



MRTFC

**MULTI-RESIDENTIAL
TIMBER FRAMED CONSTRUCTION**

Class 2 & 3 Buildings

DESIGN & CONSTRUCTION MANUAL

National Timber Development Council

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The information provided will enable designers, local authorities, developers and builders to achieve practical and economical solutions for Multi-Residential Timber Framed Construction (MRTFC).

A companion publication “MRTFC Design & Construction Manual – Class 1a Buildings” describes the requirements for Class 1 dwellings.

The information, opinions, advice and recommendations contained in this publication have been prepared with due care. They are offered only for the purpose of providing useful information to assist those interested in technical matters associated with the specification and use of timber and timber products.

Whilst every effort has been made to ensure that this publication is in accordance with current technology, it is not intended as a exhaustive statement of all relevant data. As successful design and construction depends upon numerous factors outside the scope of this publication, the authors and publishers accept no responsibility for errors in, or omissions from, this publication, nor for specifications or work done or omitted in reliance on this publication.

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1 SCOPE AND GENERAL

1.1 Introduction

Multi-Residential Timber Framed Construction (MRTFC) was introduced to Australia in Amendment No. 7 to the Building Code of Australia (BCA 90) in November 1994. The release of the new performance based Building Code of Australia in 1996 (BCA 96) has provided greater scope and flexibility for MRTFC developments, such as increasing the number of storeys, changing or mixing the use (Building Class) or changing the methods of construction.

This manual contains the design and building practices required to meet the BCA objectives for both fire and sound performance. It describes tested or certified systems and how these can be combined to meet the required fire resistance and sound performance.

The manual is intended for use by designers, specifiers, builders, code officials and certifying authorities to demonstrate compliance with BCA requirements.

This manual can be used for deemed-to-satisfy solutions or alternative solutions (using the performance provisions) of the BCA. (refer 3.1) The deemed-to-satisfy approach is generally used as the basis for explanation of the various concepts.

NOTE: The deemed-to-satisfy provisions for MRTFC in BCA 96 are basically the same as the prescriptive requirements of Amendment 7 to BCA 90.

1.2 Scope

This manual applies to timber framed, Class 2 and 3 buildings up to the limits described in the deemed-to-satisfy solutions in the BCA (as summarised in Table 1).

The systems and methods described for the deemed-to-satisfy solutions may also be applicable for any alternative solutions developed under the performance provisions of the BCA.

NOTE: Class 1 buildings are dealt with under a separate publication, MRTFC Design and Construction Manual – Class 1a.

TABLE 1 MRTFC ALLOWED UNDER DEEMED-TO-SATISFY SOLUTIONS OF THE BCA.

Class of Building	Max. Rise of Storeys	Type of Const.	Notes
Class 2	4	A, B or C	Only 3 storeys of timber framing allowed plus one ground storey constructed of masonry and/or concrete used as a garage.
Class 3	2	C	Where access to 2 exits or own direct access is provided

The information in this manual will enable designers, local authorities, developers and builders to achieve practical and economical solutions for Multi-Residential Timber Framed Construction. Principles for fire separation and sound insulation are given, together with construction recommendations and typical details.

NOTE: It is not intended that this manual provide an exhaustive statement of all the methods or construction details appropriate for this form of construction. Although the majority of systems available at the time of publication have been included, manufacturers will continue to develop new and alternative systems, and practices will invariably evolve which meet either the deemed-to-satisfy or performance requirements of the BCA.

TABLE 2 DESIGN SEQUENCE FOR MRTFC BUILDINGS

Order	Issues	Action	Reason	Section
Step 1	BCA	Determine the Class of building	Governs Type of Construction required	Section 3 & Appendix A
Step 2		Determine Type of Construction	Governs Fire Resistance required	
Step 3	FIRE	Determine FRL required of building elements (eg wall, floor, ceiling, beams and columns)	Major criteria for the selection of fire-resisting construction system for each element	Section 4 & Section 9
Step 4		Select fire-resisting construction system for building elements		
Step 5		Design and detail junctions and intersection of main building elements.	Fire resistance must be maintained at intersection of fire-rated elements	
Step 6		Maintain fire resistance of fire-rated elements.	Holes formed in barriers due to building services or construction must be sealed.	
Step 7		Determine fire-resisting construction required for secondary building elements (eg, doors, windows, stairs, etc)	Auxiliary building regulations	
Step 8	STRUCTURAL	Consider loads and forces on building		Section 5
Step 9		Determine member sizes, bracing and fixing requirements		
Step 10	SOUND	Determine BCA sound resistance requirements		Section 6 & Section 10
Step 11		Select appropriate building layout and sound resistance of main building elements		
Step 12		Ensure junctions and penetrations maintain sound resistance.	Holes and gaps must be sealed	
Step 13	DOCU-MENTATION	Prepare documents to satisfy Steps 1 - 12		Section 8

1.3 How to Use this Manual

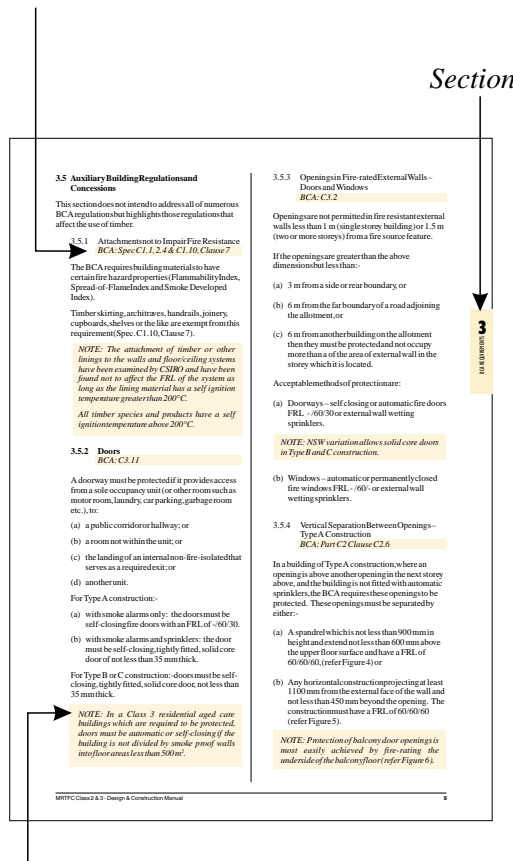
The manual has been laid out as the likely path taken in designing and constructing a residential building. The manual is divided into two main parts:-

- (a) **design considerations** which include BCA requirements, fire resistance, structural issues and noise control, and
- (b) **building practices**, practical methods on achieving the design issues described in (a).

Table 2 shows the most likely design sequence and the appropriate references.

Figure 1 shows a typical page layout, showing the graphic conventions used.

Where BCA references are given, they refer to clause numbers in the Building Code of Australia, which relate to that particular section of text.



Boxed in text that are titled NOTES or TIPS are commentary to the section of text immediately preceding it. They are included as further explanation of the text or as suggestions.

FIGURE 1. SAMPLE PAGE LAYOUT OF THIS MANUAL

1.4 Design Considerations

There a number of design considerations that are applicable to Multi-Residential Timber Framed Construction, these are:-

- (a) Fire resistance and separation between units, and
- (b) Structural design requirements such as bracing, member size and the influence of timber shrinkage, and
- (c) Sound transmission between units.

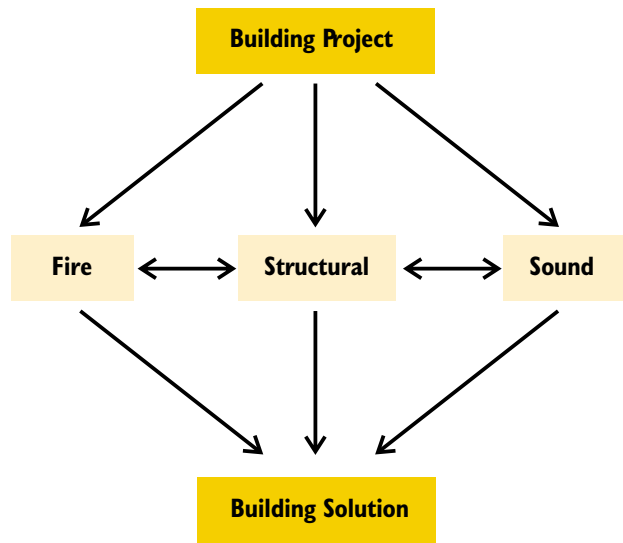


FIGURE 2. FLOW CHART FOR ORDER OF DESIGN CONSIDERATION

NOTE: Although there are many more design considerations necessary for the development of a successful project (e.g. egress, planning issues, etc.) they are not discussed in this manual, as they are not unique to timber framing. Traditional solutions in these cases should be adequate.

Fire separation, structural requirements or sound reduction may determine the building layout or the positioning of building elements. These design concepts should be looked at concurrently as a design decision may not be based on one concept alone but be developed after a process of trying out a number of combinations.

NOTE: Issues such as noise reduction and fire resistance may determine the location of windows, services or support structure.

Efficient structural systems (e.g. continuous beams) could result in poor sound performance

2 ABBREVIATIONS, DEFINITIONS, AND TERMINOLOGY

The following abbreviations and definitions apply in the use of this manual.

BCA

Building Code of Australia 1996 - Volume One - Class 2 to 9 Buildings.

CAULKING

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

NOTE: The caulking material may also need to be waterproof or flexible to allow for movement.

CAVITY BARRIER

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

DEEMED-TO-SATISFY

Provisions which are deemed-to-satisfy the performance requirements in the Building Code of Australia (BCA).

EXIT

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

- (a) An internal or external stairway
- (b) A ramp complying with Section D of BCA
- (c) A doorway opening to a road or open space.

FLANKING PATH

Where sound is transferred between units via the structure.

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.

FIRE-ISOLATED STAIR OR RAMP

A stair or ramp constructed 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

Either:-

- (a) 13 mm fire-grade plasterboard; or
- (b) 12 mm cellulose fibre-reinforced cement sheeting complying with AS 2908.2; or
- (c) 12 mm fibrous plaster reinforced with 13 mm x 13 mm x 0.7 mm galvanised steel wire mesh located not more than 6 mm from the exposed face; or
- (d) 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).

FRL – FIRE RESISTANCE LEVEL

The fire resistance, expressed as a time (in minutes) that a structural member or part of a building must achieve with respect to :-

- (a) structural adequacy – (i.e. maintain stability and adequate load bearing capacity)
- (b) integrity – (i.e. resist passage of flames, smoke and hot gases)
- (c) insulation – (i.e. maintain a specified temperature on the surface not exposed to fire)

and expressed in that order (e.g. FRL 90/90/90 for separating walls).

NOTE: A dash, for example in 90/-/-, means there is no integrity or insulation requirement for that member or part of the building.

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 Part C1 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-SOURCE FEATURE

Either:-

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

FIRE STOP

Fire-gradematerial used to close a gap or imperfection of fit that occurs where a service passes through a fire-rated element or system.

FIRE WALL

A wall that divides a storey or building into fire compartments.

Fire walls are used to either:-

- (a) separate parts of a building which have different building classifications (e.g. Class 2 residential from Class 6 commercial).
- (b) separate two different buildings (also called a common wall)
- (c) divide large buildings into two or more fire compartments which can then be treated as separate buildings.

NOTE: Walls between dwelling units are NOT regarded as fire walls. In the BCA these walls are described as “internal walls between or bounding sole-occupancy units” and may have different Fire Resistance Level requirements to fire walls.

HABITABLE ROOM

A room used for normal domestic activities and :-

- (a) Includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room and sunroom, but
- (b) 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.

IIC – IMPACT INSULATION CLASS

A measurement applied to a wall or floor/ceiling element to assess its insulation ability with respect to impact sound.

INTERNAL WALLS

Walls within, between or bounding sole-occupancy units 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

INTUMESCENT SEALER

A fire-resisting material which when exposed to fire, expands to fill gaps and maintain the required Fire Resistance Level.

ISF – INCIPIENT SPREAD OF FIRE

Resistance to incipient spread of fire in relation to a ceiling membrane, means the ability of a ceiling membrane to insulate the space between the ceiling and roof, (or ceiling and floor above), to limit the temperature rise of materials within this space and reduce the spread of fire.

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.

MINERAL WOOL

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

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, whilst ‘glasswool’ products do not.

MRTFC

Multi-Residential Timber Framed Construction

NON-COMBUSTIBLE

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

NON-FIRE-ISOLATED STAIR OR RAMP

A stairway or ramp that is not required to be in a fire-resisting shaft.

NOTE: In a building of more than 2 storeys, stairs or ramps which are required for egress (including landings) are non-fire-isolated, but must be constructed from either:-

- (a) concrete or
- (b) steel (min 6 mm thick) or
- (c) timber
 - minimum 44 mm thick
 - average density 800 kg/m³ at 12% moisture content
 - if laminated, glue to be resorcinol formaldehyde or resorcinol phenol formaldehyde

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.

RESILIENT CHANNEL OR MOUNT

A proprietary support for linings designed to improve sound insulation and reduce sound transmission.

RISE IN STOREYS

Means the greatest number of storeys calculated in accordance of Clause C1.2 of the BCA.

R_w

(Refer Weighted Sound Reduction Index)

SMOKE-PROOF WALL OR DOOR

Wall or door designed to limit the spread of smoke in a building.

SOU – SOLE-OCCUPANCY UNIT

A room or other part of a building for occupation by one owner, lessee, tenant or other occupier to the exclusion of any other owner, lessee, tenant or other occupier.

NOTE: A reference to “unit” in this publication shall be interpreted as a “sole-occupancy unit”.

STC – SOUND TRANSMISSION CLASS

The method of rating the airborne-sound-transmission performance of a wall or floor/ceiling element prior to 1999.

NOTE: The acoustic ratings required by the BCA (Amendment 6 – 1999) are now called the “weighted sound reduction index” with the symbol R_w, consistent with AS/NZS 1276.1:1999.

Test results for buildings and building elements with STC values in accordance with the 1979 version of AS 1276 remain valid (the STC value is equivalent to the R_w value).

UNIT

Sole-occupancy unit.

WALLS BOUNDING SOLE-OCCUPANCY UNITS

Fire and sound-rated walls which form the perimeter of sole-occupancy units.

WEIGHTED SOUND REDUCTION INDEX (R_w)

The rating of sound insulation in a building or building element as described in AS/NZS 1267.1:1999.

3 MRTFC AND BUILDING REGULATIONS (BCA)

3.1 General

The BCA is a uniform set of technical provisions for the design and construction of buildings and other construction throughout Australia.

The overall objective of MRTFC is to provide a building solution which meets the performance requirements in the BCA. This can be achieved by one of three paths, they are:-

- (a) **Deemed to satisfy solutions**, which are proven standard systems that fit common situations. They are derived from practices established over time and are viewed as satisfying the performance requirements of the BCA.
- (b) **Alternative solutions**, solutions based on engineering principles shown to meet the performance requirements of the BCA. They are non-standard solutions that tend to suit specific situations.

NOTE: Alternative solutions are described in more detail in MRTFC Information Bulletin No. 2 ‘Gaining Approval for MRTFC Projects under BCA 96’, available from the Timber Advisory Organisations listed on the back of this manual.

- (c) A combination of (a) and (b) above.

NOTE: In many cases, only parts of the building do not meet the deemed-to-satisfy building solution and it is only these non-conforming parts that require the development of an alternative solution. The conforming part of the building can still be built to the deemed-to-satisfy solution.

3.2 Building Classification

BCA: A3.2

Building Classification is a method used by the BCA to categorise buildings based on use, potential hazard and occupancy. This manual considers only Class 2 and 3 residential buildings. The difference between Class 2 and 3 buildings are the type of occupants:-

- a) Class 2: Buildings which include more than one SOU, each of which is generally occupied by one or more people to the exclusion of others. (i.e. owners or tenants)
- b) Class 3: Buildings which provide accommodation for unrelated people, independent on their length of stay. These include: guest house, boarding house, backpackers accommodation, hostel, accommodation for aged, disabled or children, residential part of a hotel, motel, school, health care building.

3.3 Type of Construction (Type A, B or C)

BCA: Clause C1.1

The Type of Construction, is the method used by the BCA to describe the minimum level of fire-resisting construction required for a particular building. Type A construction is the most fire-resisting while Type C is the least fire-resisting. The Type of Construction depends on the height (rise in storeys) of the building and likely time and difficulty of evacuation (i.e. number of exits). Figure 3 summarises the deemed-to-satisfy timber frame building solutions and the decisions required to determine a building's Type of Construction for MRTFC buildings.

NOTE: Building types that do not meet the deemed-to-satisfy solutions are referred to as BCA alternative solutions (refer 3.1).

3.4 Concessions Regarding Type of Construction

BCA: Part C1, Clause 1.5

Clause C1.5 of the BCA, allows a 2 storey Class 2 or 3 building, to be of Type C construction. The only requirement is that each sole-occupancy unit must either have access to at least 2 exits or have its own direct access to a road or open space.

NOTE: Own direct access can be defined as any access that does not pass a door of another compartment or unit.

For more information on Building Classification and Type of Construction (refer Appendix A).

