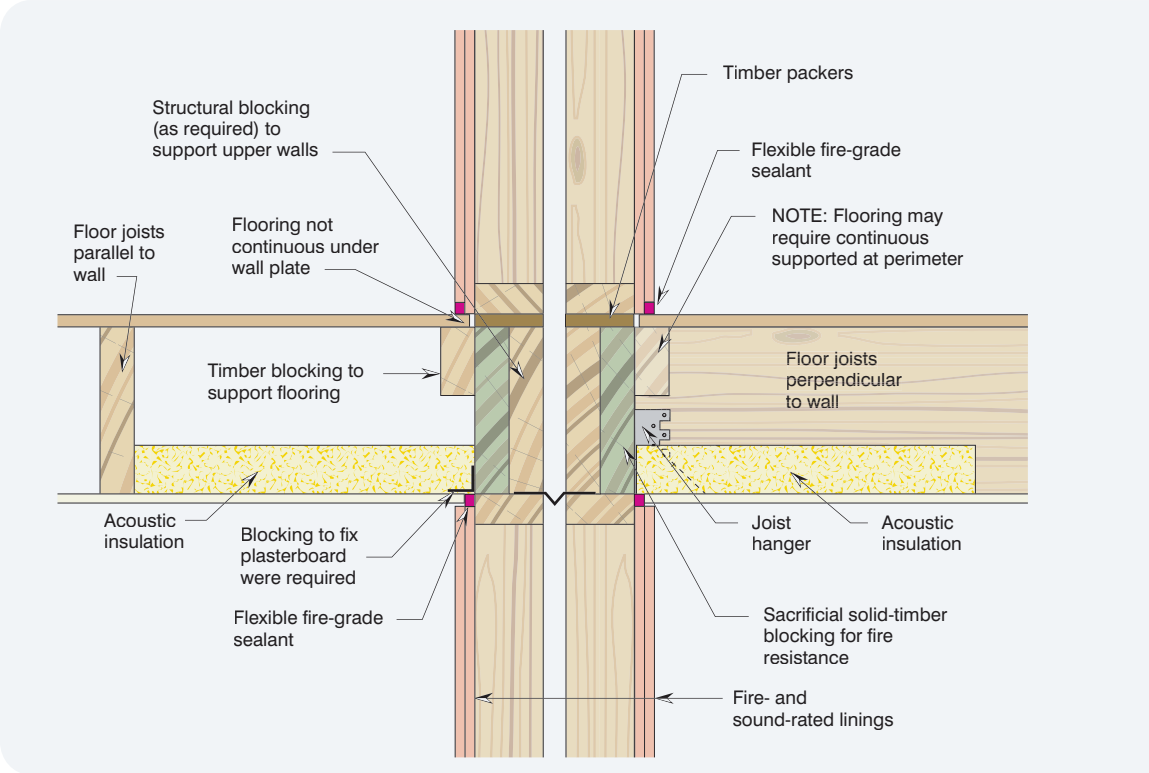

Figure 7: Sound insulation batts at floor and wall intersection – elevation view.

Isolated support for stairs – Impact sound from stair usage typically vibrates its way into separating walls, creating a greater likelihood of sound passing across the wall into attached dwellings. The best way to prevent this is by isolating the support for the stair structure (Figure 8). Options include:

- using the stringers to support the stairs, at each floor level, without intermediate support from the separating wall in between, i.e. free standing
- using Newell posts rather than the separating wall to support the stair structure.

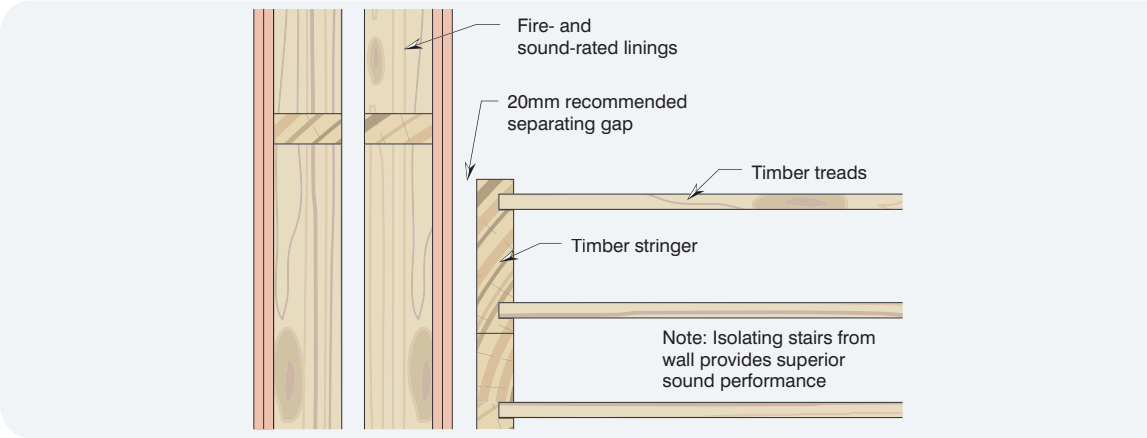

Figure 8: Isolating stair structure from separating wall – elevation view.

Batten out separating 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 separating wall (after fire essential linings have been applied) and then providing an additional lining over the top (Figure 9). The bath can then be installed into the batten space without affecting the fire- and sound-rated wall.

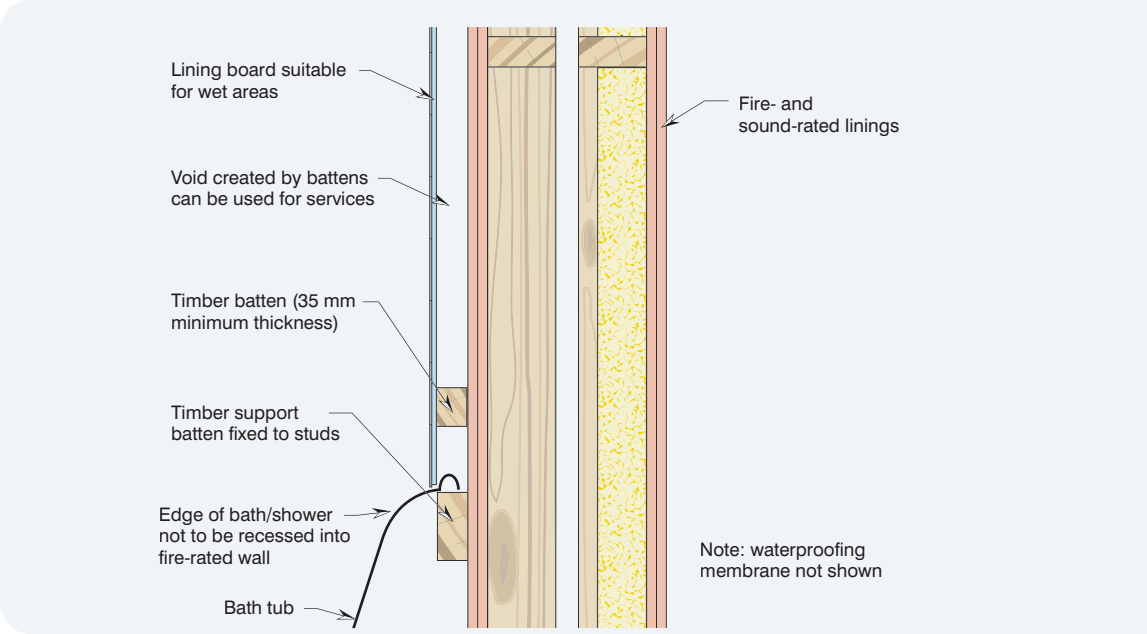

Figure 9: Batten out false wall for services – elevation view.

3.3 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, or
- go to Step 4 to find out about BCA fire-resisting construction requirements.

4

Step 4 – Define Fire-Design Requirements

Like sound, designing fire-resisting construction involves a process of understanding how the BCA's Performance Requirements translate into objective design parameters, as contained in the BCA's Deemed to Satisfy Provisions (i.e. acceptable construction practices). This is then used as the basis for selecting appropriate timber-framed construction. Key issues are discussed in this section of the Guide.

4.1 Utilising the Deemed to Satisfy Provisions for Fire Design

Refer BCA 3.7.1

As discussed previously, this Guide focuses on meeting Performance Requirements concerning protection against the spread of fire between Class 1a buildings (adjacent to each other) and associated Class 10a buildings. Acceptable construction practices that are Deemed to Satisfy these requirements and of relevance to timber-framed construction, are set out in Part 3.7.1 of the BCA. It provides Fire Resistance Levels and associated construction details for external walls and separating walls. Fire Resistance Levels represent a key requirement when selecting appropriate timber-framed construction systems for fire separation and therefore form the basis for ongoing discussion.

Recent bushfire seasons have made fire resistance a hot issue even for urban building projects.

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

- Structural adequacy (ability to withstand loads);
- Integrity (in terms of containing smoke, flames and gases); and
- 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 an FRL is expressed is: 60/60/60. Another example where not all components are required is: –/60/–. Application of this and related aspects of construction are discussed under the following headings.

4.2 Fire Resistance Levels of Wall Elements

4.2.1 External Walls

External walls are used to protect Class 1a buildings from external fire sources (Figures 1 and 2). Specific requirements pertaining to this include:

- Must have walls with an FRL of not less than 60/60/60 when tested from the outside.
- Must have walls that extend to the underside of a non-combustible roof covering or non-combustible eaves lining.
- Must have openings in walls:
  - – protected by non-openable fire window or other construction with an FRL of not less than –/60/–
  - – protected by self-closing solid core doors not less than 35 mm thick.

Additional Notes:

Refer BCA 3.7.1.7

Certain construction is allowed to encroach on the 900 mm space between an external wall and the allotment boundary or 1800 mm space between the external walls of two buildings on the same allotment (refer BCA 3.7.1.7 for details). Conditions apply as defined in BCA 3.7.1.7 but of relevance to timber-framed construction is the allowable encroachment of non-combustible eaves construction.

Certain concessions exist for windows in non-habitable rooms. Windows that face the boundary of an adjoining allotment may be used if not less than 600 mm from that boundary or, windows that face another building on the same allotment may be used if not less than 1200 mm from the building. Conditions concerning the measurement of distances, the openable area of windows and other features are detailed in BCA 3.7.14 and 3.7.1.5d.

Sub-floor vents, roof vents, weepholes, control joints, construction joints and penetrations for pipes, conduits are not considered as openings, refer BCA 3.7.1.2 (c).

4.2.2 External Walls where Class 10A Buildings are Involved

Refer BCA 3.7.1.6.

Garages and other Class 10a buildings can affect wall designation. The BCA shows the way.

The issue of external walls becomes more complicated where Class 10a buildings (such as garages) have an intervening influence between the fire source and the Class 1a building (refer BCA 3.7.1.6 for illustration of this). This potentially causes a redesignation of (fire-resisting) external wall location. Situations affected include where:

- a Class 10a building occurs between a Class 1a building and the allotment boundary;
- a Class 10a building occurs between a Class 1a building and other buildings on an allotment; and
- Class 10a buildings must be separated on an allotment because of ramifications on attached or adjacent Class 1a buildings.

The BCA gives quite a detailed description of the many options available and reference to this is recommended.

4.2.3 Separating Walls

Separating walls are used to provide fire-resistance and sound insulation between attached Class 1a buildings (Figures 1 and 2). Specific requirements pertaining to this include:

- Must have walls with an Fire Resistance Level of not less than 60/60/60.
- Must commence at the footings or ground slab and extend up according to one of the following scenarios:

  – For a non-combustible roof covering the wall must extend to the underside of the roof (Figure 2). The wall must not be crossed by timber members (or other combustible building elements) other than roof battens (maximum 75 x 50 mm) or sarking. Voids between the top of wall and underside of roofing (i.e. between battens) must be filled with solid timber 75 mm thick (min), mineral wool or other suitable fire-resisting material.

  – For a combustible roof the wall must extend 450 mm above the roof as shown in Figure 2.
- Must address potential spread of fire that can potentially occur where the end of a separating wall intersects with a masonry veneer wall and the cavity of the latter walls acts as passage for fire. Here, the cavity must be no greater than 50 mm wide and packed at the wall intersection with fire-resistant mineral wool or other suitable fire-resisting material. The packing must be detailed to meet weatherproofing requirements and further details are given in Step 5 of this Guide.
- Eaves, verandahs and similar spaces that are open to the roof space and are common to more than one Class 1a dwelling must be separated by a non-combustible vertical lining.
- For electrical cables, wires, switches, outlets, sockets or the like penetrating a separating wall, the wall at the penetration must achieve an Fire Resistance Level of 60/60/60 and must be tested in accordance with AS 4072.1 and AS1530.4.
- Other conditions also apply including the spacing between certain penetrations; the accuracy of installation; the treatment of residual gaps between the wall and electrical fitments/cables; the treatment of cavity spaces behind electrical fitments with fire-resisting materials. These aspects are addressed in Step 5 of this Guide.

4.2.4 Combined External and Separating Wall

In the situation where adjoining Class 1a buildings are stepped in height, there comes a situation where there is confusion over which part of the wall is a separation wall and which is an external wall (Figure 10). In these circumstances the BCA is silent and it is recommended that the wall above the lower roof line is treated as a fire-rated external wall.

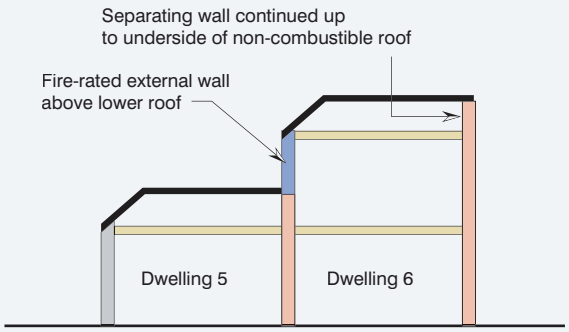

Figure 10: Stepped roof line in Class 1a buildings.

4.3 The Next Step

Having used the previous information to obtain a strong understanding of fire-resisting construction requirements in the BCA, go to Step 5 to select complying timber-framed construction.

5

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

This Step focuses on matching the previously discussed Acceptable Construction Practices for both sound (e.g. $R_W + C_{tr}$) and fire (e.g. FRLs) with appropriate timber-framed construction. This Step begins by explaining key principles used in timber-framed construction to address sound and fire 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 services and similar situations.