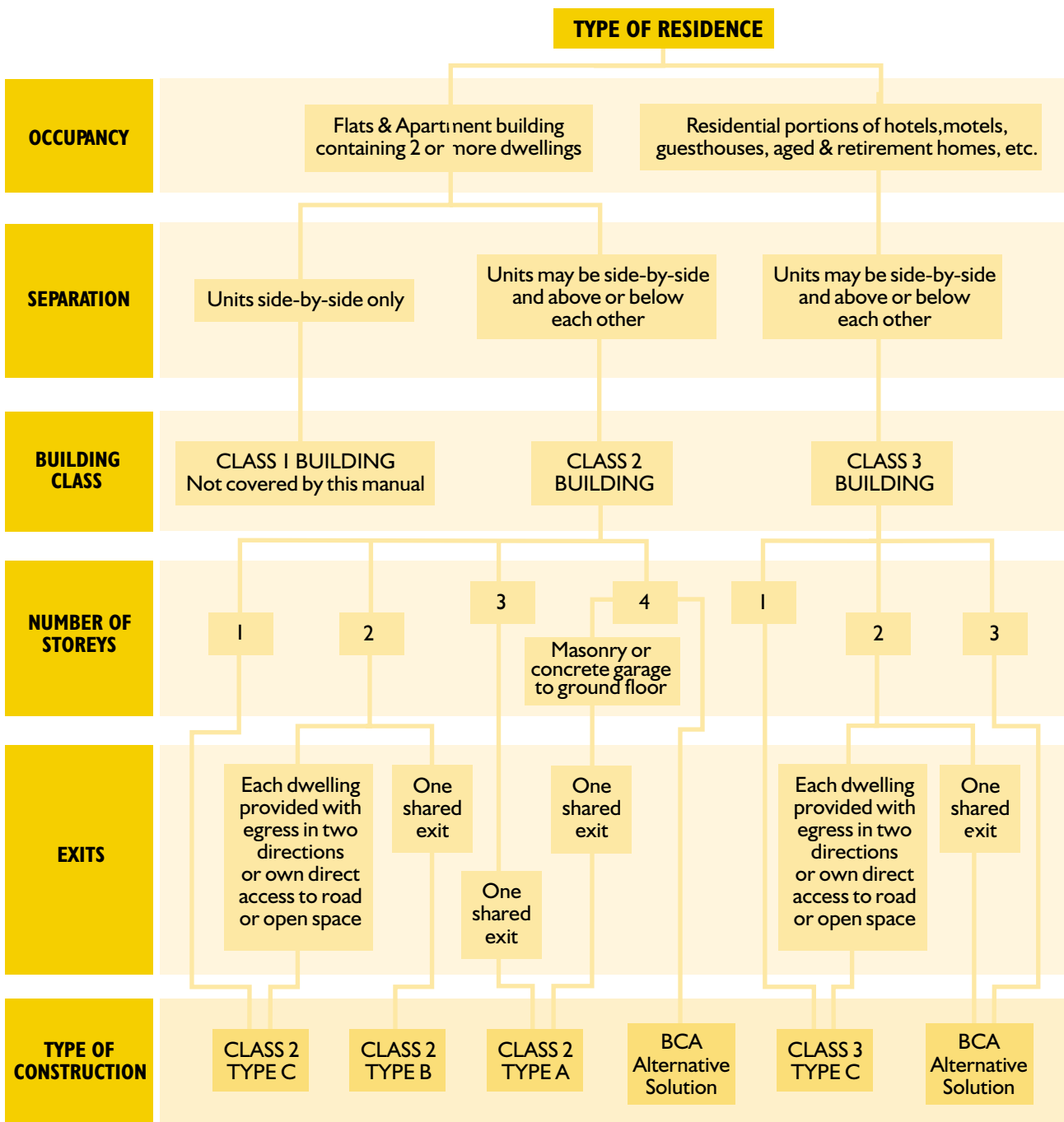


FIGURE 3 TYPE OF CONSTRUCTION FLOW CHART

3.5 Auxiliary Building Regulations and Concessions

This section does not intend to address all of the numerous BCA regulations but highlights those regulations that affect the use of timber.

3.5.1 Attachments not to Impair Fire Resistance

BCA: Spec C1.1, 2.4 & C1.10, Clause 7

The BCA requires building materials to have certain fire-hazard properties (Flammability Index, Spread-of-Flame Index and Smoke-Developed Index).

Timber skirtings, architraves, handrails, joinery, cupboards, shelves or the like are exempt from this requirement (Spec. C1.10, Clause 7).

NOTE: The attachment of timber or other linings to the walls and floor/ceiling systems have been examined by CSIRO and have been found not to affect the FRL of the system as long as the lining material has a self-ignition temperature greater than 200°C.

All timber species and products have a self-ignition temperature above 200°C.

3.5.2 Doors

BCA: C3.11

A doorway must be protected if it provides access from a sole-occupancy unit (or other room such as motor room, laundry, car park, garbage room etc.), to:

- (a) a public corridor or hallway; or
- (b) a room not within the unit; or
- (c) the landing of an internal non-fire-isolated that serves as a required exit; or
- (d) another unit.

For Type A construction:-

- (a) with smoke alarms only: the doors must be self-closing fire doors with an FRL of -/60/30.
- (b) with smoke alarms and sprinklers: the doors must be self-closing, tightly-fitted, solid-core doors of not less than 35 mm thick.

For Type B or C construction doors must be self-closing, tightly-fitted, solid-core doors, not less than 35 mm thick.

NOTE: In a Class 3 aged-care building 35 mm solid-core doors are not required to be automatic or self-closing if the building has sprinklers and is divided by smoke-proof walls into floor areas less than 500m².

3.5.3 Openings in Fire-rated External Walls

BCA: C3.2

Openings are not permitted in fire-rated external walls if they are less than 1 m (single storey building) or 1.5 m (two or more storeys) from a fire-source feature.

If the openings are greater than 1 m (single storey) or 1.5 m (2 or more storeys) but less than:-

- (a) 3 m from a side or rear boundary, or
- (b) 6 m from the far boundary of a road adjoining the allotment, or
- (c) 6 m from another building on the allotment.

then they must be protected and not occupy more than 1/3 of the area of external wall of the storey in which they are located.

Acceptable methods of protection are:

- (a) Doorways – self-closing or automatic fire doors FRL - /60/30 or external wall-wetting sprinklers.

NOTE: NSW variation allows solid-core doors in Type B and C construction.

- (b) Windows – automatic-closing or permanently-closed fire windows FRL - /60/- or external wall-wetting sprinklers.

3.5.4 Vertical Separation Between Openings Type A Construction

BCA: Part C2 Clause C2.6

In a building of Type A construction, where an opening is directly above or within 450 mm (measured horizontally) of another opening in the storey next below, and the building is not fitted with automatic sprinklers, the BCA requires these openings to be protected. These openings must be separated by either:-

- (a) 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. It must have a FRL of 60/60/60, (refer Figure 4) or
- (b) Any horizontal construction projecting at least 1100 mm from the external face of the wall and extending not less than 450 mm beyond the opening. The construction must have a FRL of 60/60/60 (refer Figure 5).

NOTE: Protection of balcony door openings is most easily achieved by fire-rating the underside of the balcony floor (refer Figure 6).

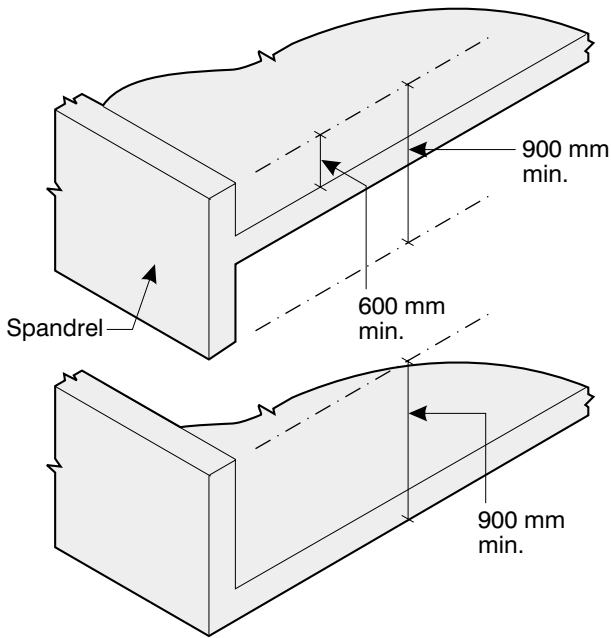


FIGURE 4 - VERTICAL SEPARATION IN TYPE A CONSTRUCTION (SPANDREL)

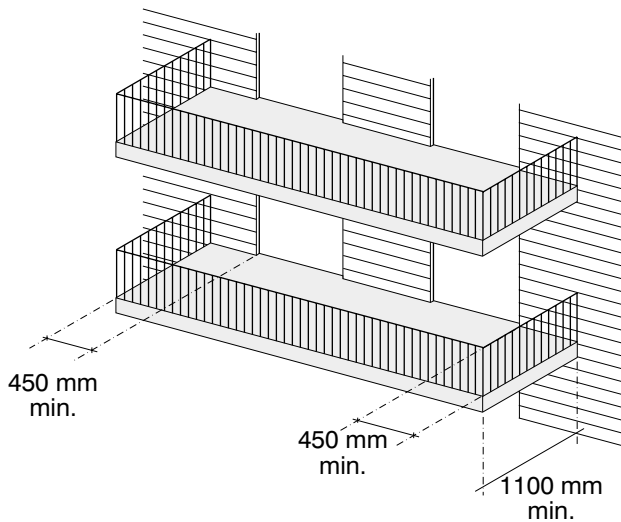


FIGURE 5 - HORIZONTAL SEPARATION IN TYPE A CONSTRUCTION

3.5.5 Balconies and Verandahs

BCA: Spec C1.1 Cl. 2.5(f)

A balcony or verandah and any incorporated supporting part needs to be fire-rated as listed in Table 3 if it:-

- (a) provides vertical separation between openings (refer 3.5.4) or
- (b) forms part of the only exit from the building or
- (c) for Type A construction it is situated not more than 2 storeys above the level that the entrance doors or exits are located. (i.e. 3 storeys above the ground)

The supporting columns for situation (c) above are required by the BCA to be constructed from non-combustible materials (steel or masonry).

NOTE: Timber columns used in situation (c) would require the development of an alternative solution.

TABLE 3 FIRE RESISTANCE REQUIRED FOR BALCONIES AND VERANDAHS

Type of Construction	Not forming part of only path of travel to an exit	Forming part of only path of travel to an exit
Type A - Up to 3 storeys above ground	No FRL required except 60/60/60 if it provides horizontal separation between openings	90/90/90
	Greater than 3 storeys above ground	90/90/90
Type B and C	No FRL required	FRL 30/30/30 or fire-protective covering

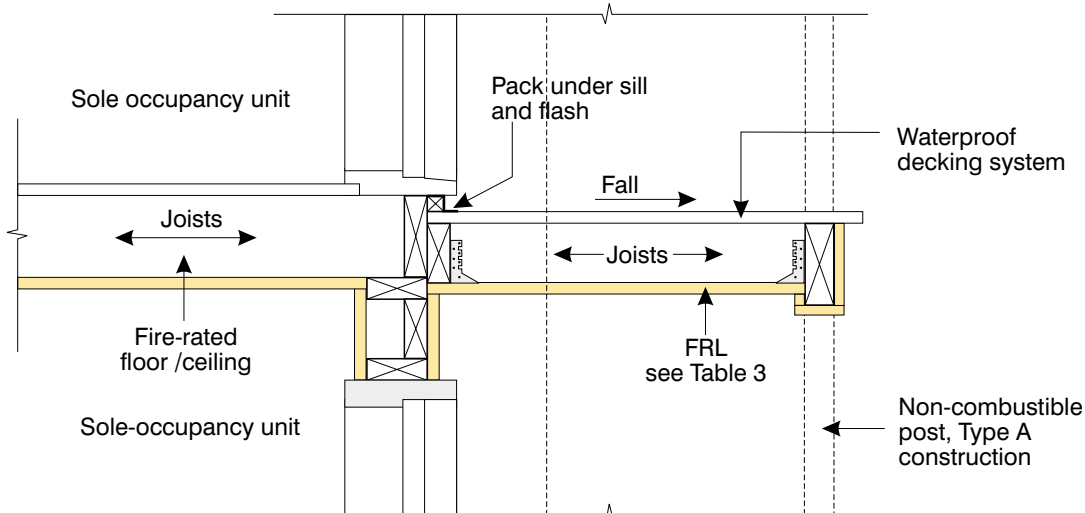


FIGURE 6 - TYPICAL BALCONY DETAILS USED AS PROTECTION TO OPENINGS

3.5.6 Stairs (Non-Fire-Isolated)

BCA: Clause D1.3, D1.9 & D2.3

Stairways may be non-fire-isolated where the exit connects not more than:-

- (a) 3 consecutive storeys (plus 1 additional storey for car parking) in a Class 2 building; or
- (b) 2 consecutive storeys in a Class 3 building.

NOTE: There is no fire resistance requirement for stairs which are contained within a unit (i.e. 2 storey unit) or do not form part of the required path of travel from the unit.

The deemed-to-satisfy provisions of the BCA require timber members within non-fire-isolated stairways and ramps to be as follows:-

- (a) have a finished thickness not less than 44 mm;
- (b) have an average density not less than 800 kg/m³ at 12% moisture content; and
- (c) if glue-laminated, be glued with a resorcinol or resorcinol phenol formaldehyde glue.

NOTE: Stairways constructed from smaller sizes or lower density timbers could be used by developing an alternative solution. Solutions that provide protection to the underside of stairways i.e. using the same fire-grade linings as required for the floors, have been well received by Building Authorities.

3.5.7 Cupboards or Rooms Under Non-Fire-Isolated Stairways and Ramps

BCA: D2.8(b)

Where non-fire-isolated stairways and ramps are enclosed (to form a cupboard storage room etc), the enclosing walls and ceilings must have a FRL of 60/60/60 and the doorway must be fitted with a FRL -/60/30 fire door.

3.5.8 Shafts

BCA: Spec C1.1, 2.7, 3.1(e)

Shafts used in Type A buildings for lifts, ventilation, pipes, garbage or the like are required to be fire-resisting to FRL 90/90/90 or -/90/90.

In Types B & C, shafts should have the same FRL as the elements they penetrate.

The shaft must also be enclosed at the top and the bottom with a floor/ceiling system of the same FRL as the walls except where the top of the shaft extends beyond the roof or the bottom of the shaft is laid directly on the ground.

NOTE: Shafts required to have fire resistance must have the rating from both the inside and the outside. This generally requires the fire-grade linings to be installed on both sides of the shaft frame and to any wall that they abut.

Openings in fire-rated shafts must be protected by:-

- (a) a self-closing -/60/30 fire door or hopper or
- (b) an access panel having a FRL of -/60/30

Shafts opening into bathrooms or laundries, must be protected by a door or panel (including its framing), constructed from non-combustible materials or with a FRL of -/30/30. (Refer to Section 6 for sound control and Section 10 for construction practice related to shafts).

3.5.9 Smoke Walls in Public Corridors

BCA: Part C2 – C2.14 & C2.5(d) & Spec. C3.4, Clause 3

Public corridors in Class 2 and 3 buildings of more than 40 m in length are required to be divided into intervals of 40 m by smoke-proof walls.

Smoke-proof walls are required to extend to the underside of the floor above or a non-combustible roof or a ceiling resistant to Incipient Spread of Fire for 60 minutes. Any glazed areas must be of safety glass. Doorways must be fitted with smoke doors and have all penetrations sealed.

NOTE: The deemed-to-satisfy solution requires smoke-proof walls to be constructed from non-combustible materials. In MRTFC construction this can be achieved by the use of laminated-plasterboard sections. Alternative solutions could also be developed. Fire-rated walls (including timber-framed systems) are regarded as having superior fire resistance to smoke proof walls for the relevant FRL time of the system.

3.5.10 Mezzanine Floors

BCA: Spec C1.1, Clause 2.6

A mezzanine floor need not comply with the FRL required for floors, as long as the floor area of the mezzanine does not exceed 1/3 of the floor area of the room or 200 m², whichever is the lesser.

To compensate for this concession, any surrounding walls and columns within 6 m of the mezzanine floor must have their FRL increased by 30 minutes (refer Table 4). The intersections of non-fire-rated mezzanine floor to any fire-rated floor or wall also requires protection.

NOTE: In some instances, it may be more economical to fire-rate the mezzanine floor to the required fire resistance nominated, rather than to increase fire resistance of the support structure.

**TABLE 4
INCREASED FRL FOR MEZZANINE FLOORS**

Nominated FRL	Increased FRL
30/30/30 -/30/30	60/60/60 -/60/60
60/60/60 -/60/60	90/90/90 -/90/90
90/90/90 -/90/90	120/120/120 -/120/120

3.5.11 Structural Tests for Lightweight Construction

BCA: Spec C1.8

The BCA requires that lightweight wall systems be able to adequately resist pressure and impact.

NOTE: Refer to lining manufacturers for confirmation that their materials meet these requirements.

3.5.12 Automatic Smoke Detection and Alarms

BCA: Spec. E2.2a

All Class 2 and 3 buildings must be fitted with automatic smoke-detection and alarm systems that are powered from consumer mains and installed and operated in accordance with specification E2.2a of the BCA.

NOTE: Location of detectors and alarms are detailed within the BCA.

3.5.13 Exit Requirements

BCA: Clause D1.4

Entrance doors of any sole-occupancy unit must not be more than either:-

- (a) 6 m from an exit (being either stairs, ramp or doorway opening to a road or open space or to a point where travel in different directions to two exits is available) or
- (b) 20 m from the doorway (at the level of egress to a roadway or open space) of a single exit to the storey.

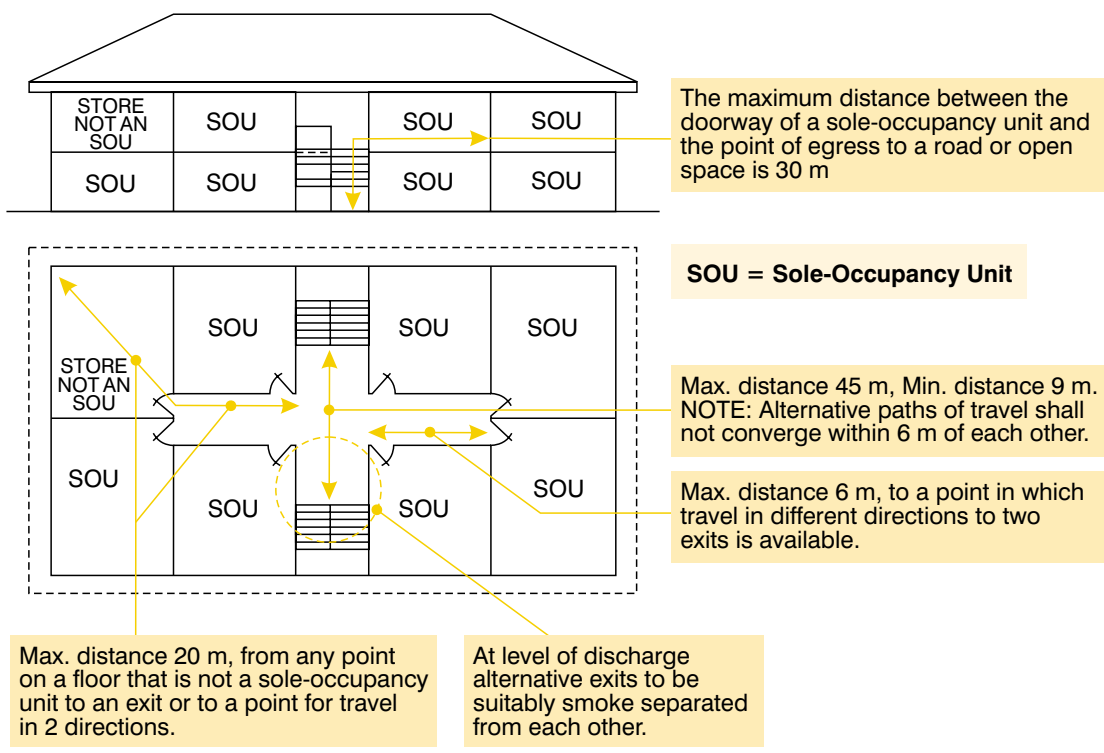
Additionally, no point on the floor of a room which is not a sole occupancy unit (example, store room, garage, common laundry, etc) must be no more than 20 m from an exit or where travel in different directions to two exits is available. (refer Fig. 7b).