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

5.1.1 Fire-Grade Linings Provide the Primary Source of Protection to Fire-Rated Timber-Framed Walls

The greater the number of layers, the greater the resistance to fire. This is evident when viewing the main fire-resistant timber framing systems described and shown in Section 5.2. Additional measures, as detailed below, 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 another area of concern. Extra attention is also needed at penetrations, openings and protrusions.

5.1.2 Construction Joints

In relationship to fire-resistance only Construction Joints 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 as shown in Figure 11
- fire-resisting sealant as shown in Figure 12.

More layers = better fire resistance.

Laps, edges, penetrations, openings and protrusions have the opposite effect.

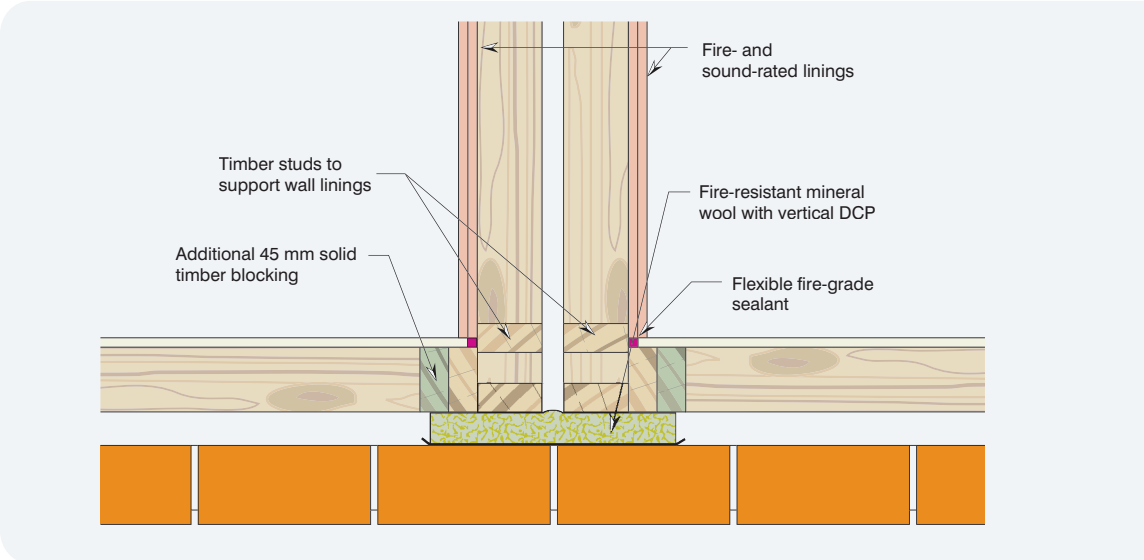

Figure 11: Fire-resisting mineral wool – plan view.

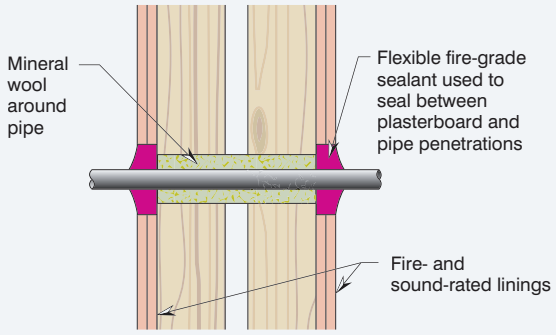

Figure 12: Fire-resistant sealant – elevation view.

By forming a char layer when it burns, solid timer can achieve the fire resistance of fire-grade linings.

Solid timber can be used as construction joints as they can achieve the equivalent fire resistance as fire-grade linings. 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 and species, in general, the more pieces of solid timber added to the joint, the longer the joint will last. Common locations where solid timber is used include wall junctions and floor junctions (Figure 13).

For information on the details of this joints in common location, refer to Section 5.4.

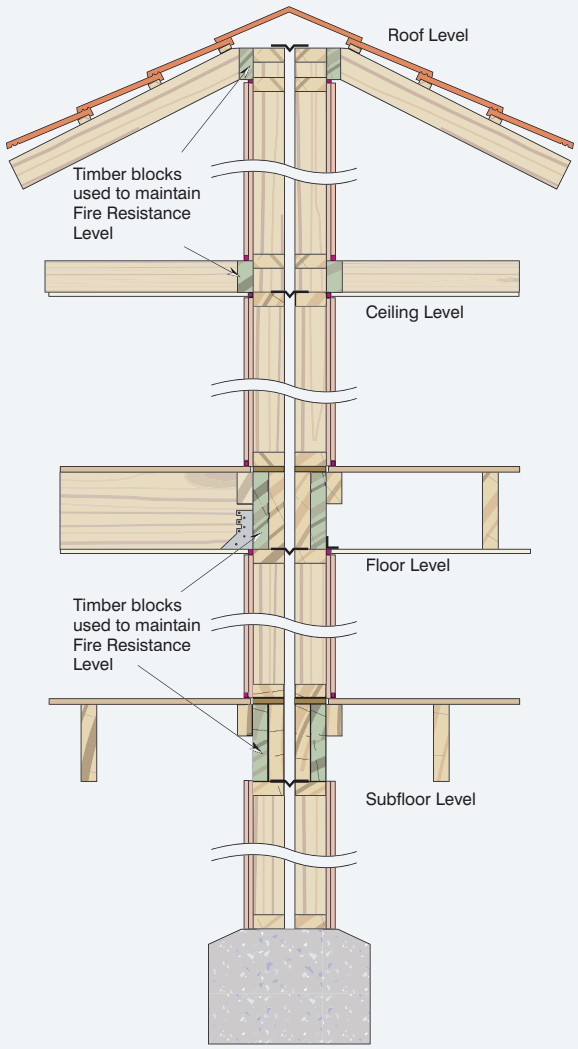

Figure 13: Common location of timber blocks that act as construction joints – elevation view.

For treating weak spots, suitable sealants have fire and sound ratings.

5.2 Principles for Achieving Sound Insulation in Timber-Framed Construction

Increasing mass of wall and floor elements can be particularly useful in reducing airborne sound transmission. A simple and effective means of doing this is to increase the thickness of wall linings and this is often achieved with the above mentioned fire-grade linings.

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

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 of the wall to the other. If required for structural stability, sound-resilient structural connectors should be used and should generally only be used at each floor or ceiling level.

Using absorptive materials to fill wall cavities can reduce airborne sound transmission. Cellulose fibre, glass fibre, polyester or mineral wool is generally used for this purpose.

Sealing sound leaks at the periphery of wall and floor elements or where penetrations are made for electrical and plumbing services. This is particularly important because penetrations create a weak spot in the system. Flexible sealants are often used in such situations and often have both a fire and a sound rating which enables requirements to be met.

5.3 Sound- and Fire-Rated Wall Construction Systems

Timber framed construction systems that have been developed to meet these fire and sound principles are shown in Figure 14 to Figure 16 and include:

- sound- and fire-resistant double stud walls, i.e. for separating walls (Figure 14);
- fire-resistant single stud, external clad walls (Figure 15); and
- fire-resistant brick veneer external walls (Figure 16).

These and similar systems are commonly provided using proprietary lining and insulation products. Each product must be assessed in order to prove compliance with the BCA. As a result, only the main design themes are shown in the drawings below.

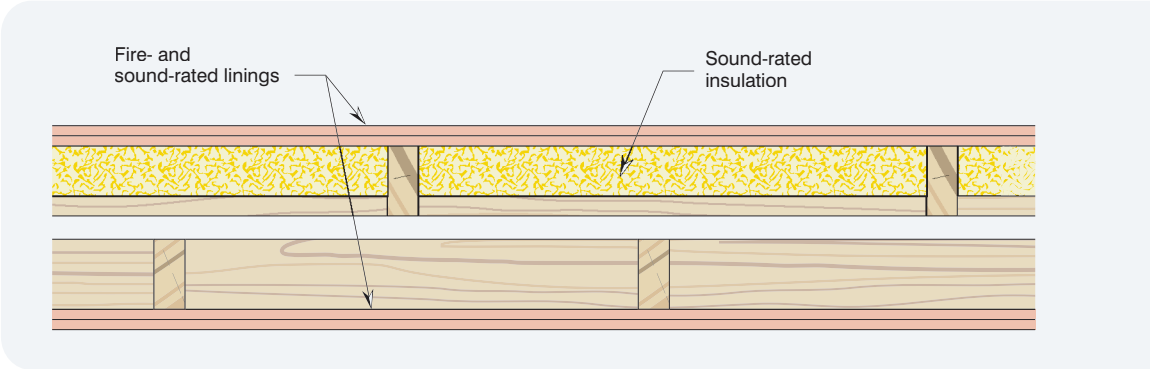

Figure 14: Fire- and sound-rated double stud separating wall systems – plan view.

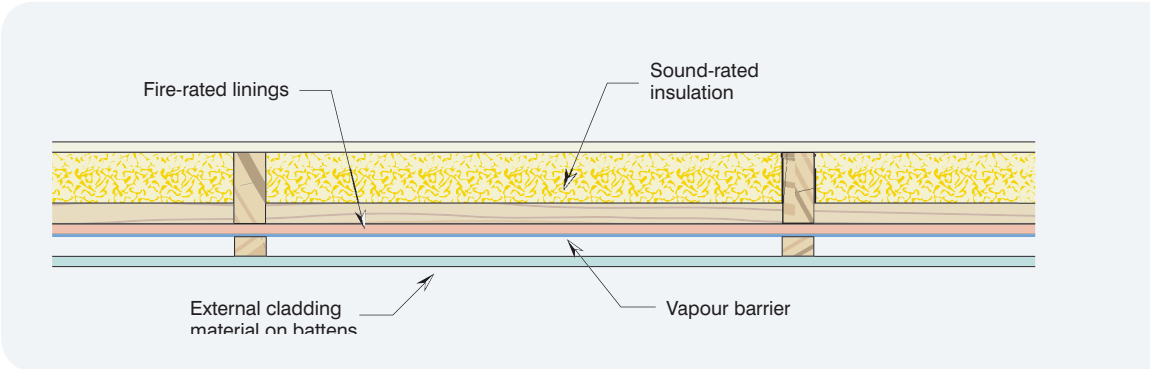

Figure 15: Fire-rated external stud wall systems (outside only) – plan view.

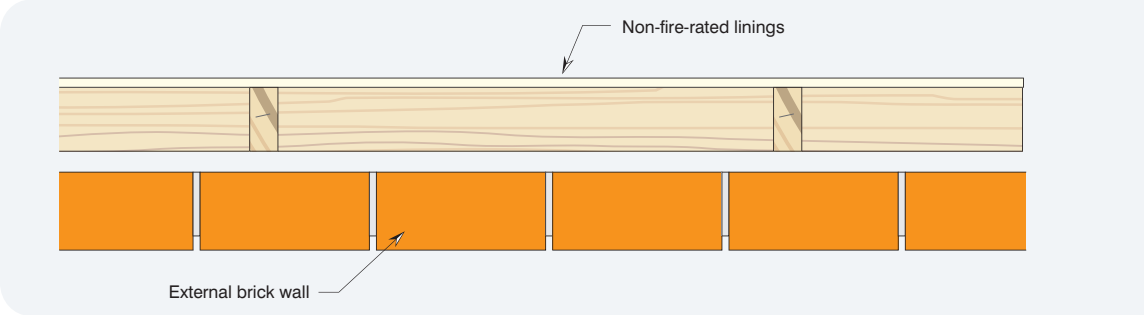

Figure 16: Fire-rated external brick veneer wall systems (outside only) – plan view.

5.4 Solid-Timber Construction Joints

As explained in Section 5.1, solid timber is used as an equivalent to fire-grade linings, the more blocks used 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. A variety of common situations are shown in Figures 17, 18, 19 and 20; each system shows different ways to maintain the walls' integrity and are dependent on the installers preference and available support to the linings.

More solid timber blocks = greater fire resistance.

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

Timber blocks can be used to close off walls where internal non-rated walls abut fire- and sound-rated walls. The blocking can be in the form of studs. Where the non-rated internal wall is loadbearing, the timber blocks used to maintain fire resistance generally cannot be used to support load.

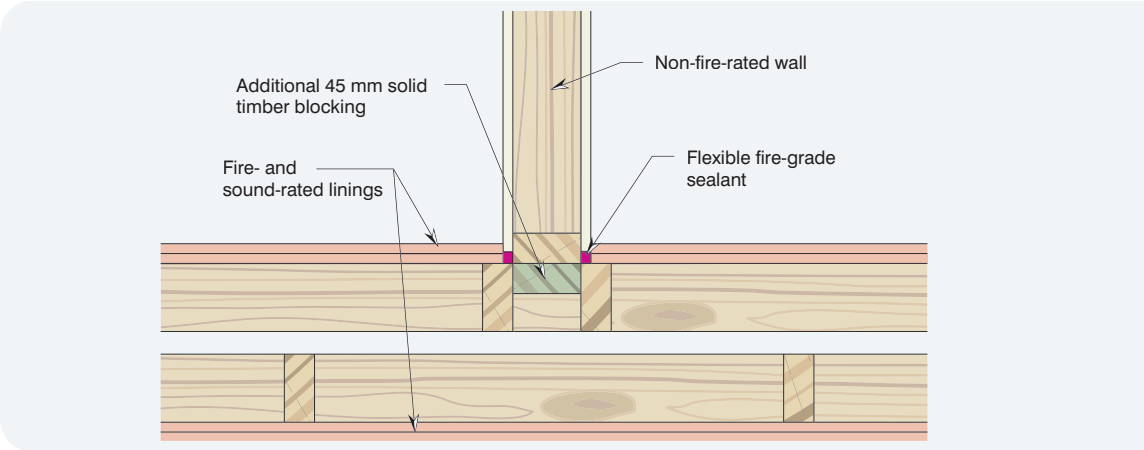

Figure 17: Junction between fire-rated and non-fire-rated and/or lower fire-rated wall – plan view.