Where two exits are provided as alternative paths of travel, the exits must be:-

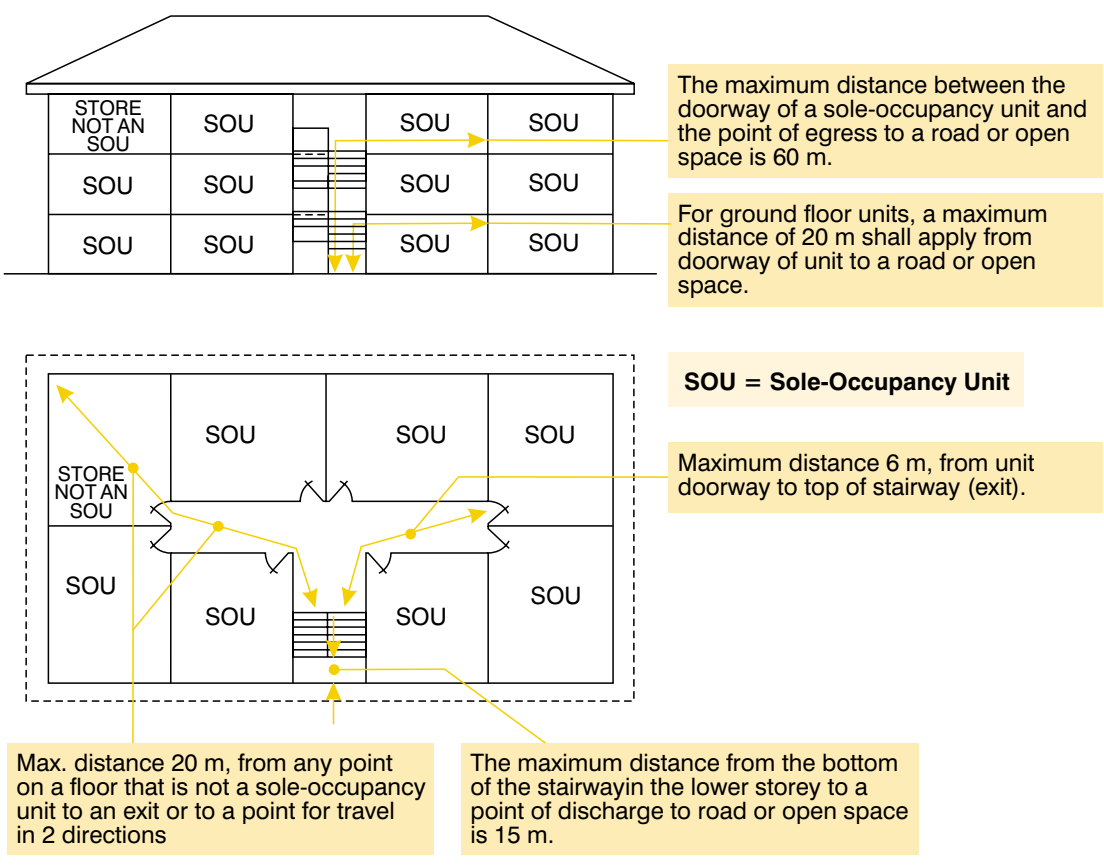
- a) evenly distributed
- b) 45 m maximum apart
- c) 9 m minimum apart

(refer Fig. 7a)

NOTE: Alternative paths of travel may converge to no closer than 6 m apart.



(a) Example - Rise of 2 storeys - 2 non-fire-isolated stairways



(b) Example - Single non-fire-isolated stairways

FIGURE 7 - TYPICAL EXIT REQUIREMENTS

4 FIRE RESISTANCE

4.1 Fire Resistance Level (FRL)

The Fire Resistance Level required for building elements in Class 2 and 3 multi-residential buildings is dependent upon the type of construction for the building (governed by rise in storeys, number of exits), location (distance from fire source) and whether automatic sprinklers are installed. Table 5 summarises the Fire Resistant Levels (FRL) required for each construction type and building element and highlights the changes permitted by the inclusion of sprinklers, (refer 4.2.1.)

NOTE: Where FRL such as 90/60/30 are required from Table 5, these systems are generally not commercially available. Typical wall and floor/ceiling systems when tested, are generally structurally dependent and will have equal FRL values for structural adequacy, integrity and insulation (e.g. 60/60/60 or 90/90/90, etc.)

TABLE 5 FIRE RESISTANCE LEVELS FOR BUILDING ELEMENTS IN CLASS 2 AND 3 BUILDINGS

BUILDING ELEMENT (Location or distance from fire source feature)	FIRE RESISTANCE LEVEL				
	TYPE C	TYPE B		TYPE A	
	Smoke Alarms only	Smoke Alarms only	Smoke Alarms & Sprinklers	Smoke Alarms only	Smoke Alarms & Sprinklers
External Wall (Loadbearing) less than 1.5 m 1.5 m to less than 3.0 m 3.0 m to 9.0 m 9.0 m to less than 18.0 m 18.0 m or more	90/90/90 nil nil nil nil	90/90/90 90/60/30 90/30/30 90/30/- nil	refer 4.2.1	90/90/90 90/60/60 90/60/30 90/60/30 90/60/30	refer 4.2.1
External Wall (Non-Loadbearing) less than 1.5 m 1.5 m to less than 3.0 m 3.0 m or more	-/90/90 nil nil	-/90/90 -/60/30 nil		-/90/90 -/60/60 nil	
External Columns Less than 1.5 m 1.5 m to less than 3.0 m 3.0 m or more	90/-/ nil nil	90/-/ nil nil		90/-/ 90/-/ nil	
Internal Walls bounding public corridors or SOU - Loadbearing - Non-Loadbearing	60/60/60 nil	60/60/60 -/60/60	60/60/60 nil	90/90/90 -/60/60	60/60/60 nil
Other Loadbearing Internal - wall, columns, beams and trusses	nil	60/-/-		90/-/-	60/-/-
Floors	Fire Protective covering or 30/30/30	Fire Protective Covering or 30/30/30		90/90/90	60/60/60
Roofs Combustible covering Non-combustible covering	nil nil	nil nil		90/60/30 nil	

4.1.1 Support of Another Part

BCA: Spec C1.1 Clause 2.2

A fire-resisting building element (floor, wall, beam etc) must not fail, due to the collapse of its supports during a fire. The supporting part is required to have a fire resistance (FRL) not less than the fire resistance (FRL) of the building element it supports.

EXAMPLES:-

- (a) An internal wall of a unit that is not required to be fire-resisting but supports a fire-resisting floor/ceiling is required to have the same fire resistance (FRL) as the floor/ceiling system.
- (b) Building elements (such as beams, roofs or floors) that give lateral support to fire-resisting walls must be either similarly fire-rated or designed so that failure of the building element in a fire does not affect the structural integrity of the fire-rated wall.

4.2 Concessions Regarding Fire Resistance Levels (FRL)

The following concessions are allowed under the deemed-to-satisfy building solution of the BCA.

NOTE: In some instances the prescribed solution may be more economical or suit the building's construction better than the allowable concession.

4.2.1 Sprinklers

BCA: Spec C1.1, Clause 3.10(C) and 4.3(b)

For Class 2, Type A & B construction, the use of sprinklers generally allows a reduction in the Fire Resistance Level of loadbearing and bounding walls from FRL 90/90/90 to FRL 60/60/60 (refer Table 5).

External walls may also reduce to 60/60/60 measured from the inside but must retain FRL 90/90/90 when measured from the outside.

Non-loadbearing internal walls between or bounding units in buildings with sprinklers may be lined with normal grade 13 mm thick plasterboard.

Doors leading into egress passages in Type A buildings with sprinklers can be 35 mm thick solid-core.

NOTE: In assessing the costs and benefits associated with the installation of sprinklers, the following should be considered;

- the cost of the sprinkler system offset against the cost of reduced construction materials, e.g. linings
- sprinkler systems may or may not reduce the amount of property damage that occurs in the event of a fire
- potential for water damage to fragile contents
- generally where fire resistance is reduced there is a reduction in linings and subsequently reduction in acoustic performance

4.2.2 Roofs (Non-combustible)

BCA: Spec C1.1, Clause 3.5

Type A buildings are required to have fire-resisting roof framing where the roof covering is combustible. When the roof is constructed with a non-combustible covering, no fire resistance is required for the structure.

NOTE: There is no requirement to fire-rate roofs in Type B or C buildings.

4.2.3 Floors

BCA: Spec C1.1, Clause 3.2

Floors are not required to have a FRL:-

- (a) if they are contained entirely within the unit, or
- (b) the space below them is not considered a storey, does not accommodate motor vehicles, is not a storage or work area or used for any other ancillary purpose.

4.2.4 Internal Columns and Walls Immediately Below the Roof in a Type A Building

BCA: Spec C1.1, Clause 3.7

In Type A buildings with an effective height of not more than 25 m, internal columns and loadbearing internal walls in the storey immediately below the roof may be FRL 60/60/60.

NOTE: There is no concession for Type B or C construction. Type B requires FRL 60/60/60 and Type C has no FRL requirements.

4.2.5 Carparks in Class 2 and 3 Buildings

BCA: Spec C1.1, Clause 2.8

For the purpose of determining the fire resistance of building elements, a single storey carpark (Class 7 classification) contained within a Class 2 or 3 building may be regarded as part of the Class 2 or 3 building.

NOTE: This concession is limited to buildings with a maximum of 4 storeys for Class 2 buildings and 3 storeys for Class 3 buildings.

Where more than one storey of carparking is used or where the Class 2 or 3 part of the building has more storeys than allowed under the deemed-to-satisfy provisions, the carpark is considered to be a separate classification (Class 7) for determining fire resistance.

4.3 Fire Resistance and Separation

The BCA requires that each sole-occupancy unit, public corridor and the like is to be separated with respect to fire. This separation is termed fire resistance and is generally achieved by the use of fire-resisting walls and floors which are designed and built to prevent the spread of fire by retaining the passage of smoke, heat, gases and flames for nominated periods.

NOTE: The objective is to contain any fire within the compartment (SOU etc.) and allow the occupants in the rest of the building sufficient time to evacuate to safety.

NOTE: MRTFC buildings are constructed from the combination of a number of certified systems i.e. fire-rated walls, floor/ceiling systems, beams, columns, etc. (Refer to Information Bulletin No 5 – Fire and Sound-Rated Wall and Floor/Ceiling Systems).

The fire resistance of timber stud walls and the timber framed floor/ceiling system, is achieved by utilising fire-grade linings (fire-grade plasterboard or a combination of fibre cement sheet with fire-grade plasterboard). The thickness and number of layers of lining material necessary will depend upon the Fire Resistance Level (FRL) required. The combination of these fire-rated systems with the building practices contained within this manual ensures the fire resistance required by the BCA is achieved.

NOTE: It is the complete wall or floor/ceiling construction, including the required lining/cladding on both sides of the timber frame that provides the fire resistance. The wall or floor/ceiling systems are laboratory tested and certified by the testing authority as achieving the relevant FRL.

4.4 Continuity of Fire Separation

Fire separation between SOU's, corridors etc, must be continuous and maintain the FRL's prescribed in the BCA. Continuous fire separation is achieved by:-

- (a) Using certified FRL rated wall and floor/ceiling elements between or units, hallways and the like and;
- (b) Using fire-resisting junctions at intersections of fire-rated elements (walls, floors/ceilings, etc) with other rated or non-rated elements and;
- (c) Fire-stopping penetrations through fire-rated elements.

Fire-rated wall or floor/ceiling system will meet each other or intersect with non-rated elements at junctions. These junctions are required to maintain the fire resistance with respect to structural adequacy, integrity and insulation. (refer 4.5).

Openings in fire-rated walls must be protected by appropriate "closures" such as doors, windows or shutters with the prescribed Fire Resistance Level. (refer 3.5.2 and 3.5.3).

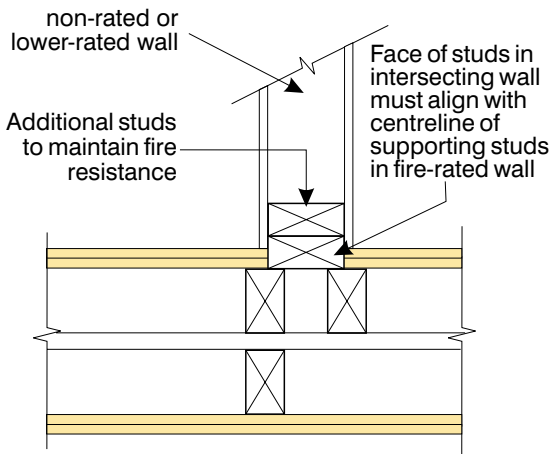
Fire resistance must be maintained by sealing gaps and imperfections of fit, where plumbing and electrical services penetrate fire-rated elements (refer 4.6).

4.5 Maintaining Fire Resistance at Intersections

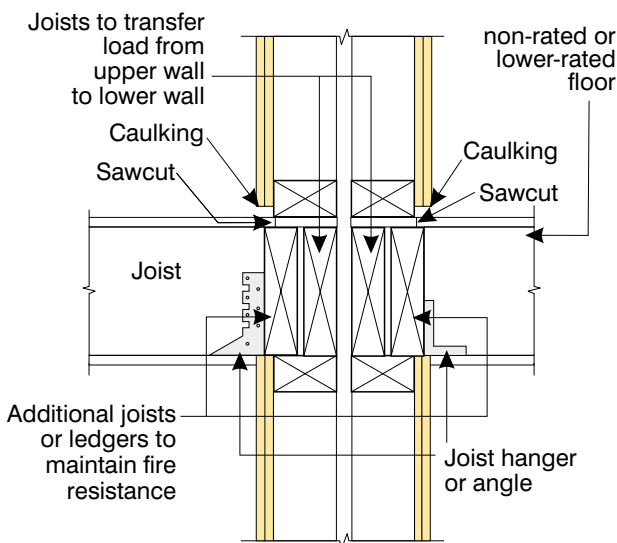
It is generally desirable to erect all of the timber framing (and preferably the roof) before the installation of linings. As a result of this construction sequence, it is often not possible to continue the fire-grade linings through intersections and other construction joints. To achieve the FRL integrity, and to maintain a complete barrier, details without continuous linings have been developed, using the charring effect of solid timber (refer 9.4). The following are typical examples.

4.5.1 Junctions between Elements with Different Fire Ratings

Figure 8 shows typical intersections between elements having different fire ratings. These junctions generally use solid timber in lieu of the fire-grade linings. (refer 9.4)



(a) Internal non or lower-fire-rated walls intersecting double stud fire-rated wall

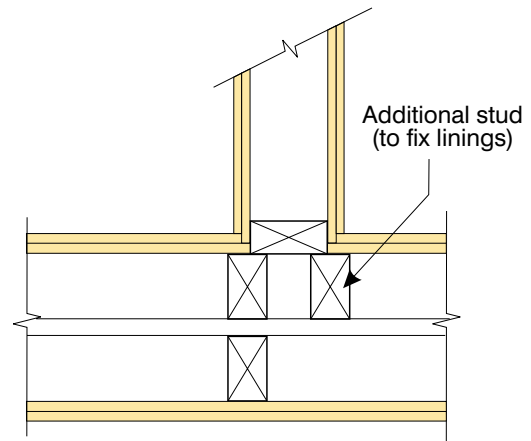


(b) Non or lower-fire-rated flooring/ceiling intersecting double stud fire-rated wall

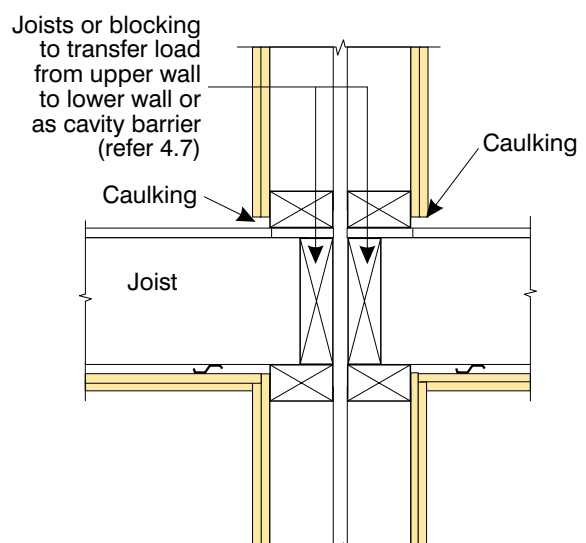
FIGURE 8 - TYPICAL JUNCTIONS BETWEEN DIFFERENT RATED ELEMENTS

4.5.2 Junctions between Equally-Rated Elements

Where fire-rated linings are continuous through the intersection or where the intersecting elements have equal rating, there are no further requirements other than to ensure that the fire-grade linings are fixed in accordance to manufacturers recommendations and that they are adequately sealed at the joints (refer Figure 9 for typical junctions).



(a) Internal fire-rated walls intersecting double stud fire-rated wall



(b) Fire-rated flooring/ceiling intersecting double stud fire-rated wall

FIGURE 9 - TYPICAL JUNCTIONS BETWEEN EQUALLY RATED ELEMENTS

4.6 Service Penetrations (Fire Stopping)

BCA: Spec. C3.15

The BCA requires that these penetrations in fire-rated walls, floors or ceiling be fire-stopped.

NOTE: There are many reasons why the fire resistance of a wall or floor/ceiling system could be breached. (Examples include service pipes through fire-resisting floor/ceiling systems, electrical or plumbing installed in fire-rated walls).

Fire stops are materials used to close a gap or imperfection of fit between a service pipe, conduit or cable and a fire-resisting system. Fire-stopping materials must maintain the Fire Resistant Level of the element that has been penetrated.

There are two ways of satisfying the requirements of the BCA with respect to fire-stopping:-

- (a) Use the BCA's deemed-to-satisfy method (refer 9.6).
- (b) Use manufacturer's certified systems and materials (refer 9.7).

In general, all openings for pipes, ducts, conduits or cables passing through fire-resisting construction should be:-

- (a) fire-stopped
- (b) kept to a minimum
- (c) kept as small as practicable
- (d) designed in a way which will allow thermal or shrinkage movement

NOTE: Fire-stopping can be avoided by placing taps, switches etc in non-fire-rated walls within the unit or by building a false wall in front of the fire-rated wall to contain the services.

4.7 Cavity Barriers

During a fire, flame, smoke and hot gases could breach barriers (linings) and get into wall or ceiling cavities and possibly travel considerable distances through these voids. As an extra precaution, it is recommended that barriers should be placed within these voids to limit this spread of fire and hot gases.

NOTE: There are many voids within a MRTFC building. These could be due to the practice of creating cavities within the fire-rated barrier for the maximising sound transmission loss (double stud walls, floor/ceiling systems) or to retard moisture ingress (brick veneer cavity). These voids may travel the length, width and height of the building.

Cavity barriers are obstructions placed in concealed air spaces in fire-rated systems. They are not mandatory under the BCA, but are recommended good building practice.

Generally, cavity barriers should be provided at the corners of each compartment, i.e. intersection of floors and walls or walls to walls (refer 9.8).

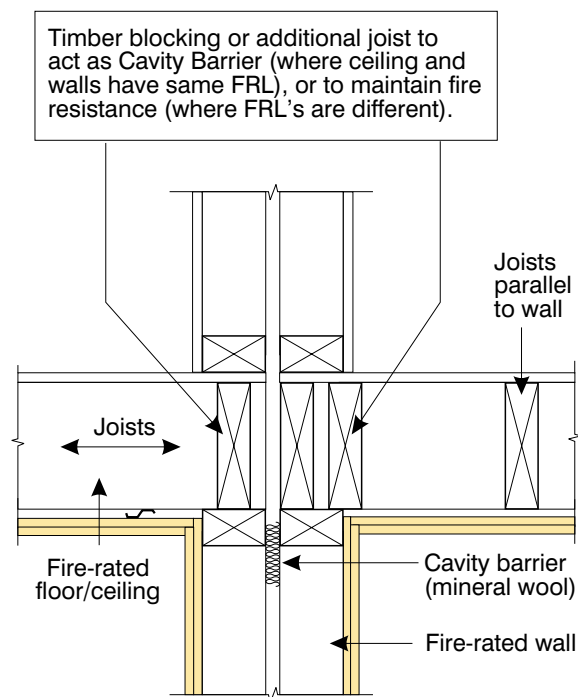


FIGURE 10 - TYPICAL CAVITY BARRIERS

5 STRUCTURAL CONSIDERATIONS

5.1 General

Although many aspects of the design of single detached timber-framed dwellings (Class 1) may be applied to Class 2 and 3 buildings, it is necessary also to consider the design criteria and loads that are specific to this form of construction. Generally Class 2 and 3 buildings in timber are:-

- (a) of lighter mass than masonry construction,
- (b) relatively tall and slender,
- (c) required to carry greater dead loads (fire and sound-rated walls and floors) than timber-framed detached houses,
- (d) required to accommodate larger numbers of people (larger live loads) than detached housing,
- (e) constructed using specific methods for attachment of linings to achieve fire/sound ratings.

These give rise to a number of structural considerations which are different to those applicable to normal timber domestic construction or multi-storey masonry construction. This section provides some guidance on these structural considerations.

NOTE: A Structural Engineering Guide for Class 2 & 3 Buildings up to 3 Storeys has been produced. For a copy of this publication or for further information on structural design contact the Timber Advisory Organisations listed at the back of this publication.

5.2 Typical Design Loads

The various types of loads or forces on Class 2 and 3 buildings need to be considered (refer to Figure 11).

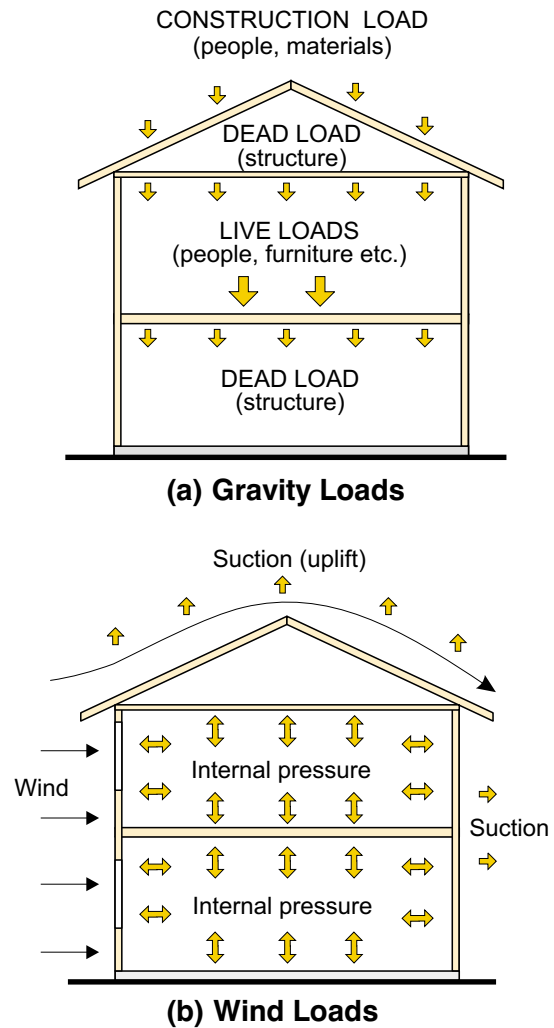


FIGURE 11 - LOADS ON BUILDINGS

5.2.1 Building Mass

The lower building mass of MRTFC buildings effects foundation and footing design and also impacts upon the structures overturning stability.

NOTE: Typical timber-framed masonry veneer construction using timber framed floors, walls and roofs could possibly have a mass less than one-half that of full masonry and concrete construction.

5.2.2 Dead and Live Loads

AS 1170.1 provide the basis for determination of appropriate dead, live design loads and load combinations applicable to Class 2 and 3 multi-residential construction. These are greater than for Class 1.

5.2.3 Wind Loads

AS 1170.2 provides the determination of wind speeds and loads. The wind velocity and therefore loads on 3 & 4 storey buildings could be much greater than experienced in house construction. This increase in velocity will increase design wind pressures and coupled with increased dead and live loads could significantly effect member design.

5.2.4 Earthquake Loads

AS 1170.4 “Minimum Design Loads on Structures – Earthquakes Loads”, provides guidance and design procedures to cater for earthquake forces on multi-residential construction.

NOTE: Multi-Residential Timber Framed Construction up to 3 or 4 storeys for most major Australian cities, would not require a static analysis of the forces acting on the building as timber-framed structures are classified ductile. One exception to this is in Category B for irregular buildings (either geometry, centre of mass or bracing resistance) which would require static analysis.

For cases that require static analysis, the shear forces can be determined from Section 6 of AS 1170.4 and resistance to these shear forces can be detailed similarly as for wind loads.

NOTE: Unlike wind forces which are a function of area of elevation, earthquake forces are a function of building mass. Therefore, earthquake forces do not decrease normal to the width of the building as occurs with wind. For long slender buildings, earthquake forces may dictate shear (bracing strength) requirements parallel to the building length.

5.3 Foundations and Footings

AS 2870 Residential Slabs and Footings, provides general guidance for residential construction up to two storeys.

For timber-framed Class 2 and 3 buildings up to two storeys, these requirements would be applicable.

NOTE: Some additional limitations apply where the first floor is suspended slab construction.

Timber-framed construction above two storeys in height require footings to be designed in accordance with AS 3600 “Concrete Structures Code” or if required AS 2159 “SAAPiling Code”.

5.4 Structural Stability

Overtuning can be an important design consideration in Class 2 and 3 buildings due to the lighter mass and the trend towards “slender buildings” (i.e. height to width ratio above 1.5:1).

It is recommended that an engineering check of overturning be carried out where the design wind velocity exceeds maximum design gust wind speed of 50 m/s (determined from AS 1170.2) and/or the height to width ratio exceeds 1.5:1.

5.5 Member Sizes

Specific engineering design of members is required for 3 and 4 storey buildings.

For Class 2 and 3 Buildings, specific engineering design of the structural framework should be carried out using the relevant loading codes and AS 1720.1 “Timber Structures – Part 1: Design methods”, as the basis of design.

In determining member sizes, it is necessary to consider loads normally applicable to structural design as well as the loads under fire conditions.

NOTE: The structural or fire-load combinations are not the same and are required to be investigated separately.

AS 1684.1 “Residential Timber-Framed Construction, Part 1: Design Criteria”, whilst specifically written for Class 1 Buildings, can also be used as a general guide for the design of members in Class 2 and 3 Buildings provided the appropriate adjustments are made to the relevant criteria, including:-

- **Dead Loads** – Due to fire and sound rating requirements these are usually much greater than traditional domestic construction due to the extra sheeting and insulation required.
- **Live Loads** – AS 1170.1 specifies higher levels of live load (floors in particular) for Class 2 and 3 Buildings.
- **Wind Loads** – Care needs to be taken to ensure that the correct design wind speed is determined due to the increased height of 3 and 4 storey buildings.

NOTE: The terrain category/height multiplier will be greater for 3 and 4 storey buildings than for one and two storey Class 1 Buildings, resulting in higher pressures on members.

- Load Combinations—AS 1170.1 details the relevant load combinations that are required to be considered in design. The general load combinations given for the framing members in AS 1684.1 for Class 1 Buildings and load combinations given in AS 1170.1 for earthquake and fire may also be applicable to Class 2 & 3 buildings.

5.6 Framing (Building Practices)

The general building practices contained with AS 1684 “Residential Timber-Framed Construction” are applicable to MRTFC buildings. This includes the allowable notching, cuts and holes into framing members.

5.7 Designing for Shrinkage

Shrinkage considerations for multi-residential construction are similar to those for normal domestic construction. For two and three storey buildings the potential for greater total shrinkage must be considered, particularly the effect it may have on the integrity of fire and sound rated walls and floors.

When designing for shrinkage potential problems can be minimised through:-

- reducing overall shrinkage by:
 - limiting the use of unseasoned timber to wall framing, in buildings of one or two storeys
 - using of seasoned joists in lieu of unseasoned joists
 - reducing one level of shrinkage by using joists and bearers in-line (joists supported off bearers using framing brackets)
 - using of seasoned framing or engineered timber products throughout.
- avoiding differential shrinkage (not using materials with different shrinkage properties e.g. steel & timber)
- providing clearances to brickwork and masonry
- allowing for shrinkage with respect to plumbing.

6 SOUND CONTROL

6.1 Airborne and Impact Sound

There are two types of sound which need to be resisted. These are from airborne sources such as speech, musical instruments and loudspeakers and the other being impact sources, such as footsteps and the moving of furniture (refer to Figure 12).

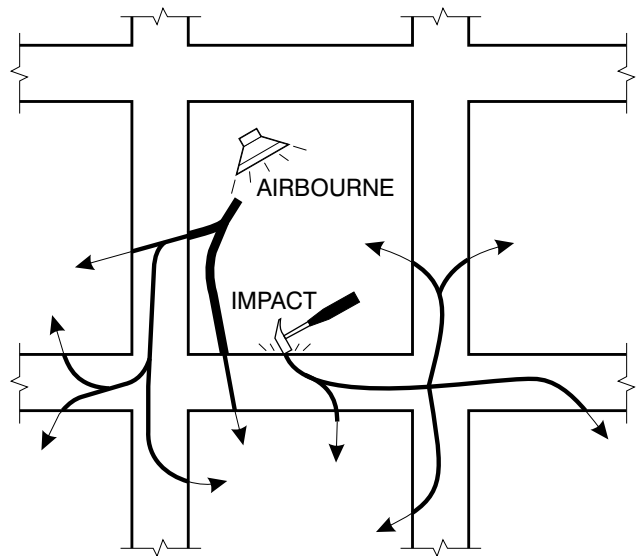


FIGURE 12 - AIRBORNE AND IMPACT SOUND PATHS

6.2 BCA Requirements

BCA: F5.3, 5.4, 5.5 & 5.6

Any wall or floor, which separates one unit from another, must provide adequate resistance to the passage of sound.

6.2.1 Airborne Sound

The BCA requires sound insulation in walls between adjoining units or between units and common spaces such as plant room, lift shafts, stair shafts, public corridors or the like. For floors, sound insulation is only required between units.

The BCA nominates the minimum Weighted Sound Reduction Index (R_w) for insulation that must be provided in walls and floors between adjoining sole-occupancy units, and around service ducts. (refer Table 6).

TABLE 6 - BCA SOUND TRANSMISSION AND INSULATION REQUIREMENTS

LOCATION	Min. Rw Required
Floors between (SOU) units	Rw 45
Walls between habitable rooms in adjoining units	Rw 45
Walls between wet areas(kitchens, WC, bathrooms, laundries, etc.) in adjoining units.	Rw 45
Walls between habitable room in one unit and wet area (kitchens, WC, bathrooms,laundries, etc.) in adjoining units.	Rw 50 + impact requirements
Walls between service pipes and habitable rooms	Rw 45
Walls separating service pipes from kitchens, WC or laundries	Rw 30
Walls between any room of sole occupancy and public hallway, stairway, etc.	Rw 45

NOTE: The BCA sets out minimum requirements for sound control. In practice these minimum limits are not satisfactory and higher levels should be provided. It is recommended that Rw50 (plus impact control) is provided in all cases to give an acceptable level of sound performance.

The Rw ratings specified for wall and floor/ceiling systems are generally based upon a laboratory test. It is well known that the rating of the systems will be degraded when installed into a building, due to workmanship not being as good as the tested prototype and flanking paths created by the structure itself. On average, between 3 and 5 Rw points will be lost by the on-site installation of the laboratory-rated system. A system that is laboratory-rated 5 Rw points above the desired level of sound attenuation should therefore be used to account for this difference between field and laboratory performance.

Therefore to achieve the recommended Rw50 when installed, systems which are laboratory tested to Rw55 should be used.

6.2.2 Impact Sound

The performance clauses of the BCA (FP 5.1 & FP 5.2) require the control of impact noise for floors and walls.

The deemed to satisfy provisions in the BCA only provide solutions for impact resistance for walls that separate bathrooms, toilets, laundries and kitchen from habitable rooms in neighbouring units (refer 6.3). No solution is given for control of impact noise for floors or other walls.

6.3 Sound Reduction

6.3.1 Sound Reduction by Room Layout

There are many aspects of the building layout that can minimise sound transmission without the need for any additional construction.

Improved sound performance can be achieved by carrying out the following:-

- (a) Position laundries, service shafts, stairs and other noisy areas in buildings as far as possible from sensitive living or sleeping areas.
- (b) Place relatively quiet areas such as bedrooms or lounge rooms next to each other.
- (c) Use mirror image floor plans in adjacent units, i.e. put a bedroom adjacent to bedroom and a living room adjacent to living room, etc.
- (d) Locate doors and windows of neighbouring units so that they are not directly opposite.
- (e) Locate waste pipes and plumbing away from sound sensitive living and sleeping areas.

Figure 13 illustrates good and bad practices for building layout.

6.3.2 Airborne Sound Reduction

To achieve the level of sound insulation between units consider the following:-

- (a) select the wall or floor/ceilings system with required Rw rating.
- (b) seal all gaps and the perimeter of walls and floor/ceilings systems
- (c) size and location of windows and external doors
- (d) the location and the proper installation of internal doors, electrical outlets, plumbing, ducts and mechanical equipment.

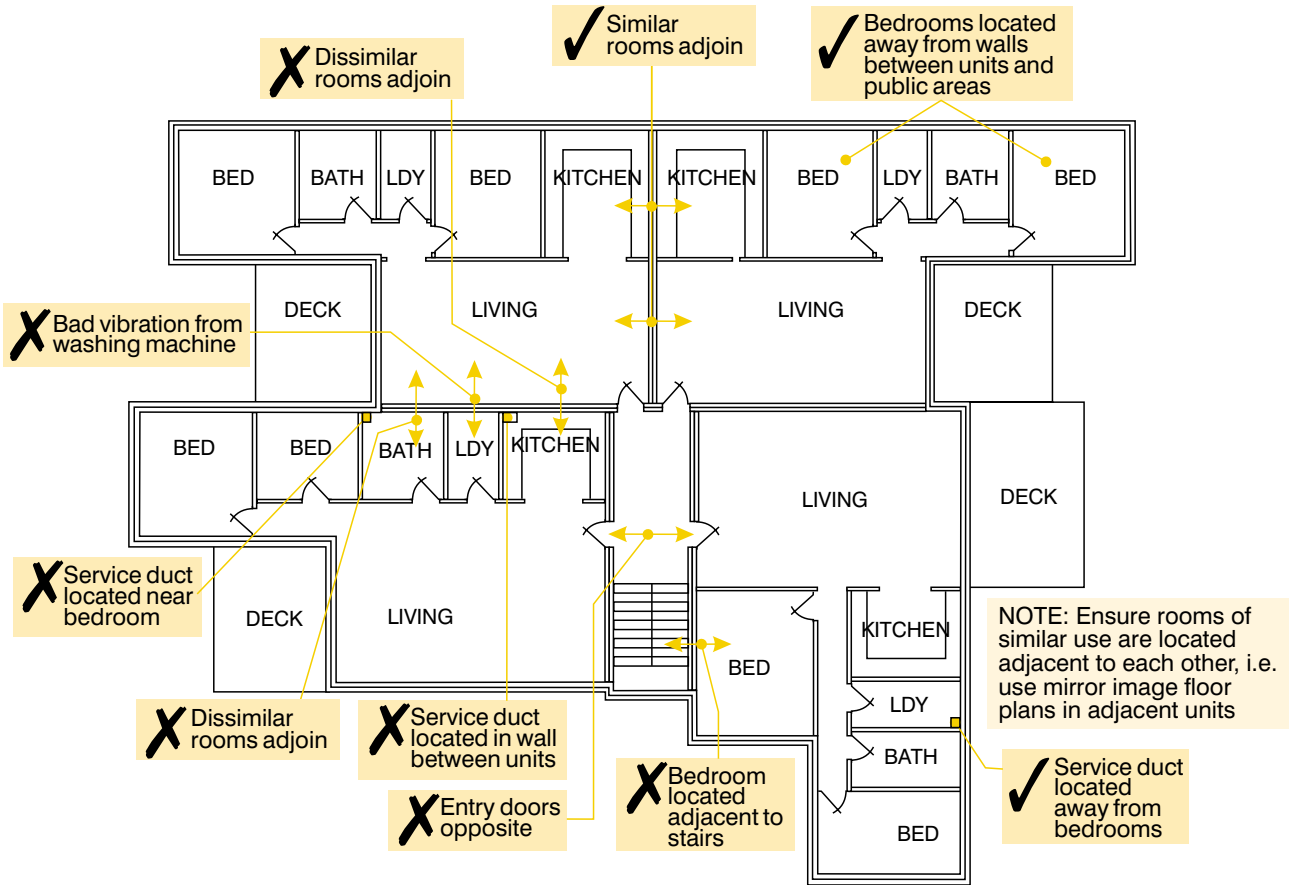


FIGURE 13 - BUILDING LAYOUT ILLUSTRATING GOOD AND BAD DESIGN PRACTICES

6.3.3 Reducing Impact Sound

Where wet areas such as bathrooms, toilets, laundries or kitchens abut habitable rooms such as bedrooms, lounge rooms, dining, etc in the adjoining units, the walls between them are required by the BCA to have “a satisfactory level of insulation against impact sound” and have a minimum R_w rating of 50.