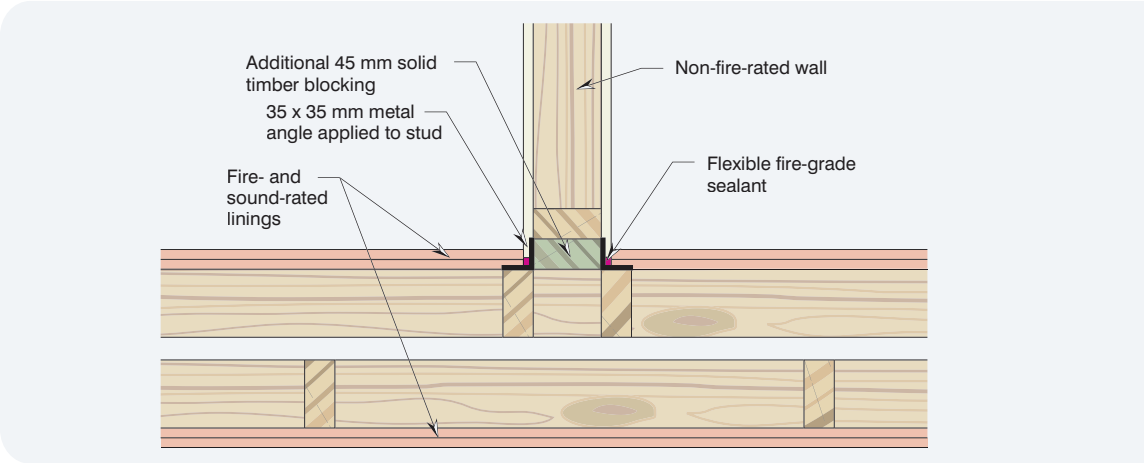

Figure 18: Junction between fire-rated and non-fire-rated wall – alternative method using metal angles – plan view.

If fire strikes, floors must be able to collapse while leaving separating walls intact.

5.4.2 Non-Rated Floor Abutting Rated Wall

Non-rated floors interfere with the wall lining to the separating wall. In this case timber blocks can again be employed. The following details a number of options that can be utilised and are generally dependant on individual choice or the framing situation. No one option is preferred.

In all cases it is also important to note that in the event of a fire, the flooring and floor joists must be free to rotate away from the separating wall. This requires that the floor sheet or boards not to be continuous under the separating wall framing. It is recommended that separate packers be used, or the flooring is sawn in this region.

Solid-Timber Blocking

Blocking is to be solid timber and measure at least the joist depth. For a Fire Resistance Level of 60/60/60, the timber blocking thickness is to be minimum of 45 mm.

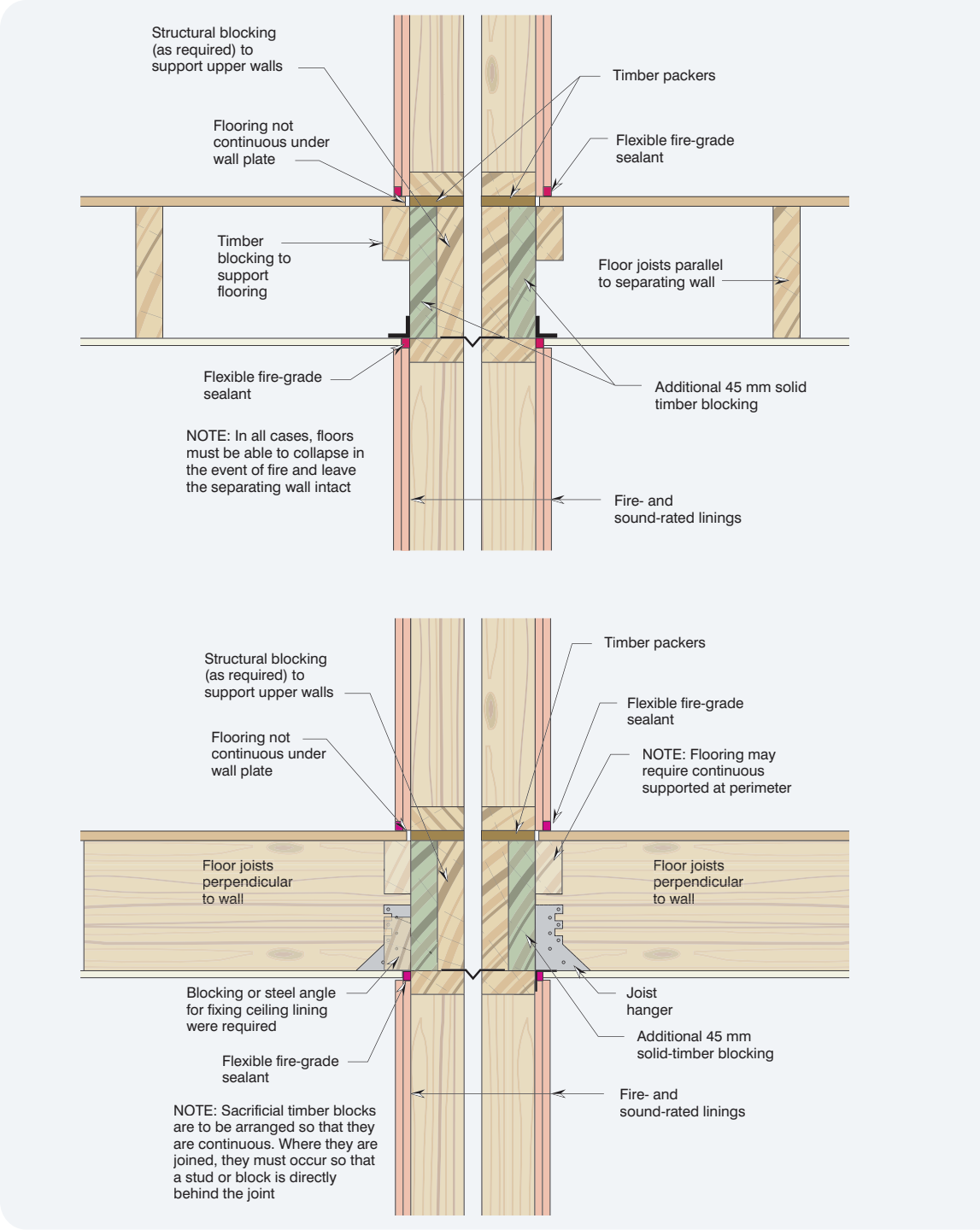

Figure 19: Joist parallel and perpendicular to wall, wall stud not continuous through junction – elevation view.

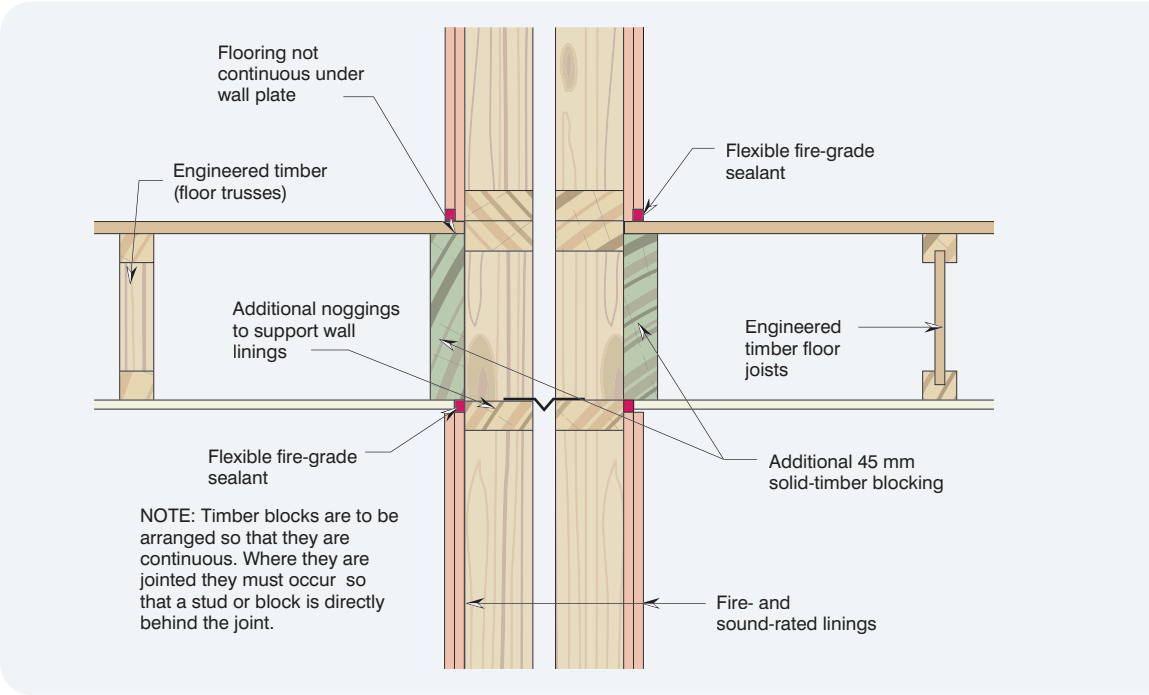

Figure 20: Wall stud continuous through junction with timber blocks – elevation view.

Burning joists that are free to rotate don't snag the wall above.

Fire Pockets in Separating Wall

Another method is to create pockets within the separating wall that allow the joists to bear on the wall. This detail can be achieved by utilising a similar technique discussed for double joists (refer to section 5.4.2.1) where one continuous solid timber joist the same depth of the joist system provides the fire protection. Where it is required to be joined, it must be butted closely, and the joint must be at least 100 mm away from any fire pocket formed.

The floor joists, being solid timber, I-beams or floor trusses, can now bear onto the top of the wall. Between the joists, additional solid-timber blocks the same depth and thickness as the inner blocking are to be tightly cut-in. The main floor joists are not to be nailed to blocking, any nailing is to occur at the base of the joist into the wall plate only. The timber packer directly above the joist that sits in the pocket is to be removed for the pocket portion width. This is to allow the joist to rotate in a fire event and not catch the bottom of the wall above (Figures 21 and 22).

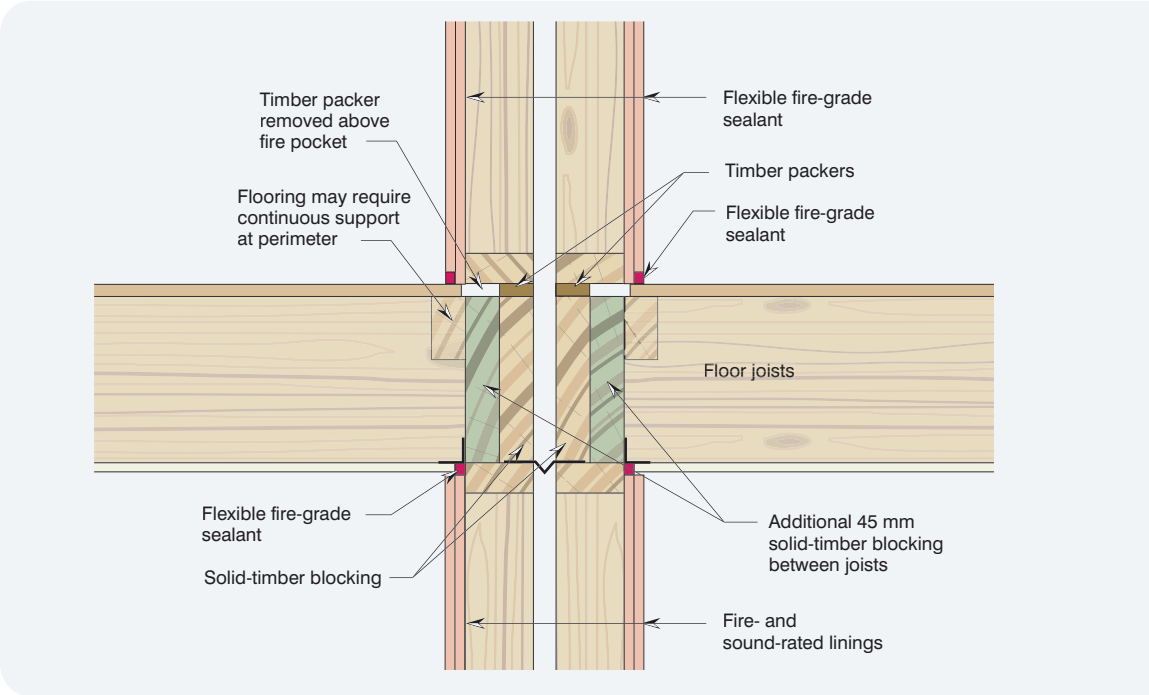

Figure 21: Fire pockets in separating wall – elevation view.

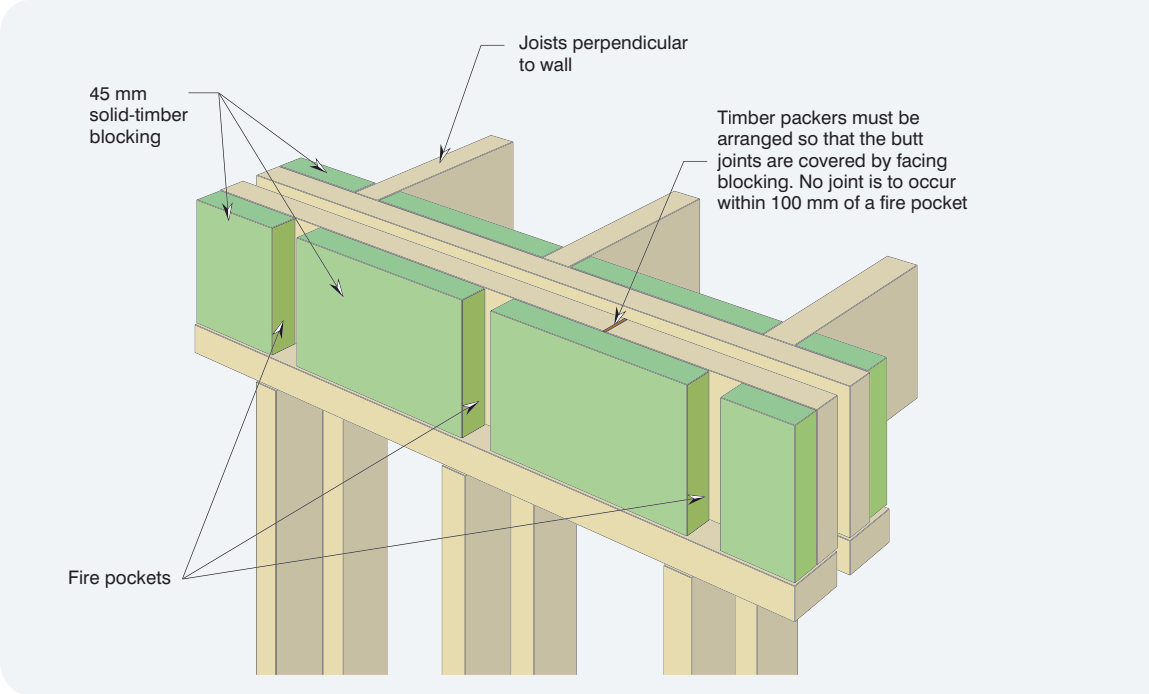

Figure 22: Pockets created in separating wall to accommodate floor joists – perspective view from above.