To satisfy the deemed to satisfy requirements, the BCA states that “walls must be in 2 or more leaves without rigid connection except at their periphery”. Staggered or double stud wall systems meet this requirement.

Though not a BCA requirement, floor/ceiling systems should also be designed for impact sound.

Satisfactory impact sound performance of floor/ceiling systems can be improved by:-

- (a) dividing a floor and ceiling into two isolated layers
- (b) the use of carpet and carpet underlay to the floor surface
- (c) isolate bare upper surfaces from the structural flooring, (e.g. use floating floors)
- (d) have no direct fixing between the floor structure and the lower ceiling (e.g. use resilient mounts)
- (e) increase the floor’s mass.

NOTE: It is suggested that impact-sound transmission be kept as low as possible. It is recommended that the floor/ceiling system have an Impact Insulation Class (IIC) of at least 65 for carpeted floors and 55 for hard surfaces (tile or decorative timber floors).

7 WALL AND FLOOR / CEILING SYSTEMS

7.1 General

A large variety of wall and floor/ceiling systems are available.

NOTE: The available range of fire and sound-rated wall and floor/ceiling systems that could be used in MRTFC buildings are summarised in Information Bulletin No. 5 – “Wall and Floor/Ceiling Systems Summary” which is available from the Timber Advisory Organisations listed on the back of this publication.

The fire and acoustic performance of the various systems will vary due to the thicknesses and combination of lining materials and the position and isolation of the supporting timber frame.

Construction details including sheet fixing requirements must comply with the specification described in the certificate from the testing authority for the selected system. These certificates are generally available from lining manufacturers.

NOTE: Once the BCA’s Fire Resistance Level (FRL) is established, wall or floor system selection is normally based on the level of sound performance required and structural considerations. Overall wall thickness may also be a criteria for selection.

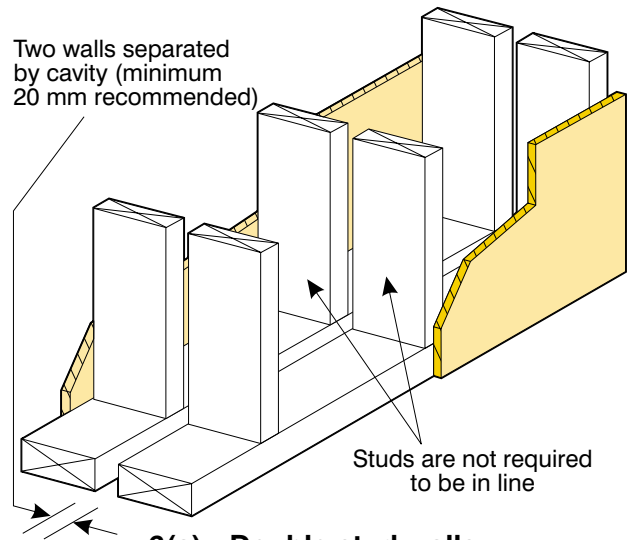
7.2 Internal Walls

In MRTFC buildings, the walls between or bounding units are required to be fire and sound-resisting. The fire grade linings give the required fire rating. To achieve the sound resistance, wall systems are double stud, staggered stud or resilient separated single stud walls (refer Figure 13).

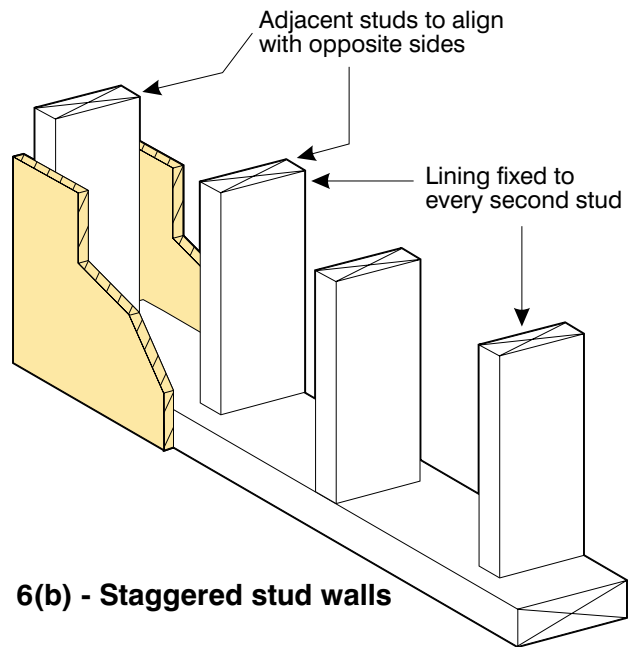
Double stud wall systems perform the best as they have truly independent leaves. Staggered studs have separate studs but share top and bottom plates, therefore allowing some “short circuiting” sound energy. Single studs walls rely on the resilient supports to reduce sound energy. This isolation of the linings is difficult to maintain at junctions.

NOTE: Loadbearing walls that are within the unit may also be required to be fire-resisting. Walls which support fire-resisting floors are required to have the same rating as the floors they support. They can, however use single stud constructions with fire-grade linings as they require no sound resistance.

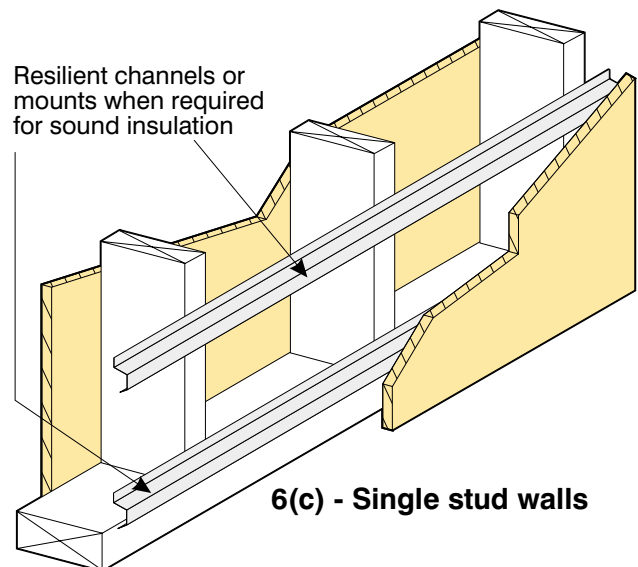
Walls supporting floors which are protected by fire-protective coverings are not required to be fire-resisting.



6(a) - Double stud walls



6(b) - Staggered stud walls



6(c) - Single stud walls

FIGURE 13 - WALL FRAMING OPTIONS

7.3 External Walls

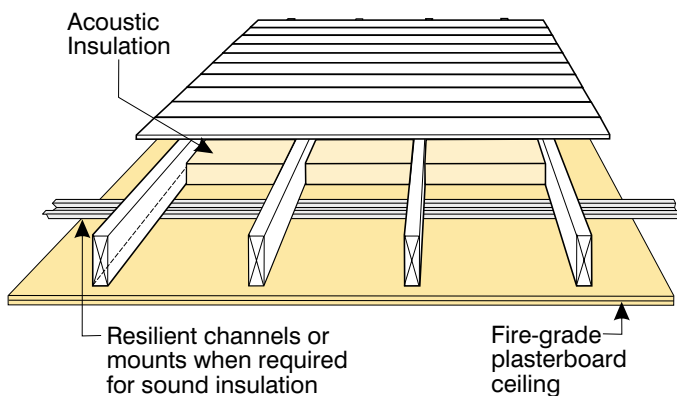
External walls are required to be fire-resisting if they are close to a fire-source feature (refer Table 5). These walls are also required to be weatherproof. Fire-rated external wall systems can be either brick veneered or lightweight clad using fibre cement, timber cladding or plywood over fire-grade plasterboard.

7.4 Floor/Ceiling Systems

Floor/ceiling systems can use either solid timber or engineered timber joists (nail-plated, floor trusses, LVL or I-beams) with resiliently supported ceilings (resilient mounts or channels) (refer Figure 14). To improve the airborne sound reduction, insulation is generally added above the fire-grade plasterboard.

For floor systems, the highest level of impact-sound resistance is achieved when carpet and carpet underlay is included. Where hard surfaces are required (timber feature floors or wet area floors), the use of floating floors, independent ceilings or a combination of both is recommended.

NOTE: For Type B or C construction, a fire-protective covering can be used in lieu of a certified fire-resisting system. The sound resistance provided by the fire-protective covering may not be adequate.)



**FIGURE 14 -
TYPICAL FLOOR / CEILING SYSTEMS**

8 DOCUMENTATION AND INSPECTION

8.1 Documentation

The BCA fire and sound requirements are similar for all materials used to construct apartment buildings (i.e. there are no special requirements for timber-framed buildings). The level of documentation necessary for timber-framed buildings should therefore be similar to that required for masonry or concrete buildings.

NOTE: Because this form of construction is relatively new, a higher level of documentation may be required by some certifiers, particularly regarding some of the building practice issues discussed in this manual. When MRTFC becomes common practice, it is likely that less documentation will be required.

8.2 Certification of MRTFC Construction

The construction practices and information given in this manual discuss fire and sound issues that are relevant for timber-framed apartment buildings. The manual has been written so that where the practices are followed, fire resistance and sound reduction required by the BCA will be achieved.

This manual and any other support information (e.g. lining manufacturer's information, testing authority certificates) can be used as the basis of certification for MRTFC buildings.

NOTE: No additional certification for this form of construction is required by the BCA.

8.3 Inspection

In addition to the normal inspections carried out by local authorities or certifiers (foundations, final, etc.), it is recommended that inspection of the frame occurs before it is lined. Another inspection should occur after the linings have been installed, stopped and sealed.

NOTE: Due to the fast construction of MRTFC buildings, planning and coordination may be required for each recommended inspection.

9 CONSTRUCTION PRACTICES - FIRE

9.1 General

The following section describes practices and typical details utilised in MRTFC buildings to maintain fire resistance. They include:-

- (a) Junctions (intersection of fire-rated and non-fire-rated elements)
- (b) Fire stops (sealing around penetrations)
- (c) Cavity barriers

NOTE: The information is not exhaustive and it is envisaged that there are many more details that are not covered. As long as the principles described are followed, the typical details can be adapted to achieve the required fire resistance in other applications.

9.2 Junctions

Wall intersections and junctions between floors/ceilings and walls must be designed and built to maintain the required fire resistance by restricting the passage of smoke, heat, gases as well as flame for the equivalent performance of the fire-grade linings used.

This section describes methods to maintain fire resistance at common intersections of building elements. These include:-

- (a) Non-rated or lower-fire-rated walls intersecting fire-rated walls (refer 9.5.1)
- (b) Non-rated or lower-fire-rated floor/ceiling systems intersecting fire-rated walls (refer 9.5.2)
- (c) Non-aligned floors (refer 9.5.3)
- (d) Non or lower-fire-rated floor/ceiling systems intersecting fire-rated external walls (refer 9.5.4)
- (e) Non or lower-fire-rated walls intersecting fire-rated floor/ceiling systems (refer 9.5.5)
- (f) Non or lower-fire-rated bearers or beams supported by fire rated walls (refer 9.5.6)
- (g) Sealing around doors and windows in fire-rated walls (refer 9.5.7)
- (h) Fire-rated junctions at the eaves (refer 9.5.8)
- (i) Top of fire-rated walls taken to underside of non-combustible roofs (refer 9.5.9)
- (j) Intersection of fire-rated walls with exterior non-rated walls (refer 9.5.10)

9.3 Junctions between Building Elements with the Same Fire Rating

Where equally fire-rated elements intersect, there is no further construction required, other than to ensure that the fire-resisting linings are installed in accordance with manufacturer's recommendations and that the intersections are adequately sealed (refer Figure 9).

NOTE: Although not mandatory under the BCA, cavity barriers are recommended at many of these intersections. (Refer 4.7 and 9.8)

9.4 Maintaining Fire Resistance Using the Charring Effect of Solid Timber

When timber burns, it chars relatively slowly from the outside at a predictable rate. This fact allows the use of timber in lieu of fire-grade linings to protect the structural members and maintain the fire resistance at intersections.

COMMENTARY: To maximise the time and cost savings of MRTFC, it is generally desirable to erect all of the timber framing (and preferably the roof) before the installation of linings. As a result, it is often not possible to continue the fire-grade linings through intersections and other construction joints.

The timber used to replace the fire-grade lining is in addition to any structural member within the fire-rated wall or floor. The amount of timber required is dependent on the level of fire resistance necessary and the type of strengthening used at the relevant junction (i.e. the addition of plasterer's angle, intumescent sealer or fibre cement linings). Any timber grade or species (softwood and hardwood framing) can be used provided it has a minimum average dry density of 450 kg/m³.

NOTE: The fire resistance to be obtained by the solid timber is the difference between the FRL's of the intersecting elements (e.g. non-rated wall or floor intersecting FRL 60/60/60 wall has a difference of 60/60/60 – FRL 30/30/30 floor intersecting FRL 90/90/90 wall has a difference of 60/60/60).

9.4.1 Additional Solid Timber only in Junctions

Additional solid timber (blocking, extra studs or joists, etc) can be used in lieu of fire-grade linings to protect the timber frame.

Figure 15 shows typical junctions where only solid timber has been used in lieu of fire-grade linings to maintain the required fire resistance. The thickness or number of additional timber members required for the difference in FRL is detailed within the figure.

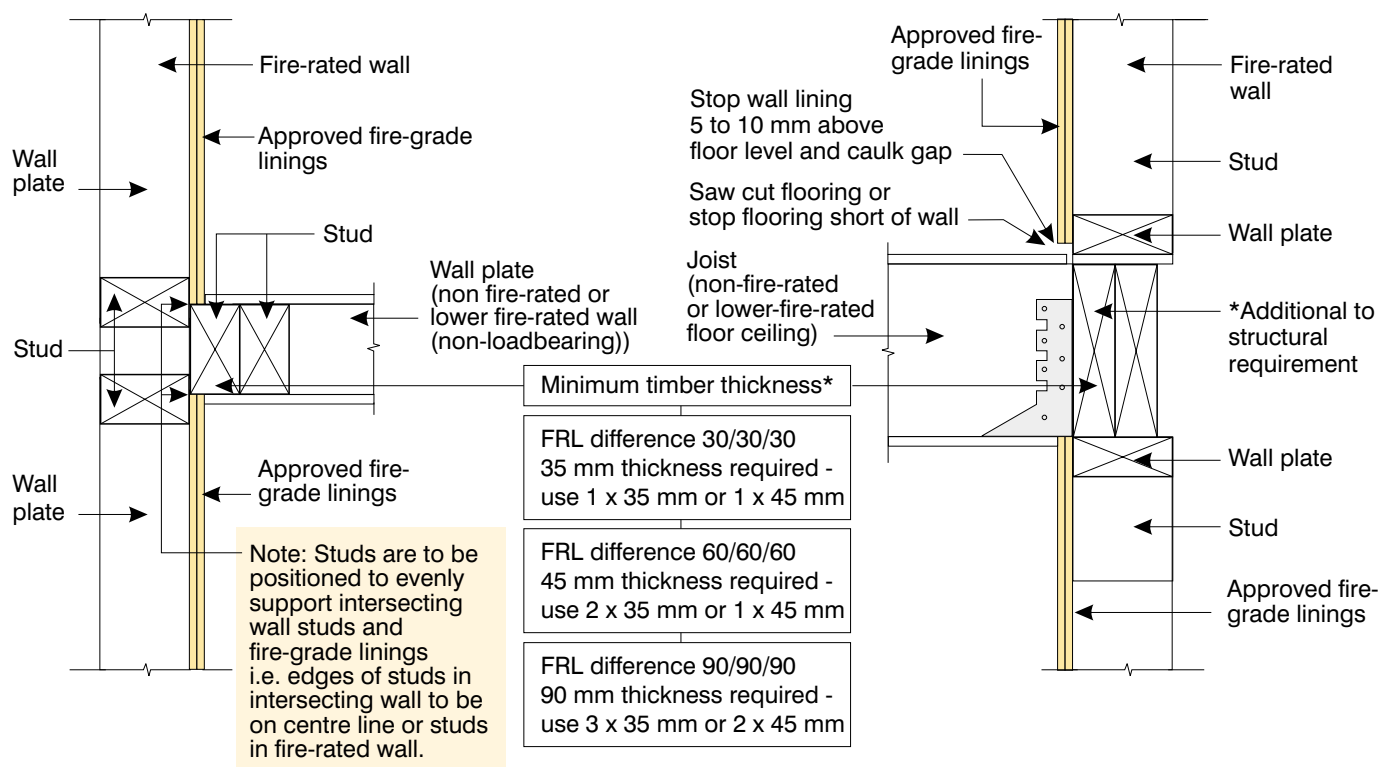


FIGURE 15 - ADDITIONAL SOLID TIMBER IN JUNCTIONS

9.4.2 Additional Solid Timber in Junctions with Fire-Grade Linings Edge Supported

Equivalent performance to the all timber solution, can be achieved by utilising a reduced thickness of solid timber with additional lining support.