Top Chord Support Detail for Floor Truss

Floor trusses are commonly used as floor joists. This form of floor joist has the unique ability to be top chord supported. A similar support mechanism as the pocket described above can be used. Here only the top chord needs to be pocketed (Figure 23). An alternative method is to form a ledger to support the floor truss top chord (Figure 24).

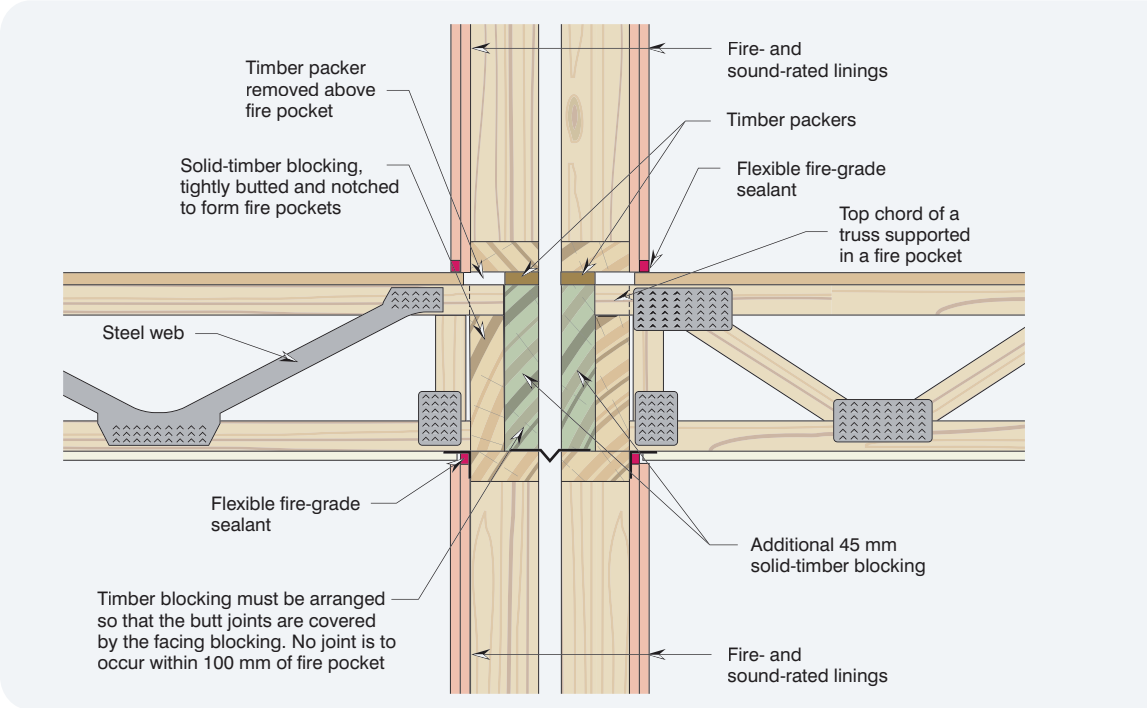

Figure 23: Floor truss top chord support in pockets – elevation view.

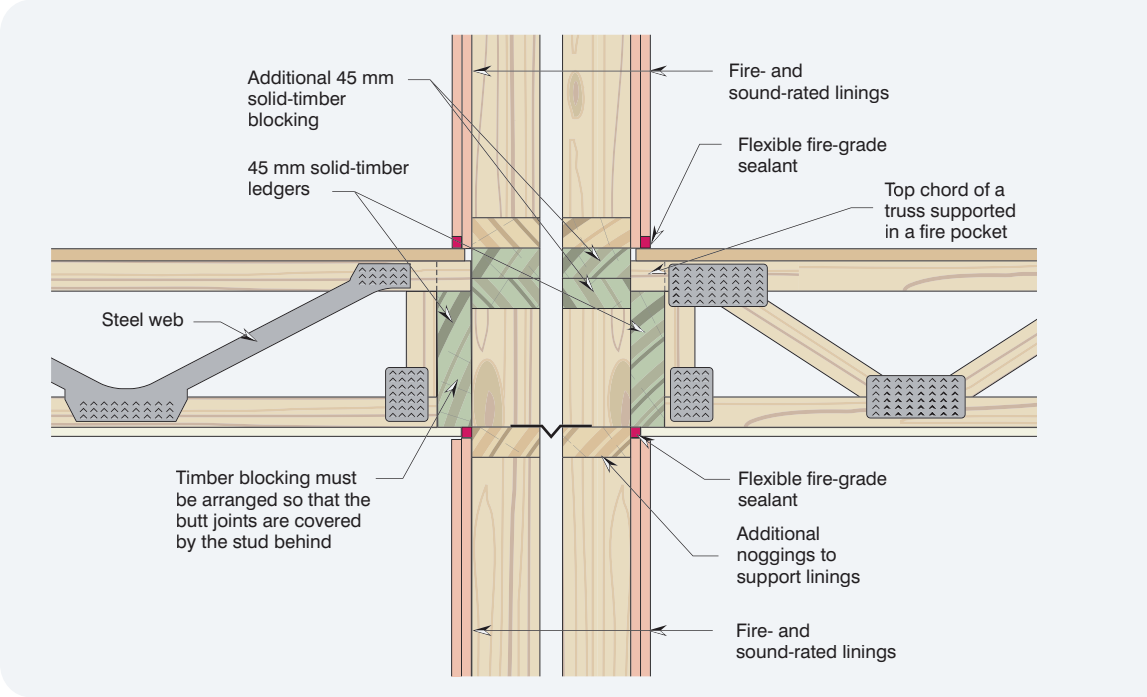

Figure 24: Floor truss top chord support on timber block – elevation view.

Separating walls must be fully grounded.

5.4.3 Lowest Floor and Subfloor

Where the lowest floor is elevated off the ground there is a requirement to continue the separating wall to the ground. Typically, a concrete or masonry plinth that is at least 75 mm higher than the finished ground level can be utilised.

Where the floor intersects with the separating wall, the construction details to maintain fire and sound resistance are similar to the junction of floors at the first floor level. Care is required to ensure construction in the subfloor region is durable for the location (Figure 25).

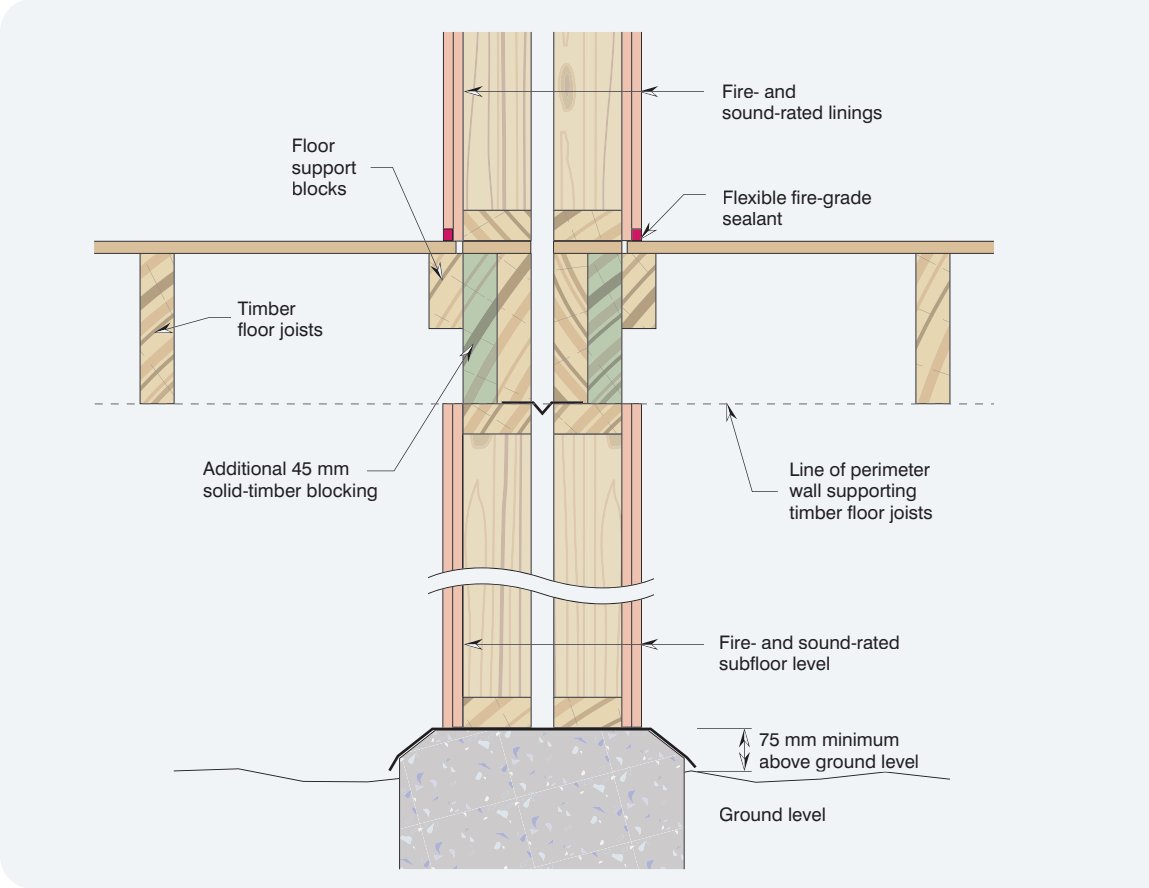

Figure 25: Subfloor details – elevation view.

5.5 Treatment of Roof Voids

As mentioned in Section 3.2, there is the possibility of fire and sound jumping from one dwelling to another through the roof void. To prevent this occurring in timber-framed construction, the fire/sound wall is continued through the roof void to the roof covering.

5.5.1 Roof Framing or Trusses Parallel to Separating Wall

Where the roof framing is parallel with the separating wall there are no special details other than to allow enough room to install the fire-grade linings (Figures 26 and 27).

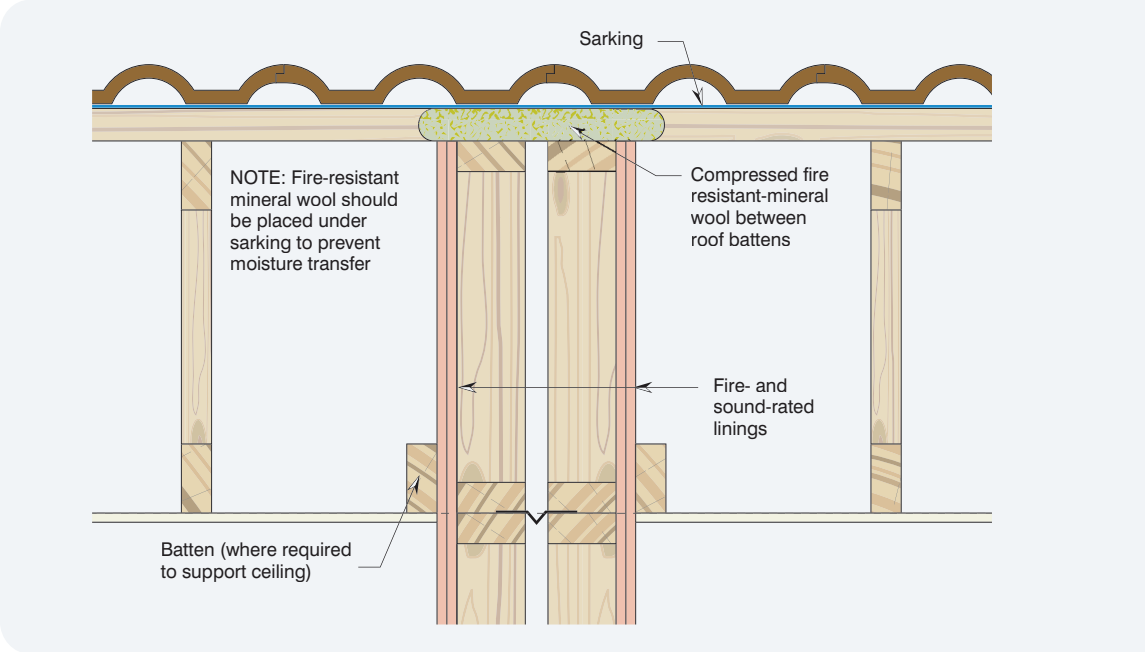

Figure 26: Double stud fire/sound rated wall in roof cavity – elevation view.

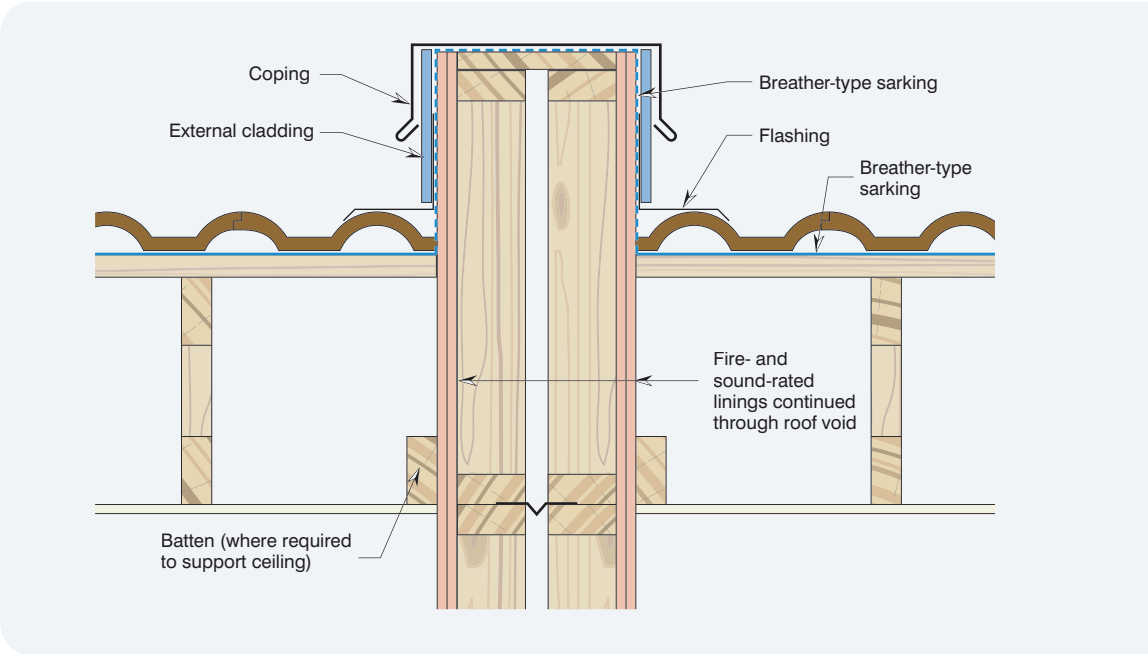

Figure 27: Separation wall above the roof line – elevation view.

5.5.2 Roof Framing or Trusses Perpendicular to Separating Wall

Where roof framing or trusses are perpendicular to the separating wall they need to be supported off the wall by the use of timber blocks as discussed for floor joists. The same technique can be utilised here (Figures 28 and 29).

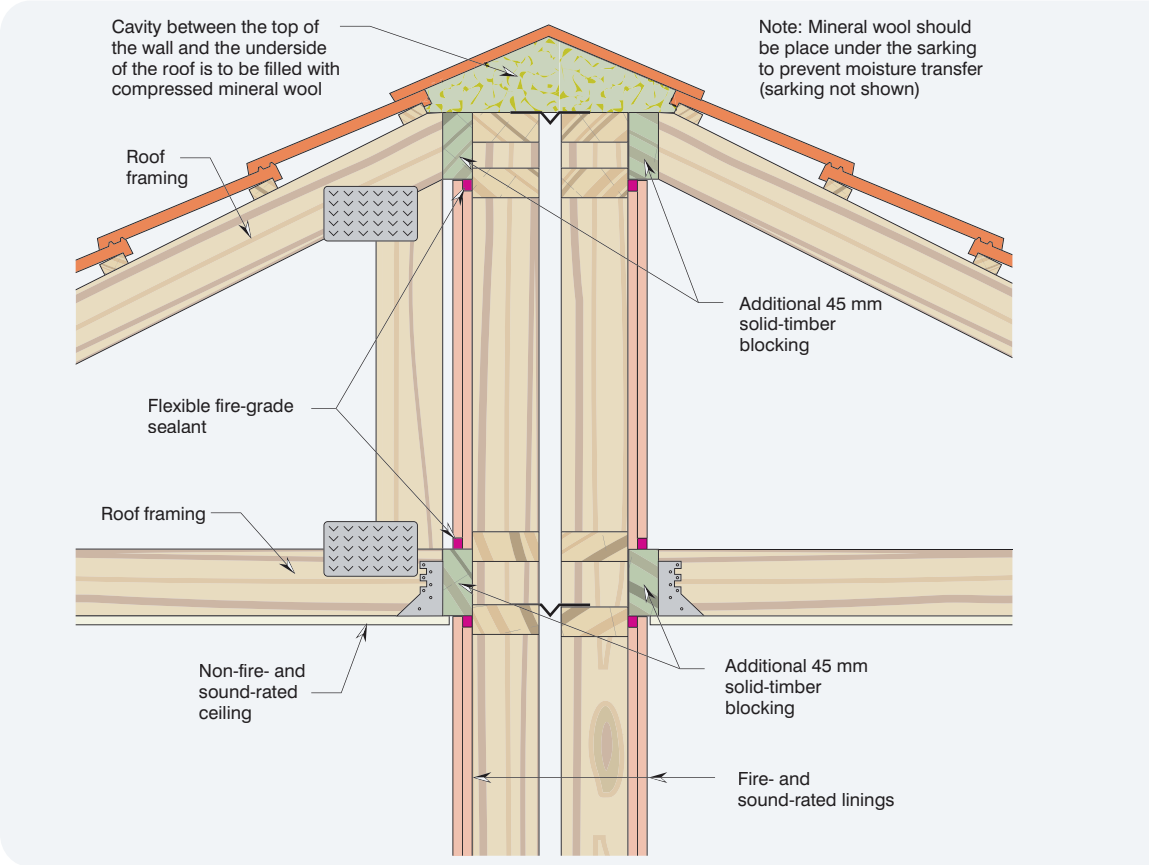

Figure 28: Trusses or roof framing support off separating wall – elevation view.

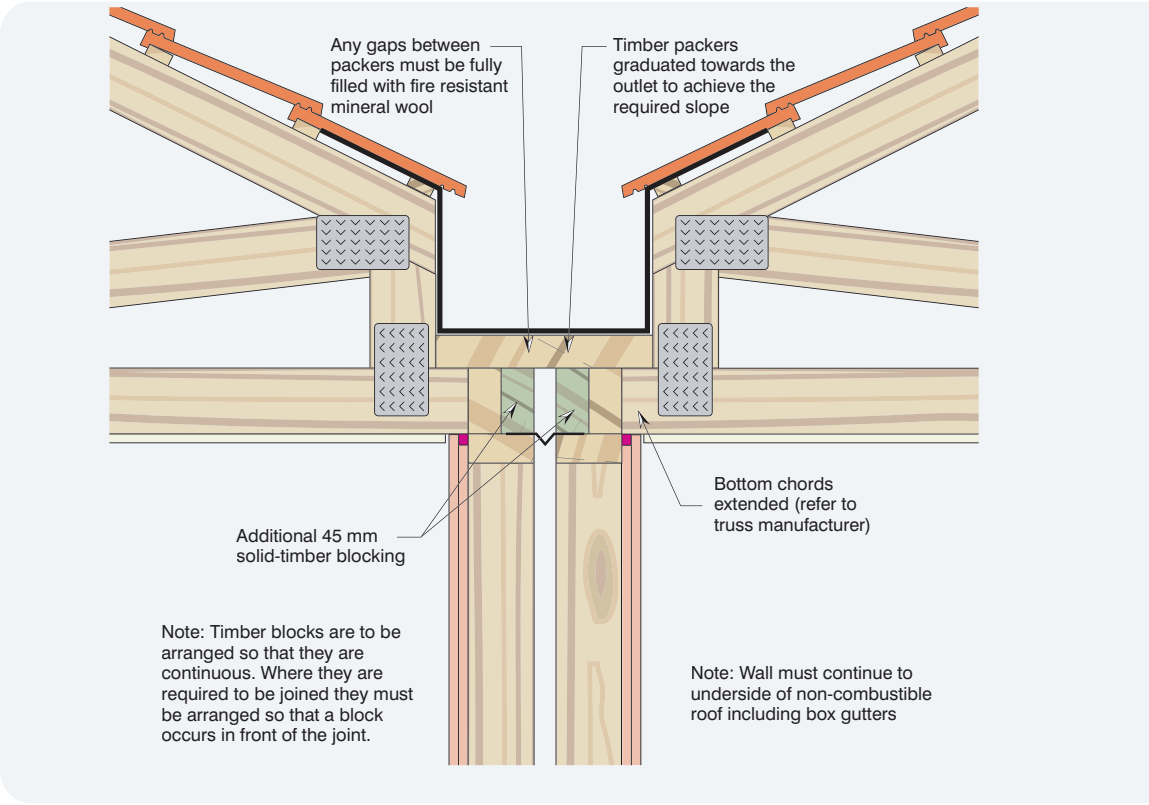

Figure 29: Typical box gutter detail at top of separating wall – elevation view.

Alternatively, a girder truss can be utilised to support the roof framing or trusses off the separating wall to allow access to uninstall the fire-resistant linings (Figure 30).

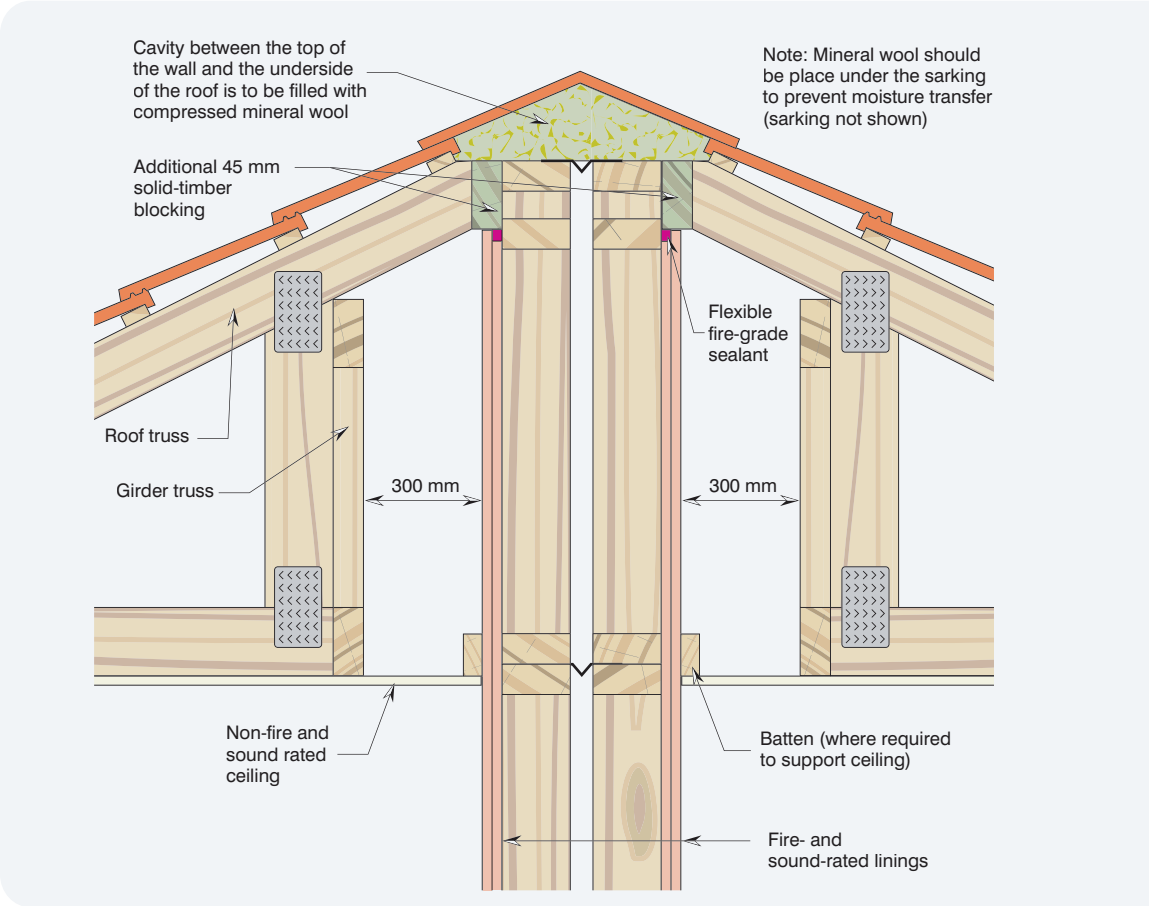

Figure 30: Alternative support detailing girder truss running parallel to wall, allowing access for wall lining installation – elevation view.

These days, roof 'voids' are anything but!

5.5.3 Eaves and Verandah Roof Voids

Where eaves and verandah roofs are open to the roof space and are common to more than one dwelling, the roof void is required to be separated by non-combustible linings.

This can be achieved by the inclusion of fibre-cement or plasterboard lining to one side of the framing as shown in Figure 31 or closing of the space back to one of the dwellings as shown in Figure 32.

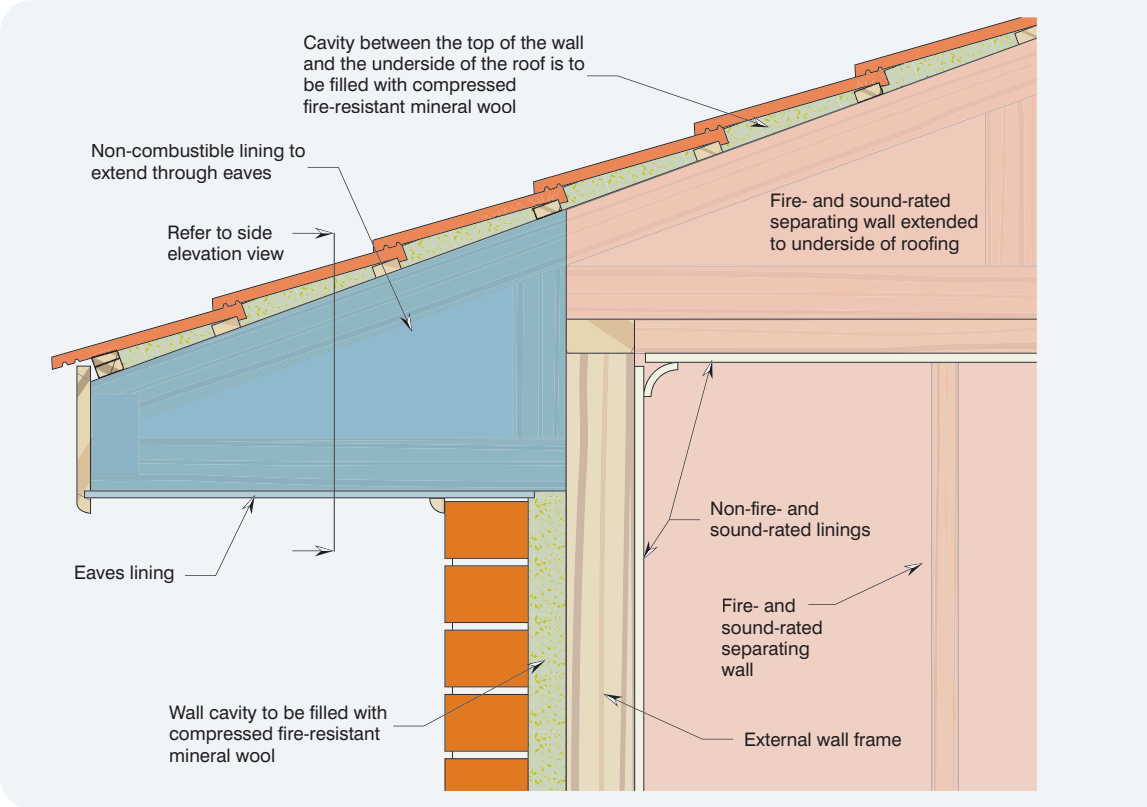

Figure 31: Eaves blocking – front elevation view.