COMMENTARY: Laboratory testing has shown that strengthening of the joint between the fire-grade linings and the timber within the intersection, initially reduced the number of timber surfaces exposed to fire. This resulted in slower consumption of the ancillary timber. Therefore with edges strengthened, thinner ancillary timbers than required in the “timber only” solution can be used.

Three methods for strengthening the joint between the fire-grade linings and timber can be used, they are:

- (a) 35 x 35 mm plasterer’s angle fixed to the timber and the fire-resisting linings (refer Figure 16).
- (b) Intumescent sealer in the gap formed between the end of the fire-resisting lining and the timber. Intumescent sealer must have resistance equivalent to the highest FRL required in the junction and be installed in accordance to the manufacturer’s instructions (refer Figure 17).

- (c) A continuous band of 6 mm fibre cement through the junction. Where combination of fibre cement and fire-grade plasterboard is used as the fire-grade lining, continuation of the fibre cement through the junction is sufficient. Alternatively, a strip of fibre cement 50 mm wider than the intersecting wall or floor could be used (refer Figure 18).

Studs within the fire-rated wall should be located so that they provide support to the fire-grade lining, as well as the stud in the intersecting walls. Where linings are edge supported, these studs should be positioned such that their face is no further than flush with the narrow face of studs in the intersecting wall (i.e. no gap between the studs in two intersecting walls).

NOTE: For information on required support and fixings of fire-grade linings, and using fire-rated mineral wool to maintain fire resistance - refer to manufacturer’s instructions.

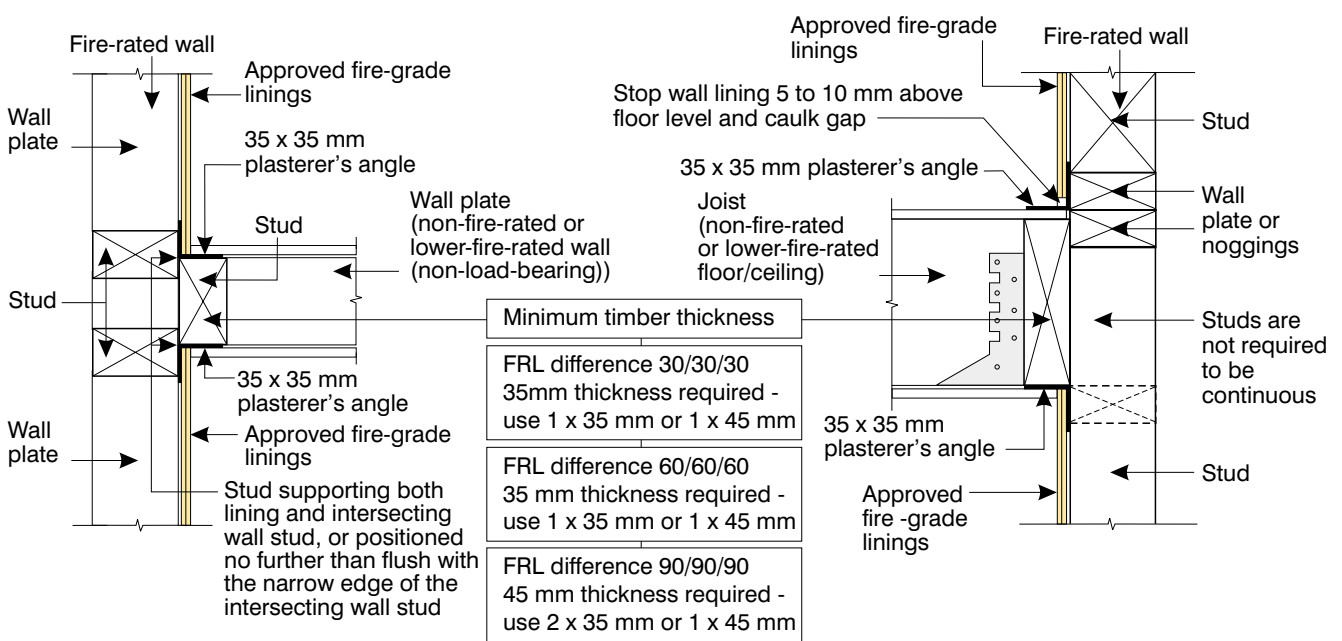


FIGURE 16 - ADDITIONAL SOLID TIMBER WITH PLASTERER'S ANGLE EDGE SUPPORT

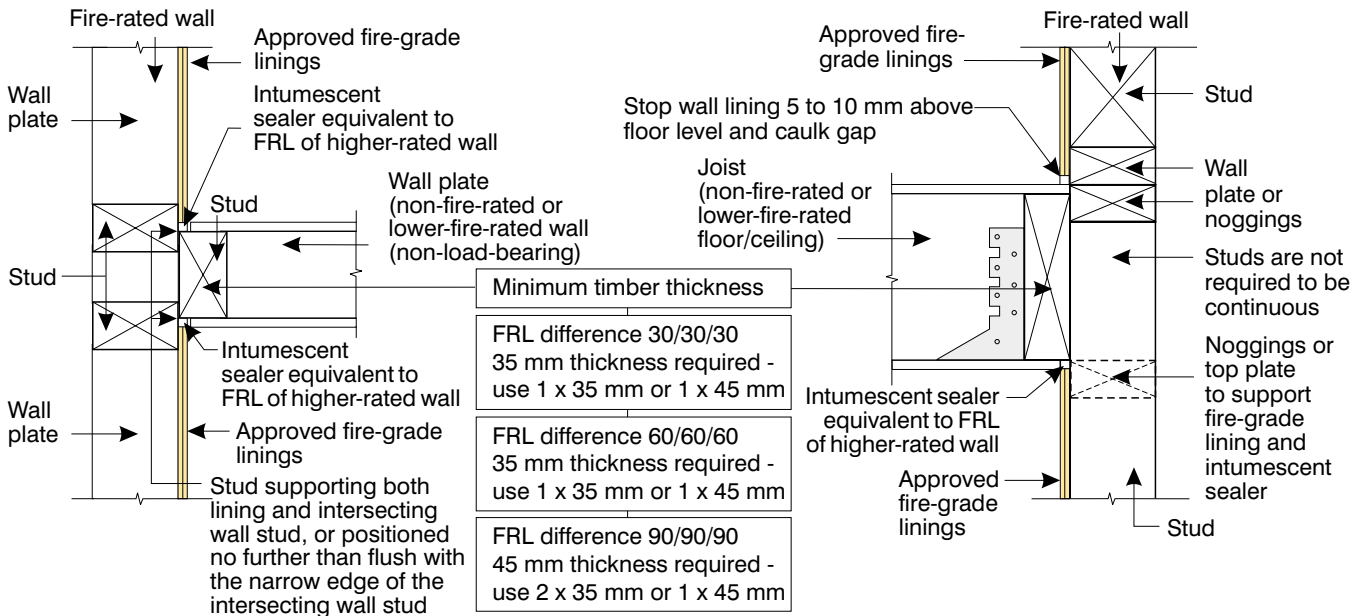


FIGURE 17 - ADDITIONAL SOLID TIMBER WITH INTUMESCENT SEALER

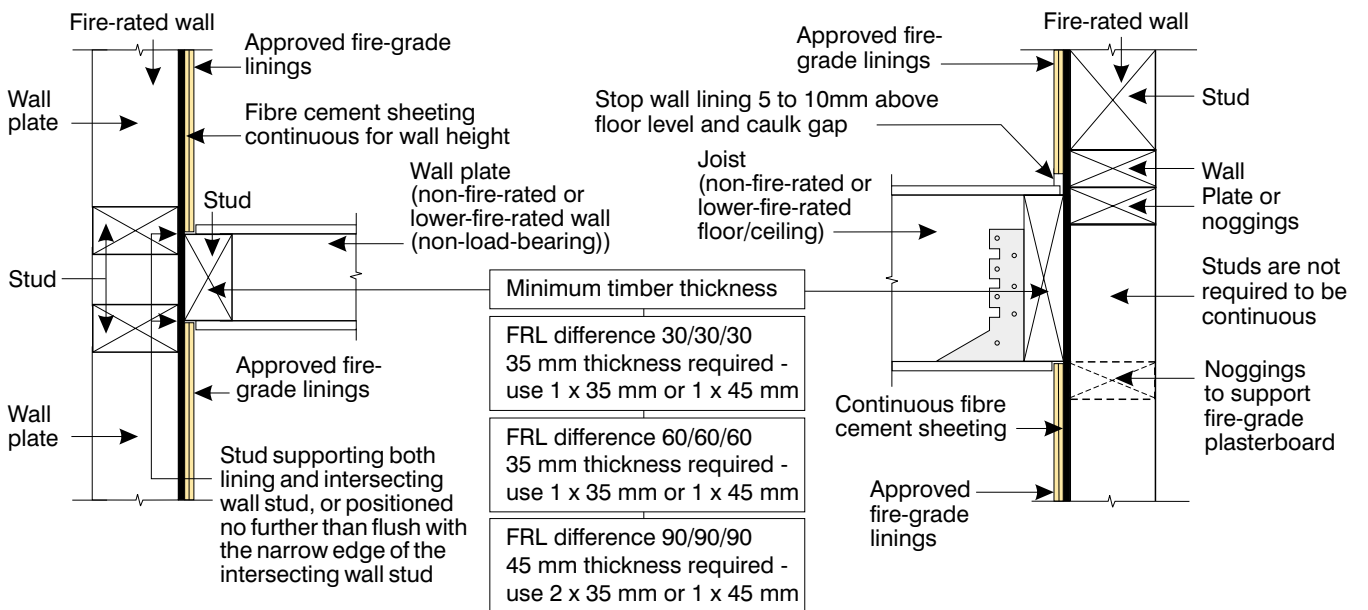


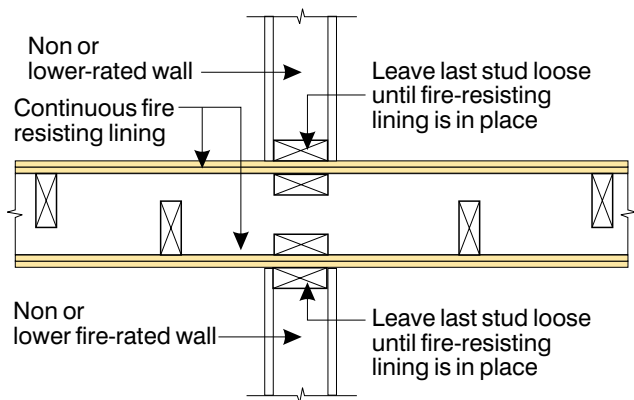
FIGURE 18 - ADDITIONAL SOLID TIMBER WITH CONTINUOUS FIBRE CEMENT LINING

9.5 Junctions between Building Elements with Different Fire Ratings

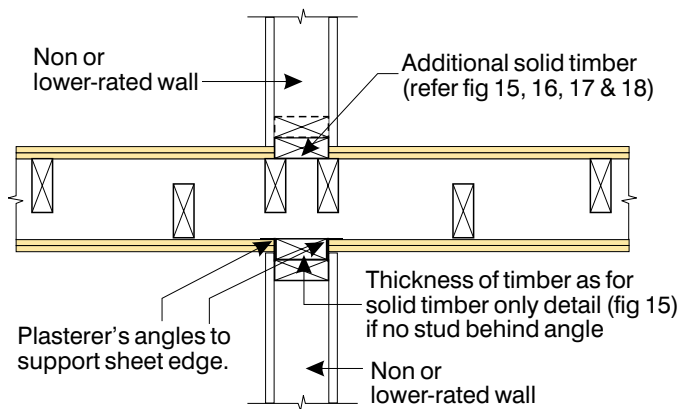
9.5.1 Non-Rated or Lower-Fire-Rated Walls Intersecting Fire-Rated Walls

Figures 19 and 20 detail various stud configurations and methods to maintain continuity of the fire-resisting linings using solid timber or solid timber and edge supports to linings.

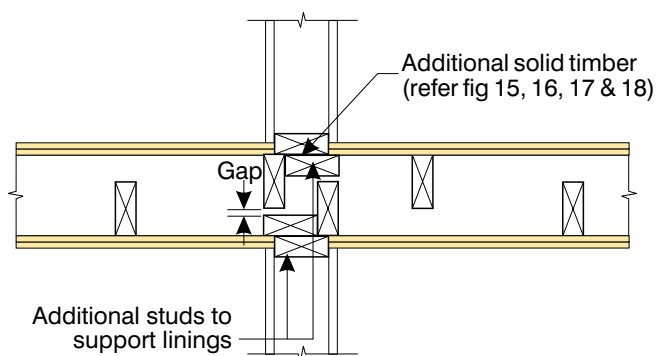
In all cases, the wall's surfaces are isolated to ensure that the sound transmission loss of the wall systems are maintained.