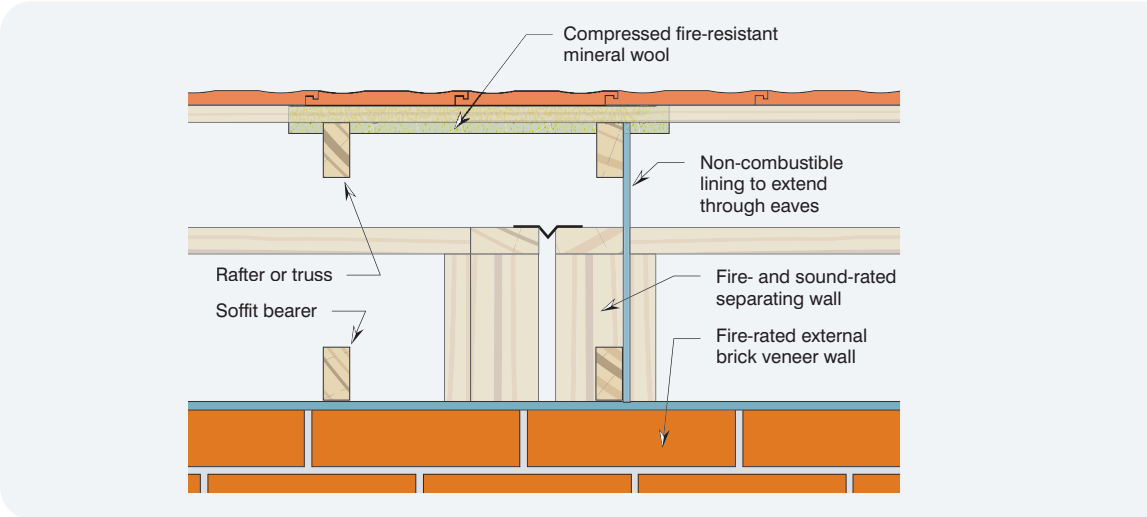

Figure 31a: Eaves blocking – side elevation view.

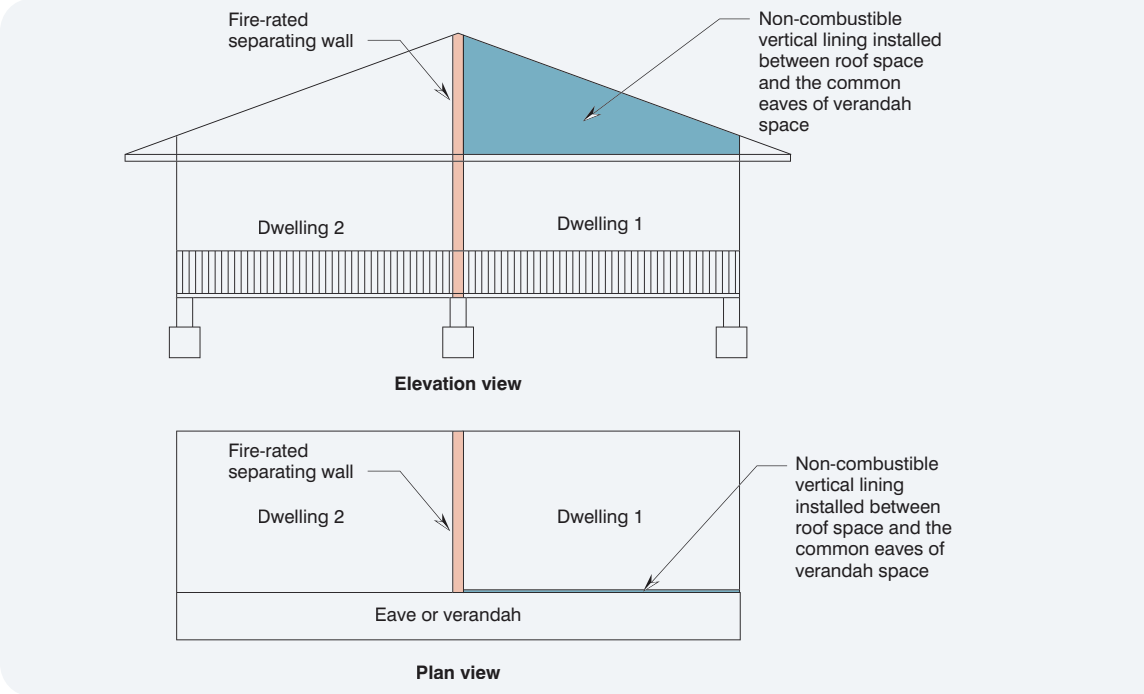

Figure 32: Sealing of eaves or verandah voids.

5.6 Separation Wall Abutting External Walls

5.6.1 Brick Veneer Cavity

Cavity materials must be fire resistant and durable.

The gap formed at the end of the separating wall and the external brick skin of the brick veneer wall requires fire-resistant construction. Timber blocks are used to extend the separating wall to the cavity. Within the cavity the materials used must be fire-resistant and durable. Figure 33 details fire-resistant mineral wool and a moisture break between the brick skin and the fire-resistant material is required.

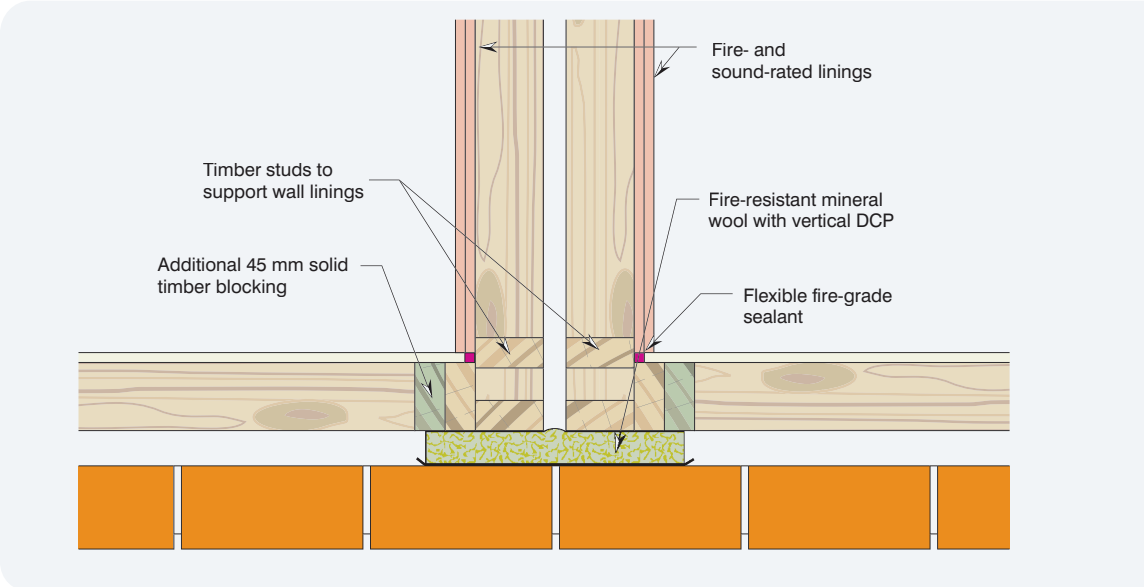

Figure 33: Fire-resistant mineral wool in brick veneer cavity – plan view.

5.6.2 Separating Walls at Staggered External Wall Alignments

Where dwellings are offset to each other continuation of the separation wall is recommended. Figure 34 details typical additional fire-resistant construction.

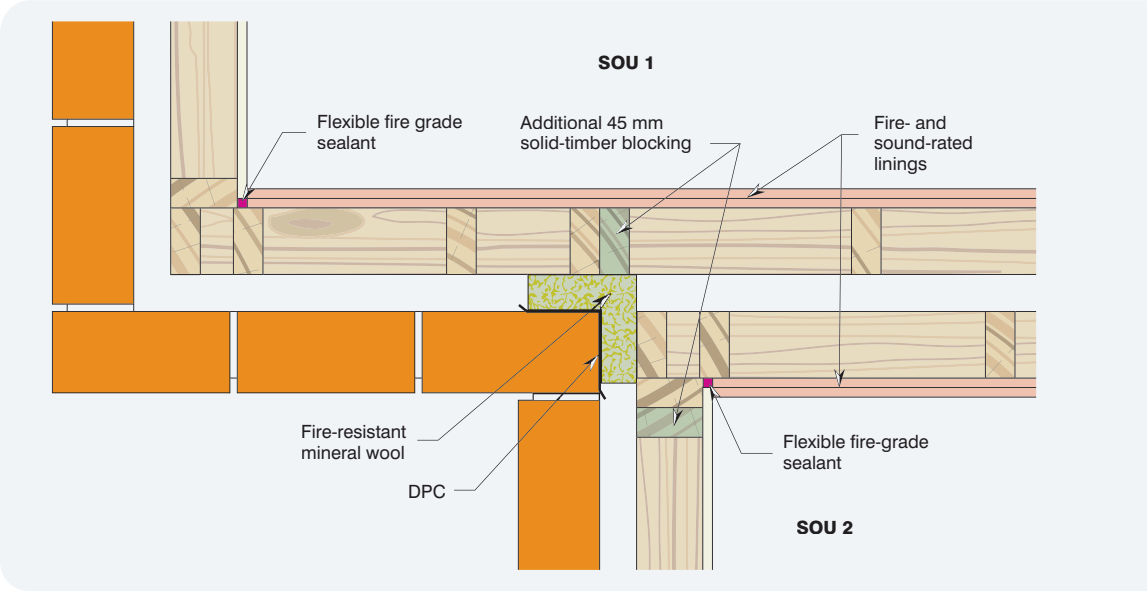

Figure 34: Additional blocking in offset dwellings – plan view.

5.6.3 Lightweight Wall

For lightweight walls, timber blocking is only required to extend the separating wall to the exterior lining (Figure 35).

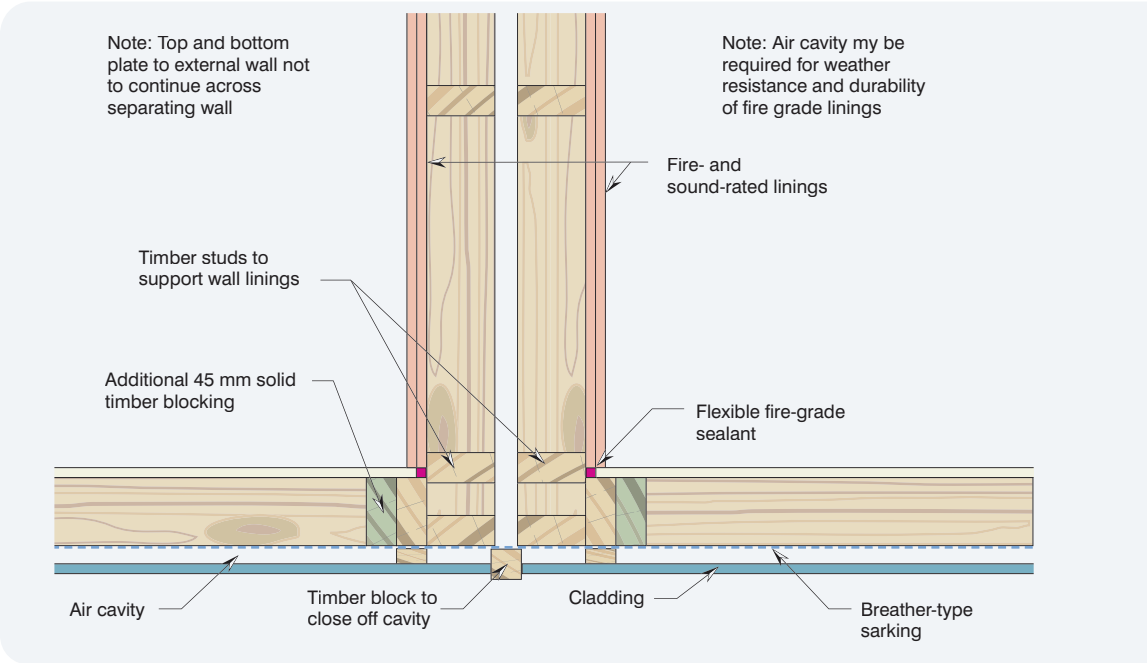

Figure 35a: Lightweight walls – plan view.

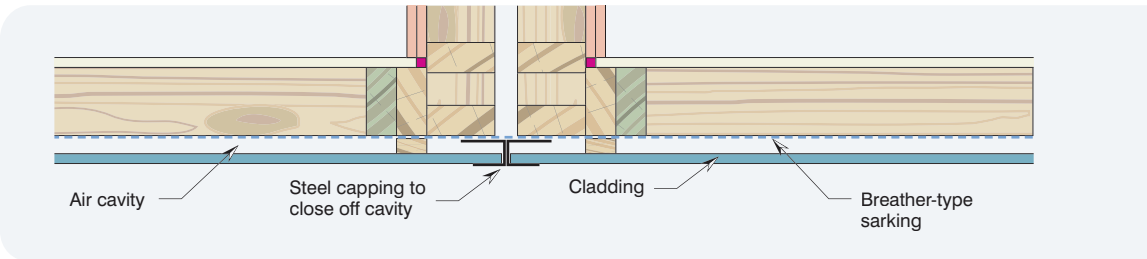

Figure 35b: Lightweight walls – alternative detail – plan view.

5.6.4 Staggered Roof Linings at Separating Walls

Although no guidance is given in the BCA, it is recommended that where separation walls in staggered roof linings are made, that the higher leave of the separating wall is continued up to the highest roof line. Fire resistance is to be maintained as for Figure 36.

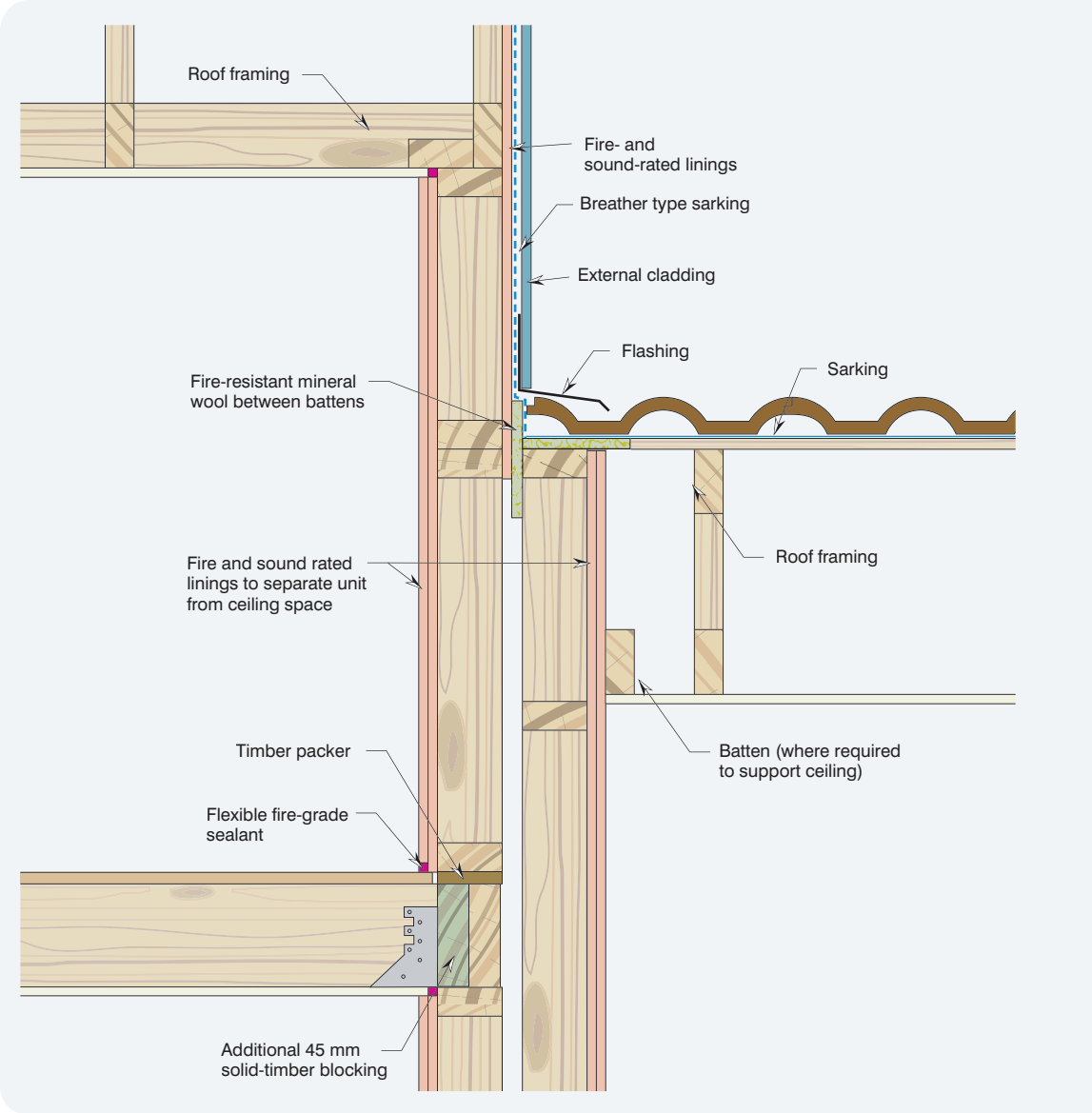

Figure 36: Staggered roof lines meeting at a separating wall – elevation view.

5.7 Steel Columns in Separating Walls

Steel beams can create complications, but solutions are at hand.

In modern living there is often a need to provide large openings. In typical timber-framed townhouse construction there may be a large opening at the end of the building spanning between separating walls, supporting brickwork above.

Often it is desirable to enclose the beam and its support within the timber framing, meaning that the steel beam column supports are often housed in the separating wall. This creates a complication in maintaining fire resistance as the steel beam is normally not fire protected, and during a fire, the steel beam may collapse and impair the separating wall.

To account for this, testing has been carried out to design a steel beam and its column enclosed within the wall. To achieve this outcome it is necessary to create a pocket for the steel beam to sit within the wall. Then, during a fire, the beam may rotate out of the pocket, leaving the separating wall intact.

This pocket is achieved by sitting the steel beam on top of the column with no physical connection other than bearing. The column is located by the surrounding timber framing, and is fire protected as the fire-rated linings run pass the column face.

Mineral wool features heavily in fire-resistant designs.

The beam sits in its own created pocket with timber framing surrounding it. Fire safety is achieved by using fire-resistant mineral wool packed in and around the beam. A metal flashing is placed at the back of the pocket to seal the pocket from the separation wall cavity.

Directly above where the beam will sit in the pocket it is necessary to leave a minimum of 20 mm gap to allow this rotation of the beam. Normally this could simply be achieved by removing the floor sheet or packer at this location. Again fire-resistant mineral wool is placed in this void to maintain the fire rating. Figure 37 is a detailed cut away view of the framing and columns and Figure 38 contains more precise detail information.

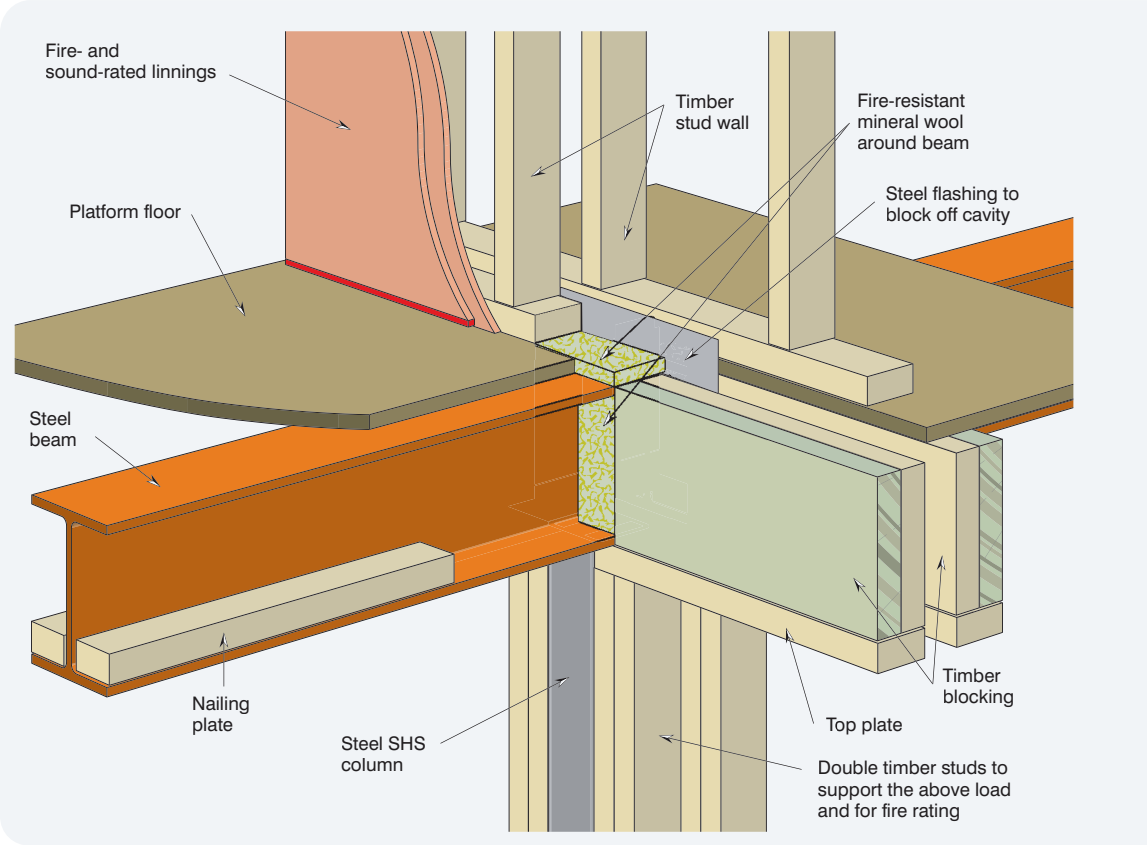

Figure 37: Cut away view of steel beam and column housed in a timber-framed separating wall – perspective view from above.

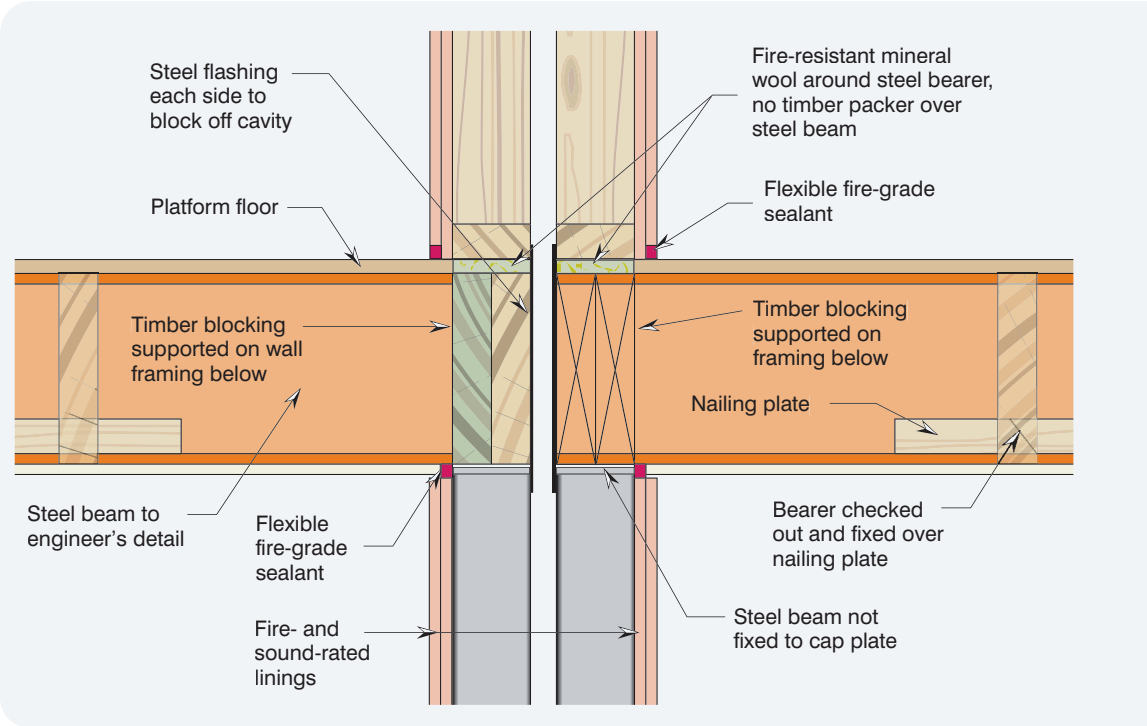

Figure 38a: Details of the steel beam pocket in timber-framed separation wall – elevation view.

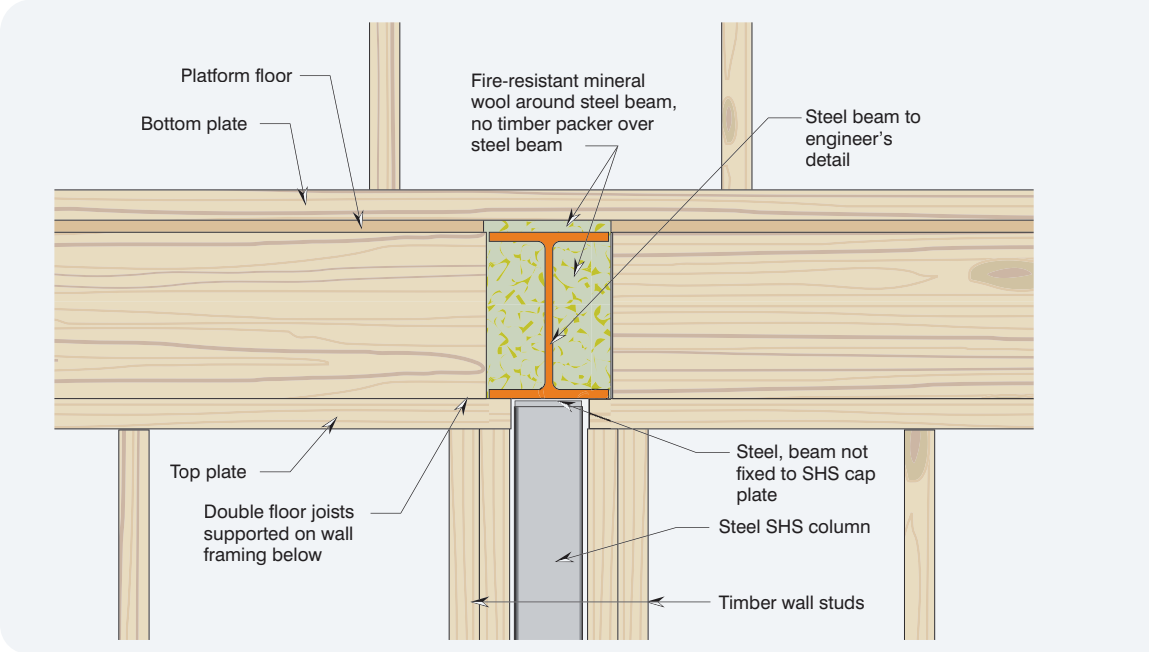

Figure 38b: Details of the steel beam pocket in timber-framed separation wall – elevation view.

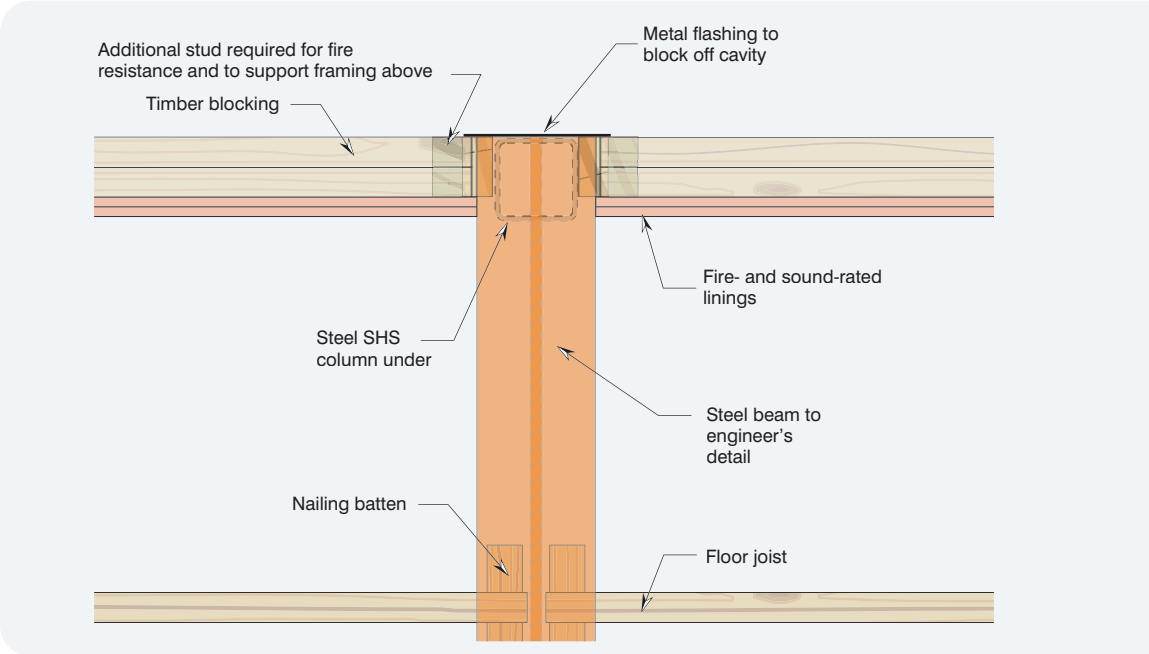

Figure 38c: Details of the steel beam pocket in timber-framed separation wall – plan view showing one wall leaf only.