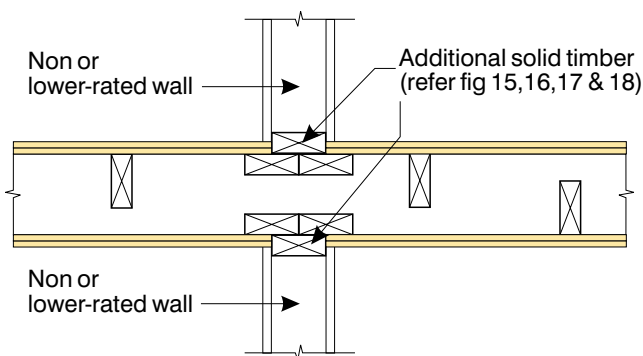
19a



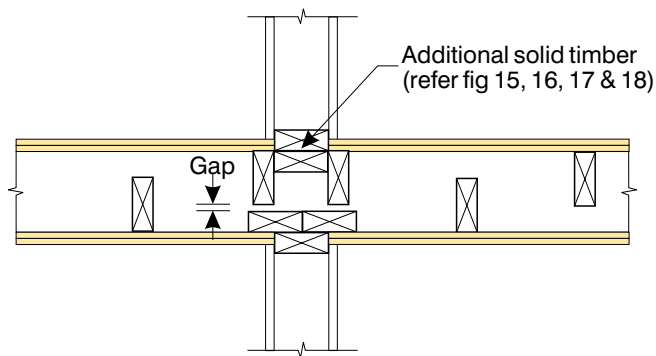
19c



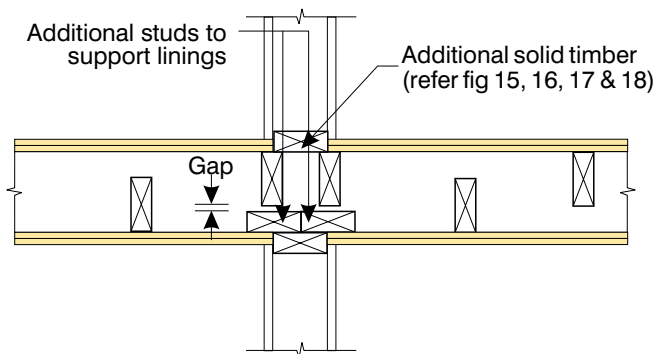
19d



19b

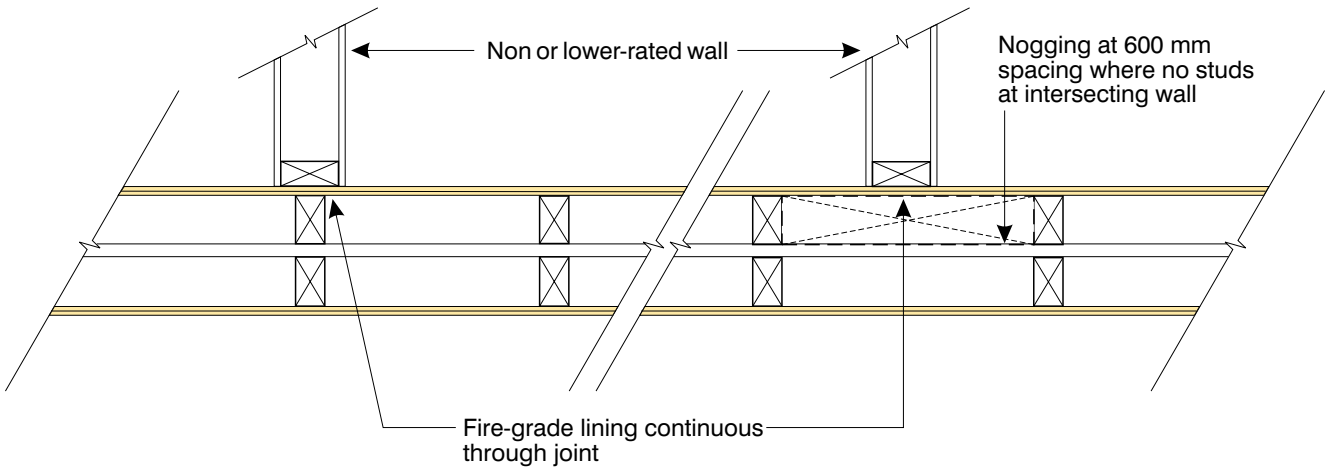


19e

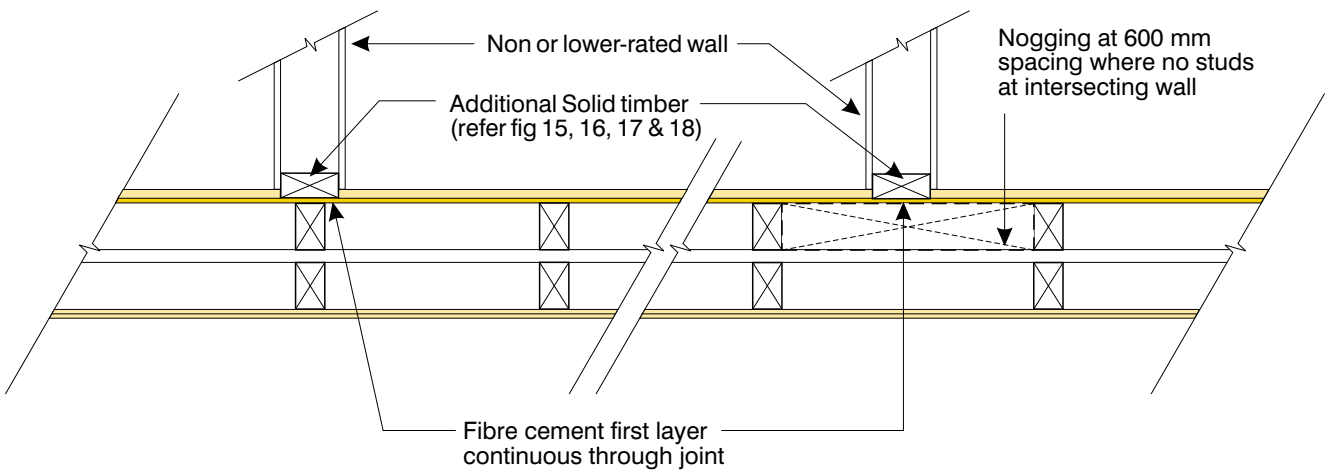


19f

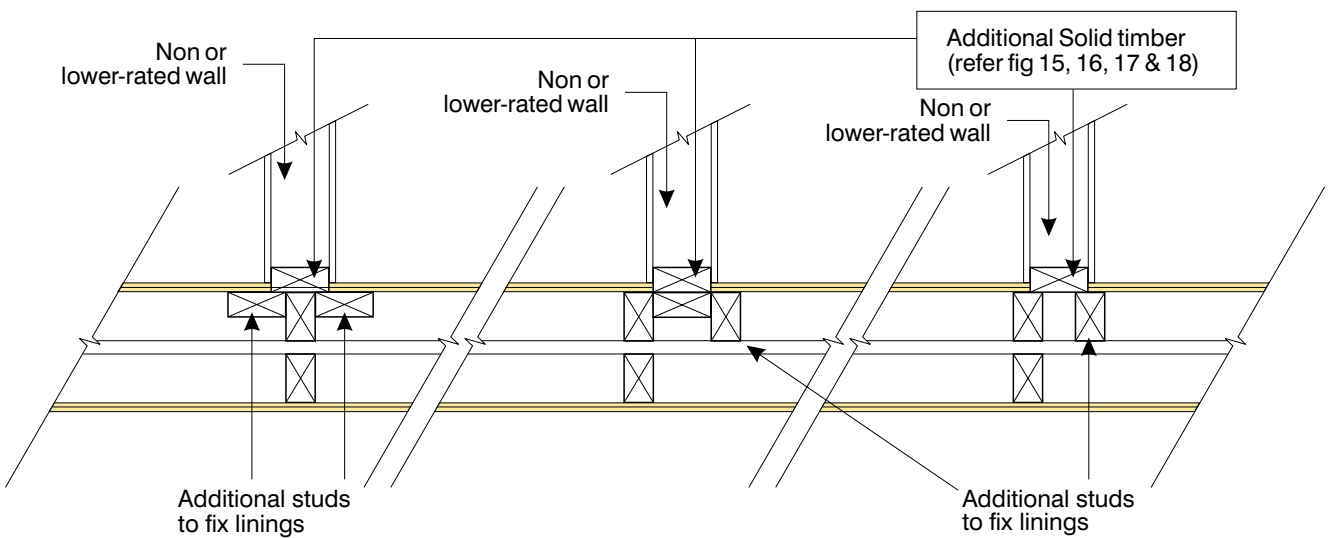
**FIGURE 19 -
NON-RATED OR LOWER-FIRE-RATED WALL
INTERSECTING FIRE-RATED
STAGGERED STUD WALL
(TYPICAL EXAMPLES)**



20(a) - All fire grade linings continuous



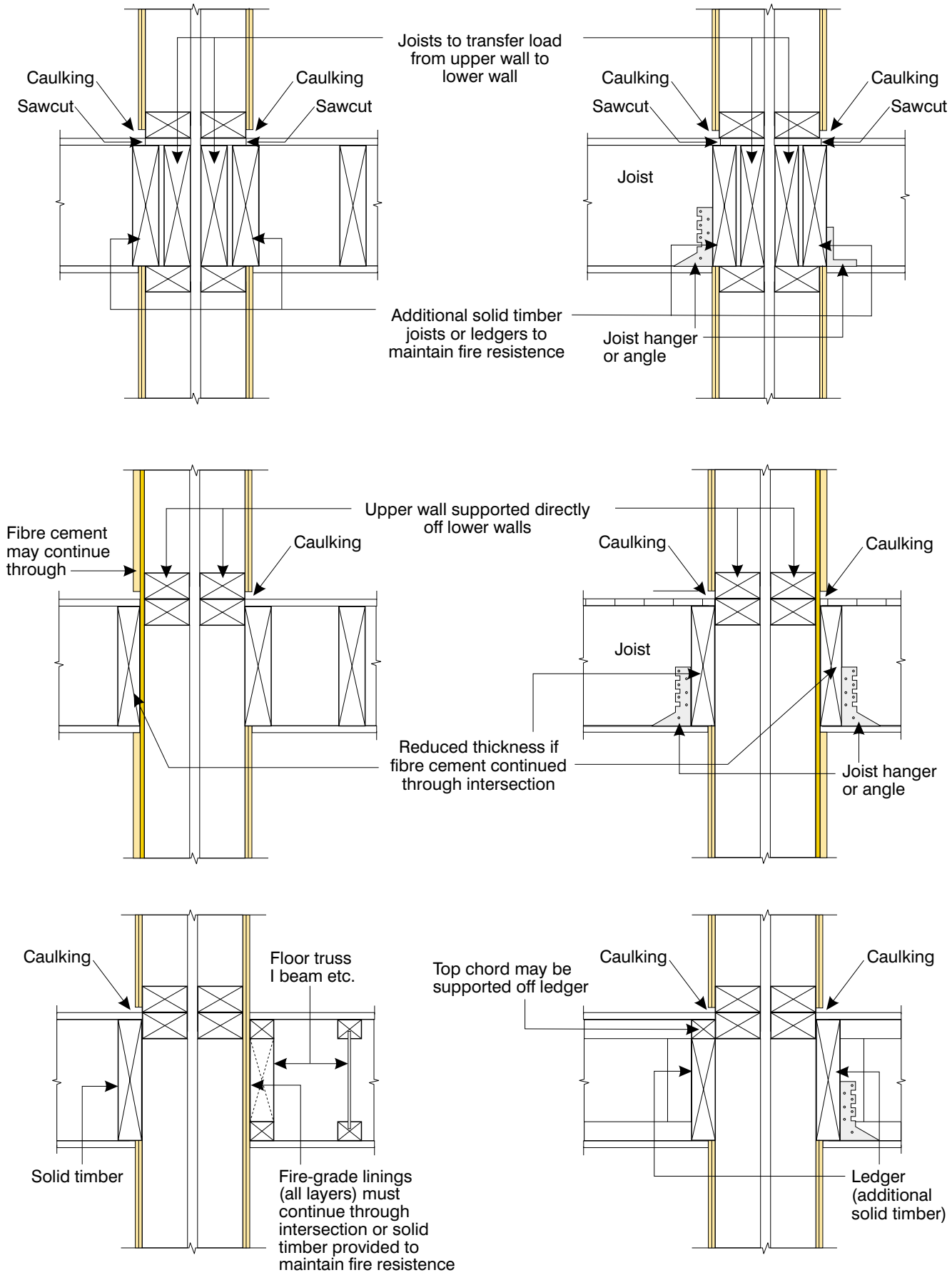
20(b) - First layer (fibre cement) continuous



20(c) - Studs in intersecting wall used to maintain fire resistance

FIGURE 20 - NON-RATED OR LOWER-RATED WALL INTERSECTING FIRE-RATED DOUBLE STUD WALL

Note: In all cases, floors must be able to collapse in the event of fire and leave the separating wall intact.



21(a) - Joists parallel to separating walls

21(b) - Joists perpendicular to separating walls

FIGURE 21- INTERSECTIONS BETWEEN NON OR LOWER-RATED SUSPENDED FLOOR AND DOUBLE STUD WALLS

9.5.2 Non or Lower-Rated Floor/ Ceiling System Intersecting Fire-Rated Wall

Where non or lower-fire-rated floor/ceiling system intersects a fire-rated wall, it is generally not possible to continue the fire-resisting linings through the junction.

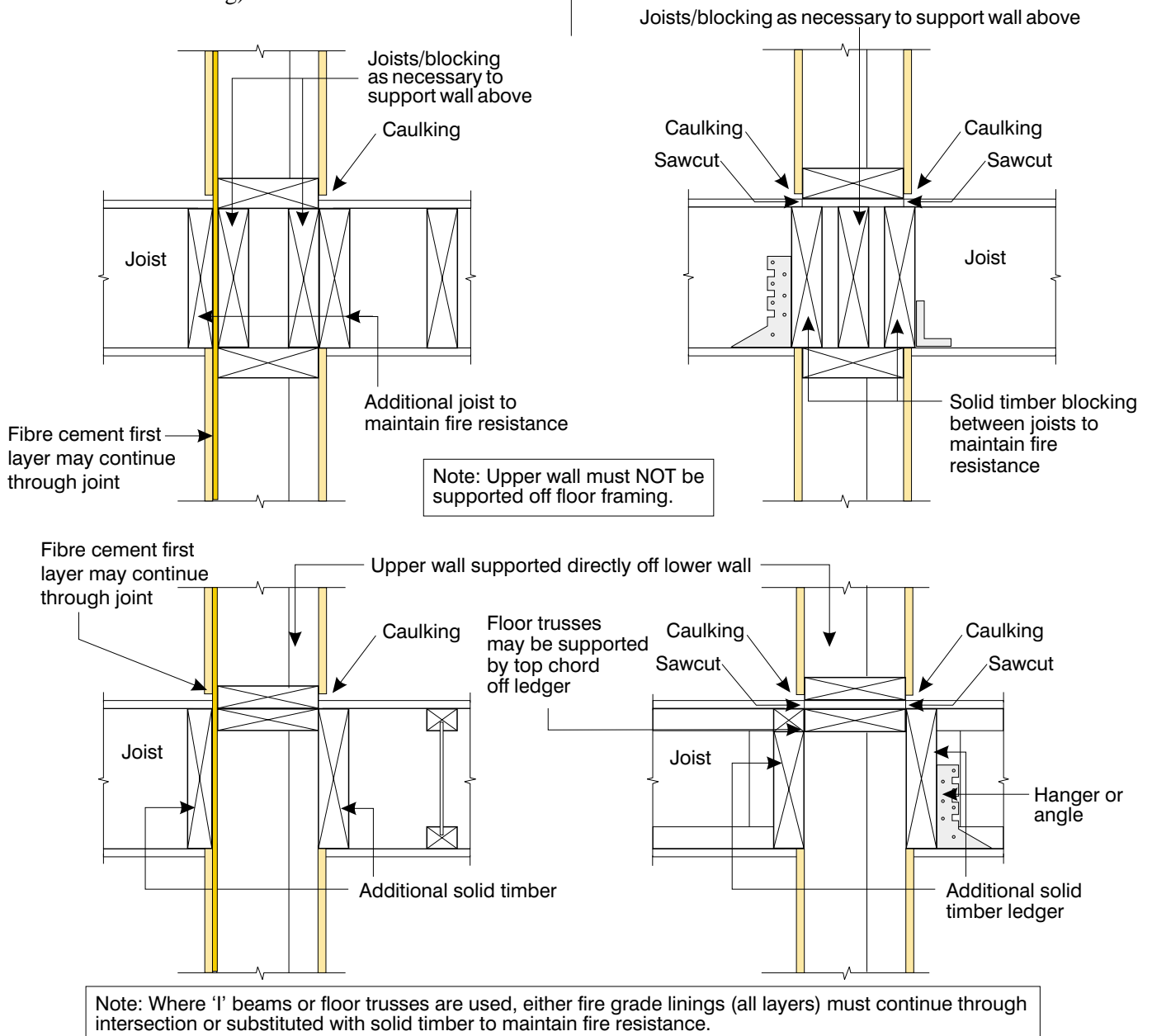
The junction must be designed to maintain the fire resistance of both the wall and the floor/ceiling system (if rated) at this intersection point.

As with wall to wall junctions, solid timber can be used to perform this function. The important difference is that the floor/ceiling must be designed to rotate off the wall in the event of a fire burning through the non or lower-fire-rated floor/ceiling system and leave the higher rated wall intact (i.e. the upper wall can not be supported off the floor framing).

This ability for the floor to rotate off is critical to maintain the full resistance of the fire-rated wall. The use of a joist hanger or a ledger to the side of the wall will satisfy this requirement (refer Figures 21 and 22).

Unless the floor/ceiling system has the same fire resistance as the wall, no structural member is to be continuous through the wall. Where possible floor joists, flooring and floor beams are to be supported at the wall's face. Flooring or other construction within the wall's construction must be separated from an adjoining dwelling or unit.

NOTE: For maximum sound performance the construction on one side of the wall should not be fixed to the construction on the other side of the wall.



22(a) - Joists parallel to separating wall

22(b) - Joists perpendicular to separating wall

FIGURE 22 - INTERSECTIONS BETWEEN SUSPENDED FLOORS AND FIRE-RATED STAGGERED STUD NON OR LOWER-RATED WALL

9.5.3 Non-Aligned Floors

Where floors are non-aligned, no unique construction is required (i.e. any of the options in Figures 21 and 22 could be used).

NOTE: Where platform floor construction is used (i.e. floor joists supported on wall plates) the use of staggered or single stud walls to support the non-aligned floors is not recommended as it is difficult to achieve satisfactory sound performance

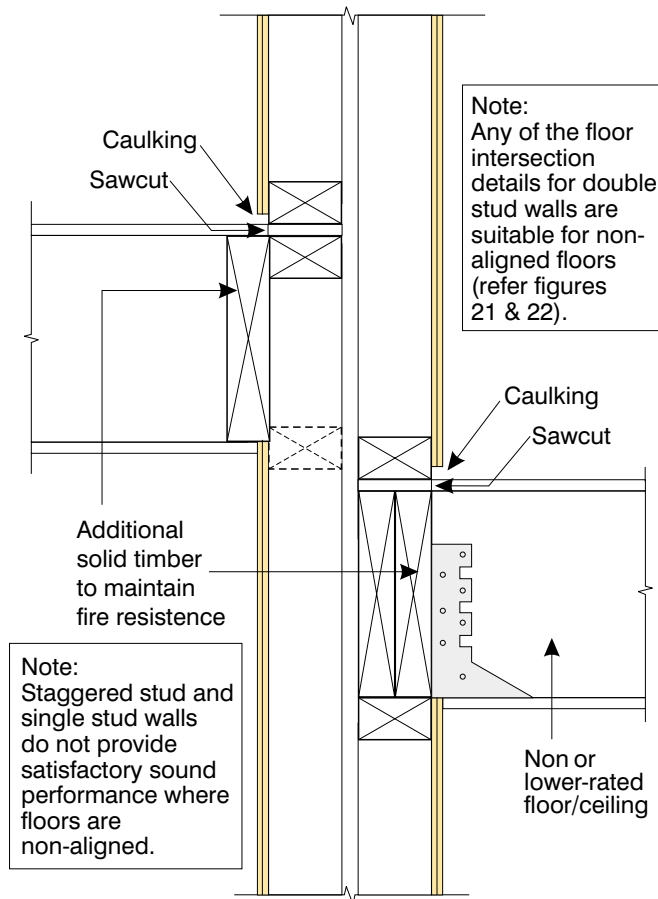
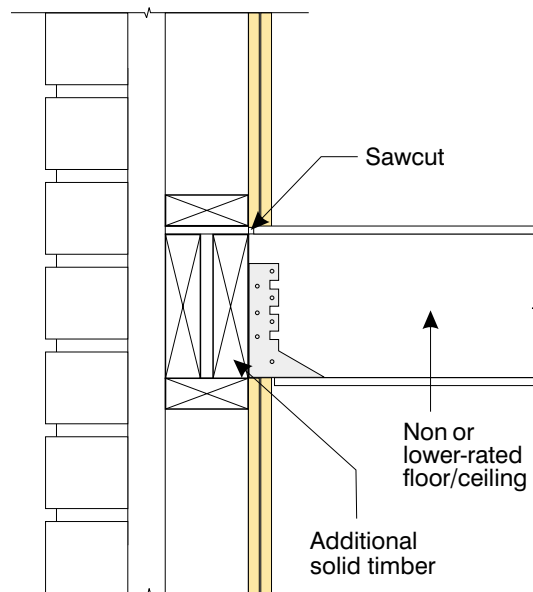


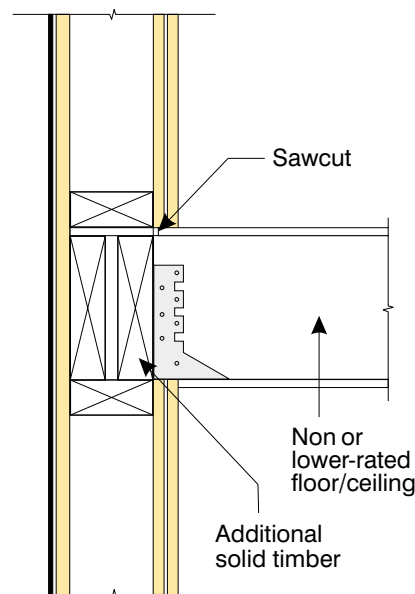
FIGURE 23 - TYPICAL NON-ALIGNED FLOORS (Cavity barrier not shown)

9.5.4 Non or Lower-Rated Floor/Ceiling System Intersecting Fire-Rated External Walls

These details are similar to those for floor/ceiling systems intersecting internal fire-rated walls (refer Figures 21 and 22). The only difference for external wall junctions is that there is no need to consider sound transmission. The floors must be able to rotate off the wall. Figure 24 shows typical examples.