5.8 Service Penetrations

Strive to minimise service penetrations of separating walls.

The installations of plumbing or electrical services in separating walls have the potential to reduce the fire and sound performance. Where possible, these services should not be located within separating walls, i.e. place them in neighbouring internal walls or false walls over the separating wall.

Where services within separating walls cannot be avoided, the integrity of the wall must be maintained for both sound and fire resistance.

Two options are available, either using the Deemed to Satisfy Provisions in the BCA Clause 3.7.1.8 and 3.8.6.4, or using a system that has been tested for the fire resistance and acoustic performance required.

6

Step 6 – Further Design Assistance (Appendices)

The previous Steps in the Guide require consideration of additional information on topics closely linked to the design of fire- and sound-rated construction. The following appendices cover structural design considerations, Deemed to Satisfy fire requirements not covered by this Guide, other design references and a glossary.

Appendix A – Resolving Structural Design Considerations and Construction Practices

Loads, timber member sizes and construction practices not described in the Guide should be determined in accordance with AS 1684 – Residential Timber-Framed Construction Standard.

In designing stud sizes for fire-rated walls it is necessary to consider a special load condition for fire. This is another load condition required by the loading and timber engineering standards. In most cases today, the wall systems offered by lining manufacturers are not sensitive to the fire load condition as long as the walls are laterally supported at a maximum of 3.0 m intervals, discussed in more detail below. As this manual does not go into the particular design details of proprietary systems, reference to the provider of the fire-rated wall system is required to ensure this fire condition design is satisfied or is required.

It's ironic that the best structural designs pay heed to their possible destruction.

A key consideration is the need for fire-load design as the lateral support from the floor and ceiling structure cannot be taken into account when it is from the potentially fire-affected side. As separating walls are normally double stud there will potentially be no lateral restraint to the entire wall height (i.e. on the fire side of the separating wall). This is because the floor or ceiling framing on one side of the wall is designed to rotate away during a fire without dragging the wall with it. This means that under fire, the separating wall can stay in place to carry structural loads and retain the fire-resistant linings.

The 3.0 m height reflects the maximum height fire testing of walls is typically undertaken. As a result, extra structural support is required in the wall system to deal with the gap between theoretical assumptions and what is achievable in practice. In a double stud wall this is commonly dealt with under the assumption that the non-fire affected side of the wall will remain laterally restrained by the first floor and ceiling, even though the floor on the (other) fire affected side has burnt and rotated away.

Resilient structural connectors are then used to hold the fire affected side of the wall, to the non-fire affected side. Such ties are typically placed at each floor and ceiling level (only) as the BCA requires discontinuity of light weight walls except at their periphery. It is important that these ties be 'acoustic ties' in order to prevent sound transmission across the wall structure. Such ties are typically placed at 1200 mm spacings (Figure A1).

Ties at the roof line are normally achieved by the tile or roof sheet battens. Where battens are not tying the top of the wall, additional ties will be require.

It is also important to note to allow this rotation of the flooring away from the separating wall requires that the floor sheet or boards not be continuous under the separating wall framing. It is recommended that separate packers be used under the bottom plate or the flooring is saw cut in this region.

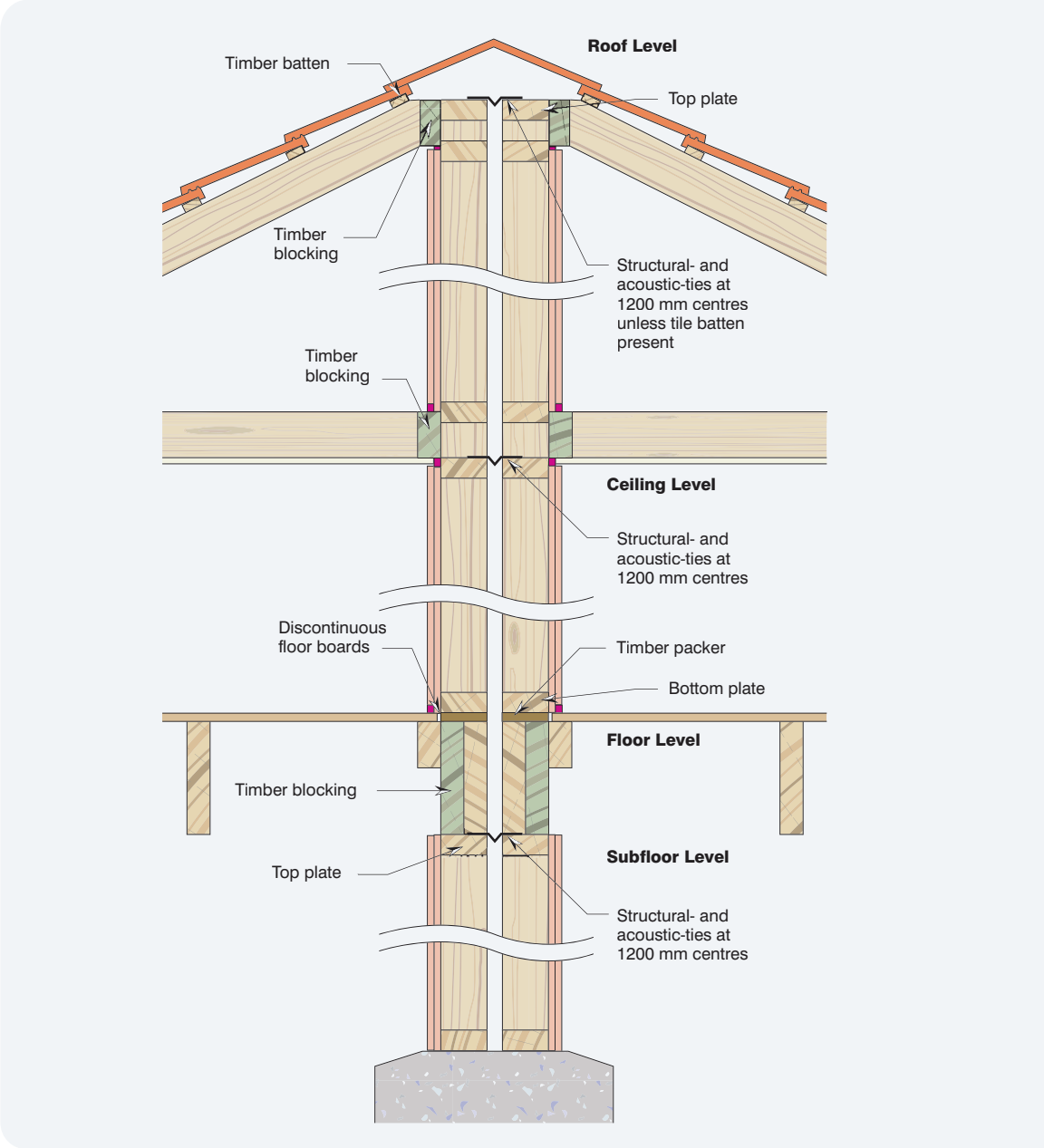

Figure A1: Structural and acoustic ties used to laterally support the separating wall – elevation view.

Appendix B – Design References

Design References

Australian Building Codes Board

- Building Code of Australia (BCA) 2009 – Volume 1 & 2.

Australian Standards

- AS1530.4 – Methods for fire tests on building materials, components and structures – Fire-resistance tests on elements of construction.
- AS1684 – Residential Timber Framed Construction Standard.
- AS/NZS 1267.1 Acoustics – Rating of sound insulation in buildings and building elements.
- AS/NZS 2908.2 – Cellulose cement products – Flat sheets.
- AS4072.1 – Components for the protection of openings in fire-resistant separating elements – Service penetration and control joints.

WoodSolutions

The following publications are available as free downloads at woodsolutions.com.au:

- #02 Timber-Framed Construction for Multi-Residential Buildings Class 2, 3 and 9c – Design and construction guide for BCA compliant sound- and fire-rated construction
- #03 Timber-Framed Construction for Commmercial Buildings Class 5, 6, 9a and 9b – Design and construction guide for BCA compliant fire-rated construction

Free resources available at woodsolutions.com.au

Test and Assessment Reports

Bodycote Warringtonfire (Aus)

- 22567A Assessment Report: The likely fire resistance performance of timber-framed walls lined with plasterboard if tested in accordance with AS 1530.4 2005, September 2008.
- 22567B Assessment Report: The likely fire resistance performance of MRTFC wall floor junctions if tested in accordance with AS 1530.4 2005, September 2008.
- RIR 22567B Regulatory Information Report: The likely fire resistance performance of MRTFC wall floor junctions if tested in accordance with AS 1530.4 2005, September 2008.
- 2256701 Test Report: Fire resistance test of a timber wall floor junction in general accordance with AS 1530.4 2005, September 2008.
- 2256702 Test Report: Fire resistance test of a wall beam junction when tested in general accordance with AS 1530.4 2005, September 2008.

Exova Warringtonfire Australia

- 2365300 Test Report: Fire resistance test of floor junctions incorporating timber and plasterboard in general accordance with AS 1530.4 2005, November 2009.
- 2365400 Test Report: Fire resistance test of floor junctions incorporating timber and plasterboard in general accordance with AS 1530.4 2005, November 2009.
- 2365500 Test Report: Fire resistance test of floor junctions incorporating timber and plasterboard in general accordance with AS 1530.4 2005, November 2009.

Appendix C – Glossary

BCA

Building Code of Australia (BCA) 2009 – Volume 1 – Class 2 to 9 Buildings.

Cavity barrier

A non-mandatory obstruction installed in concealed cavities within fire-rated wall or floor/ceiling systems.

Discontinuous construction

A wall system having a minimum of 20 mm cavity between two separate wall frames (leaves) with no mechanical linkage between the frames except at the periphery i.e. top and bottom plates.

Construction joint

Discontinuities of building elements and gaps in fire-rated construction required by the BCA to maintain fire resistance. Refer to Deemed-to-Satisfy Provision C3.16, Volume 1, BCA.

Exit

Includes any of the following if they provide egress to a road or open space:

- an internal or external stairway
- a ramp complying with Section D of the BCA
- a doorway opening to a road or open space.

Fire-grade lining

Either fire-grade plasterboard, fibre-cement or a combination of both, used to provide the required Fire Resistance Level (FRL) for walls or floor/ceiling systems. Individual linings manufacturers should be contacted to determine the extent to which a given lining material provides fire-resisting properties.

Fire-isolated stair or ramp

A Stair or ramp construction of non-combustible materials and within a fire-resisting shaft or enclosure.

Fire-isolated passageway

A corridor or hallway of fire-resisting construction which provides egress to a fire-isolated stairway or ramp.

Fire-protective covering

- 13 mm fire-grade plasterboard; or
- 12 mm cellulose fibre-reinforced cement sheeting complying with AS 2908.2; or
- 12 mm fibrous plaster reinforced with 13 mm x 13 mm x 0.7 mm galvanized steel wire mesh located not more than 6 mm from the exposed face; or
- Other material not less fire-protective than 13 mm fire-grade plasterboard.

Note: Fire-protective covering must be fixed in accordance with normal trade practice (e.g. joints sealed).

Fire Resistance Level (FRL)

The period of time in minutes, determine in accordance with Specification A2.3 (of the BCA) for the following:

- Structural adequacy
- Integrity
- Insulation.

Mineral wools are not all the same. Check product sheets to ensure correct fusion temperature.

Fire-resisting mineral wool

Compressible, non-combustible, fire-resisting material used to fill cavities and maintain fire resistance or restrict the passage of smoke and gases at gaps between other fire-resisting materials.

Note: The mineral wool to be used in all applications in this manual, must be fire-resisting and therefore must have a fusion temperature in excess of 1160° C. 'Rockwool' type products generally meet these requirements, while 'glasswool' products do not.

Fire-resisting (Fire-rated)

As applied to a building element means, having the FRL required by the BCA for that element.

Fire-resisting construction

Construction which satisfies Volume 2 of the BCA.

Fire-resisting junction

The intersection between a fire-rated wall or floor/ceiling system and or another rated or non-rated system, which maintain the fire resistance at the intersection.

Fire-resisting sealant

Fire-grade material used to fill gaps at joints and intersections in fire-grade linings to maintain Fire Resistance Levels.

Note: The material should also be flexible to allow for movement and where required waterproof as well.

Fire-source feature

Either:

- the far boundary of a road adjoining the allotment; or
- a side or rear boundary of the allotment; or
- an external wall or another building on the allotment which is not of Class 10.

Habitable room

A room for normal domestic activities and includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room and sunroom, but excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, clothes-drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.

Internal walls

Walls within, between or bounding separating walls but excluding walls that make up the exterior fabric of the building.

NOTE: Fire walls or common walls between separate buildings or classifications are NOT internal walls.

Lightweight construction

Construction which incorporates or comprises sheet or board material, plaster, render, sprayed application, or other material similarly susceptible to damage by impact, pressure or abrasion.

Non-combustible

Applied to a material not deemed combustible under AS 1530.1 – Combustibility Tests for Materials; and applied to construction or part of a building – constructed wholly of materials that are not deemed combustible.

Performance Requirements

The objectives, functional statements and requirements in the Building Code of Australia that describe the level of performance expected from the building, building element or material.

R_w

Refer to Weighted sound reduction index.

Unit

Sole-Occupancy unit.

Weighted sound reduction index (R_w)

The rating of sound insulation in a building or building element as described in AS/NZS 1267.11999.

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