(a) Brick Veneered External Wall (Cavity barrier not shown)



(b) Lightweight Clad External Wall

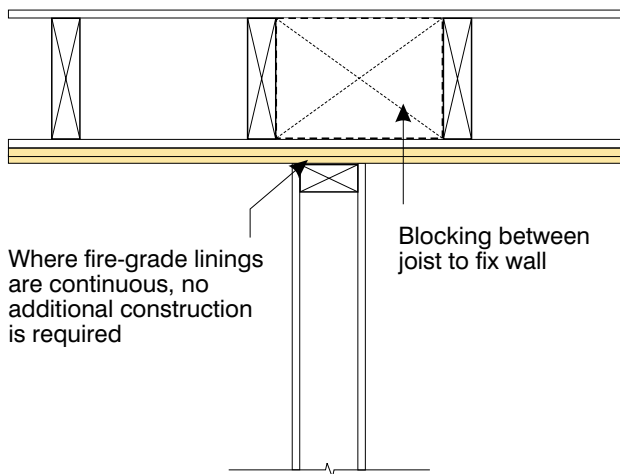
FIGURE 24 NON OR LOWER- RATED FLOOR / CEILING TO FIRE-RATED EXTERNAL WALL

9.5.5 Non or Lower-Rated Wall to Fire-Rated Floor/Ceiling System

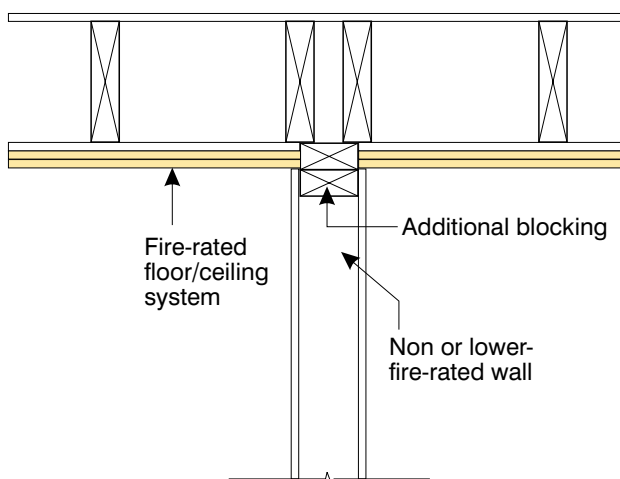
Placement of linings normally occurs after the frame installation is complete. When this occurs, it is difficult to run the fire-grade ceiling linings (furring channel etc) over the top of the wall (refer Figure 25(a)).

Where ceiling linings are not continued across the wall, solid timber must be used (as for wall intersections) to seal the void in the linings. The top plate of the non-fire-rated walls can be included in the thickness of timber required (refer Figure 25(b)).

NOTE: An alternative method is to fire rate the wall to the same fire resistance level as the floor/ceiling system.



(a) Ceiling Linings Continuous

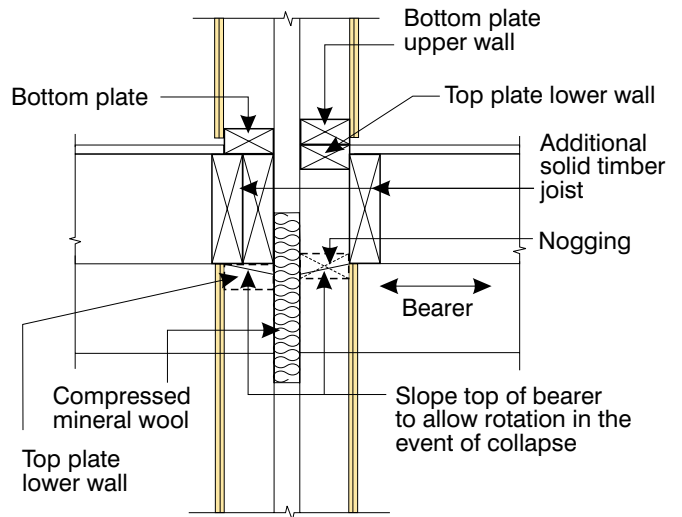


(b) Timber Blocking to Seal Void

FIGURE 25 - NON OR LOWER-RATED WALL INTERSECTING FIRE-RATED FLOOR/CEILING SYSTEM

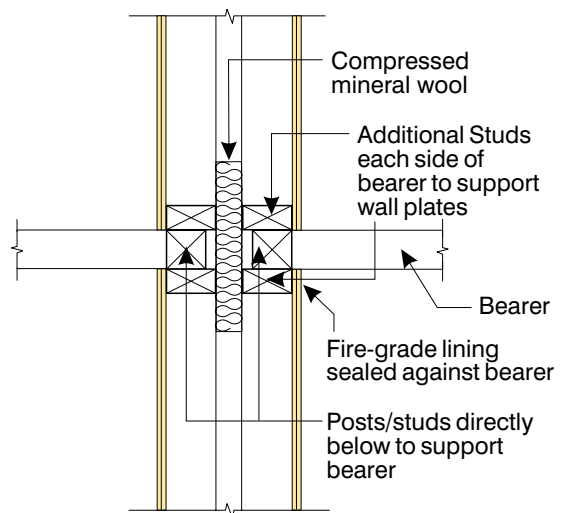
9.5.6 Non or Lower-Rated Bearers or Beams Supported by Fire-Rated Wall

Where beams or bearers have a lower fire resistance than their supporting wall, then (as for floor systems), they must be designed to rotate off the wall in the event of a fire. Figure 26 details methods of connecting beams or bearers to fire-rated walls.



Note: Upper wall must not be supported off bearers

(a) - Section / Elevation



(b) - Plan view

FIGURE 26 - NON OR LOWER-RATED BEAM OR BEARER SUPPORTED BY FIRE-RATED WALL

9.5.7 Sealing Around Doors and Windows in Fire-Rated Walls

There are many instances where doors, windows or similar construction can penetrate through fire-rated walls. Examples include doors or windows through external walls, entrance doors to a unit from a corridor or a door in a loadbearing internal wall which is required to be fire resistant. These penetrations must be designed and built to maintain the fire resistance and restrict the passage of smoke, heat, gases as well as flame into any wall cavity.

Protection can be provided by:-

(a) Fire-Grade Lining

The easy way to ensure that fire resistance is maintained is to continue the fire grade linings around the opening. The thickness and number of linings are identical to what is used on the wall. Figure 27 details a section through typical door opening.

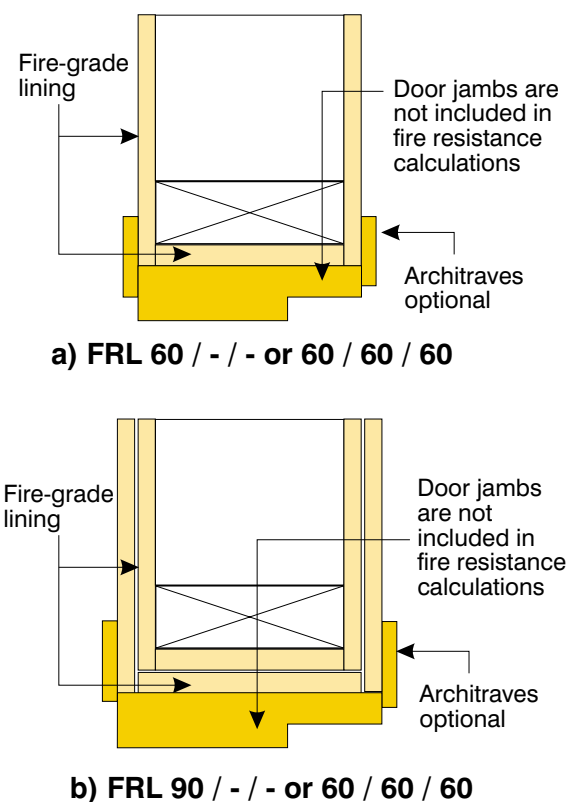


FIGURE 27 - FIRE GRADE LININGS PROTECTION AT DOOR OPENING

(b) Additional Timber

Where there is an exposed timber frame, additional sacrificial timber can be used to provide protection. The total thickness of the timber is to be as per Table 7.

The timber that can be used as protection must have no loadbearing function, e.g. timber reveal, framing used to locate window opening, additional sacrificial timber. Timber framing such as lintels or studs at the side of openings are structural and cannot be used in the calculation.

Sacrificial timber is required to be full thickness, width and length of opening (refer Figure 28).

NOTE: Where fire-rated doors and door frames are used, the protection offered by the door frame will be sufficient.

**TABLE 7
TIMBER THICKNESS FOR DIFFERENT FRL**

FRL	Total Timber Thickness (mm)	Examples
60 / - / - or 60/60/60	30	Window Opening: Timber reveal (19 mm) plus 35 mm sacrificial stud or lintel equals 54 mm > 30 mm OK
90 / - / - or 90/90/90	50	Door Opening: Timber reveal (19 mm) plus 35 mm sacrificial stud or lintel equals 54 mm > 50 mm OK

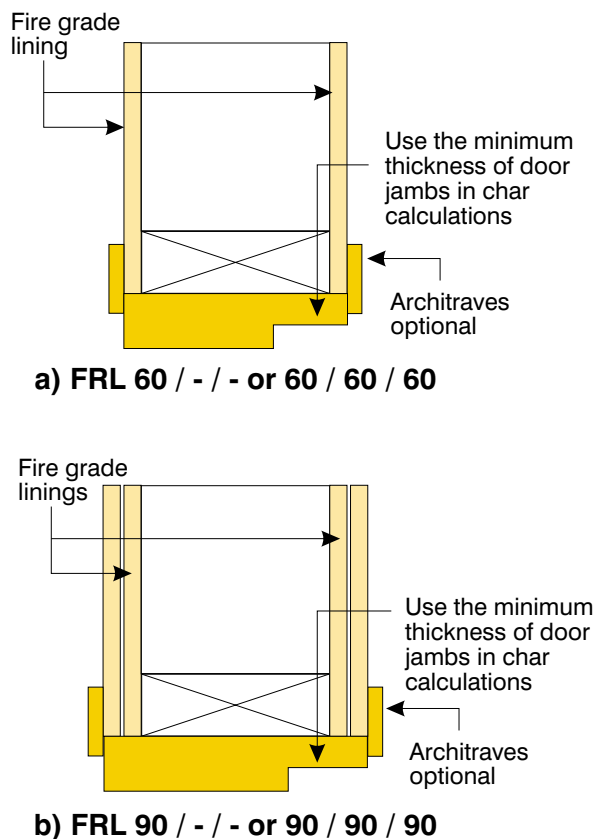


FIGURE 28 - SACRIFICIAL TIMBER PROTECTION AT DOOR OPENING

(c) Closing Cavities in Brick Veneer Walls

In addition to the construction for the protection of the timber frame described in (b) it is necessary to close the cavity formed between the timber framing and brick veneer. This can be done by the addition of timber blocks which are to the thickness listed in Table 7 and are the full width and length of the cavity. Alternatively, fire-resisting mineral wool to the appropriate fire resistance can be used.

NOTE: When installing these products moisture penetration must be considered. Timber blocks or Mineral Wool generally require a flashing or damp proof course placed between them and the brickwork. (Refer Figures 29 & 30).

Where conventional window sills are constructed in brick veneer walls, fire-resisting blocking to the window sill is not required.

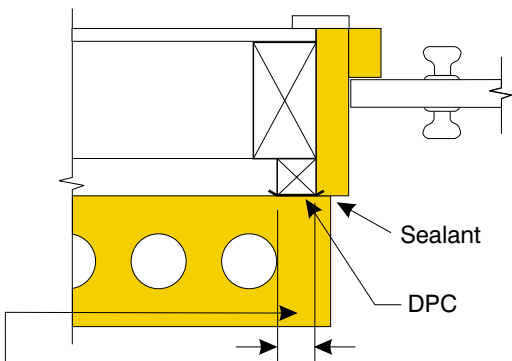


FIGURE 29 - SACRIFICIAL TIMBER PROTECTION AT DOOR OPENING

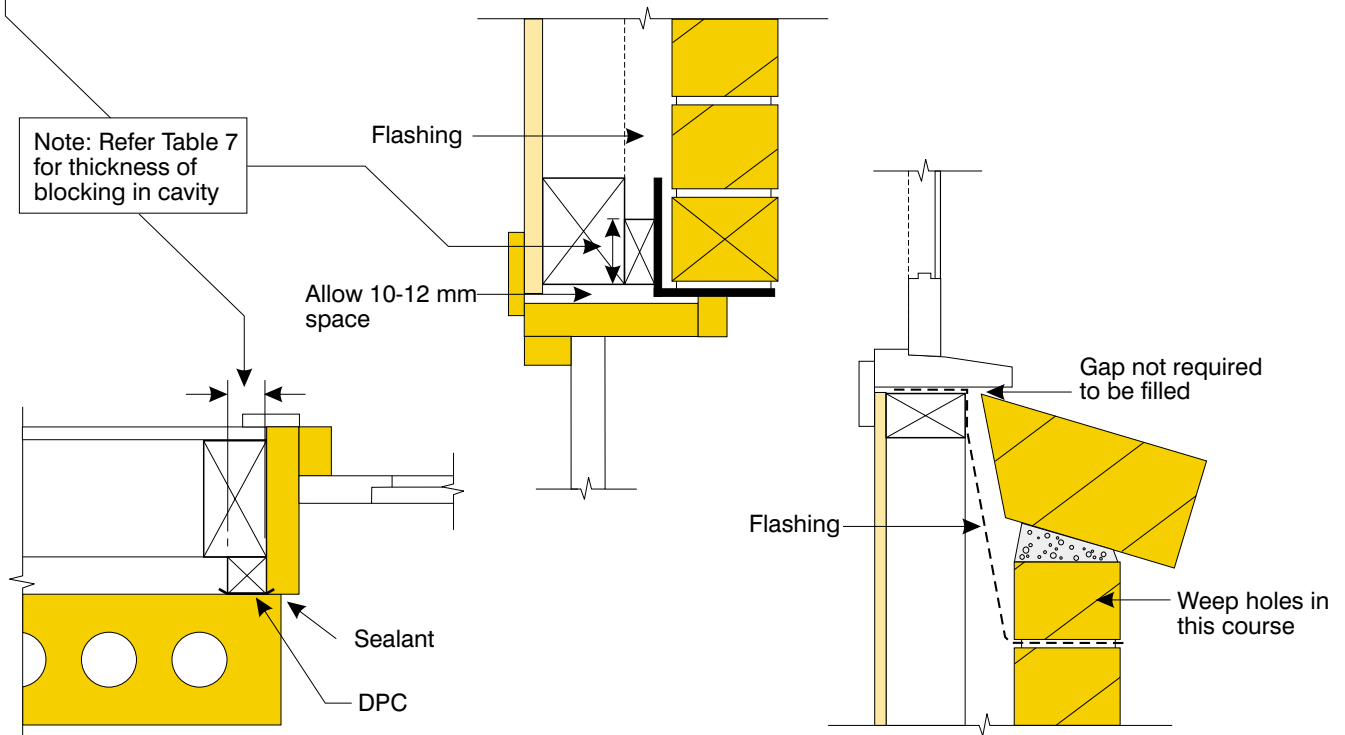


FIGURE 30 - WINDOW OPENING IN FIRE-RATED BRICK VENEER WALL

9.5.8 Fire-Rated Junctions at the Eaves

(a) Boxed Eaves (Fire-Rated internal Walls between units are taken up to Roof)

Where fire-rated walls are extended to the underside of a non-combustible roof, and a void is formed by the slope of the rafter and the horizontal soffit, this void must be properly sealed to provide fire separation within the eaves space (refer Figure 31).

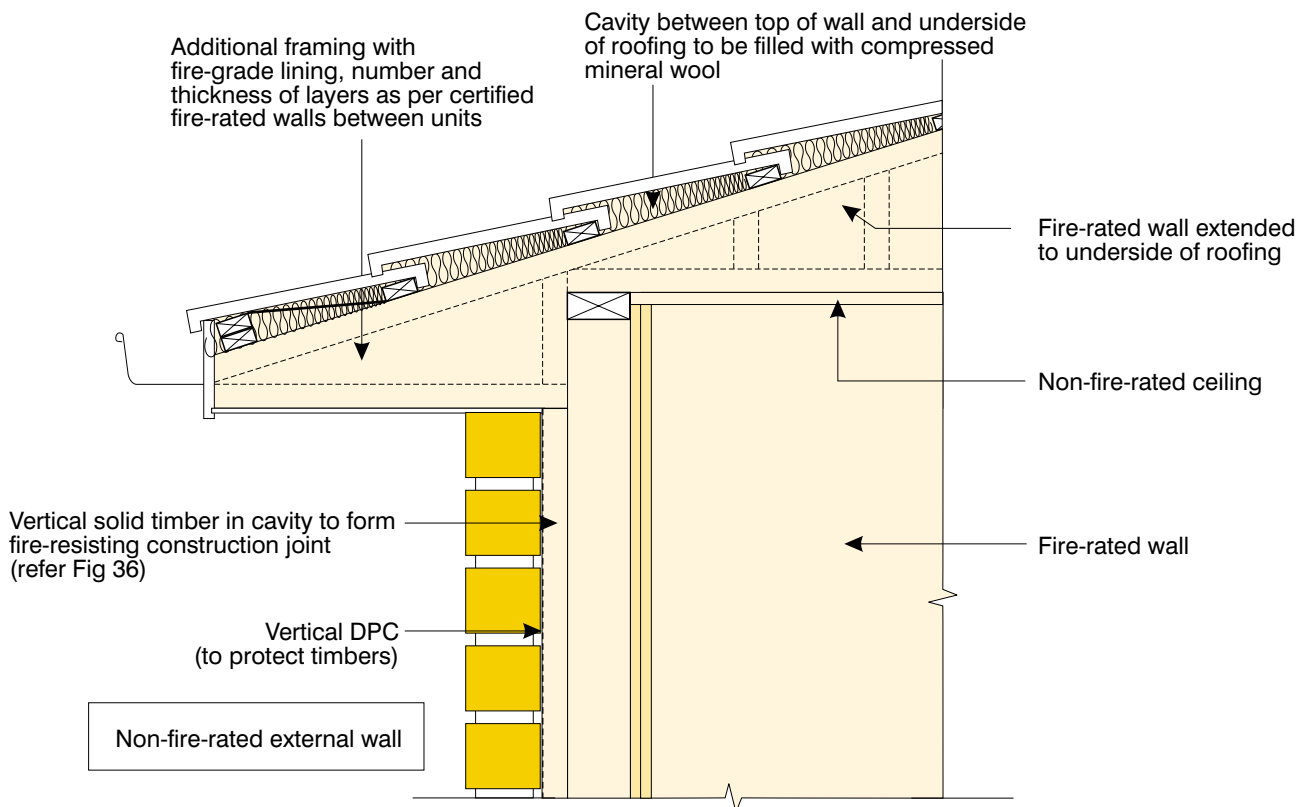
This is best achieved by fixing fire-grade linings to both sides of additional framing cut to suit the profile of the roof slope, and tightly butted to the fascia board. Fire-grade linings should be the same as for fire-rated walls either:-

- 1 x 16 mm fire-grade plasterboard or 1 x 13 mm fire-grade plasterboard plus 6 mm fibre cement for a FRL 60/60/60 or -/60/60; and
- 2 x 13 mm fire-grade plasterboard or 1 x 16 mm fire-grade plasterboard plus 6 mm fibre cement for a FRL 90/90/90 or -/90/90.

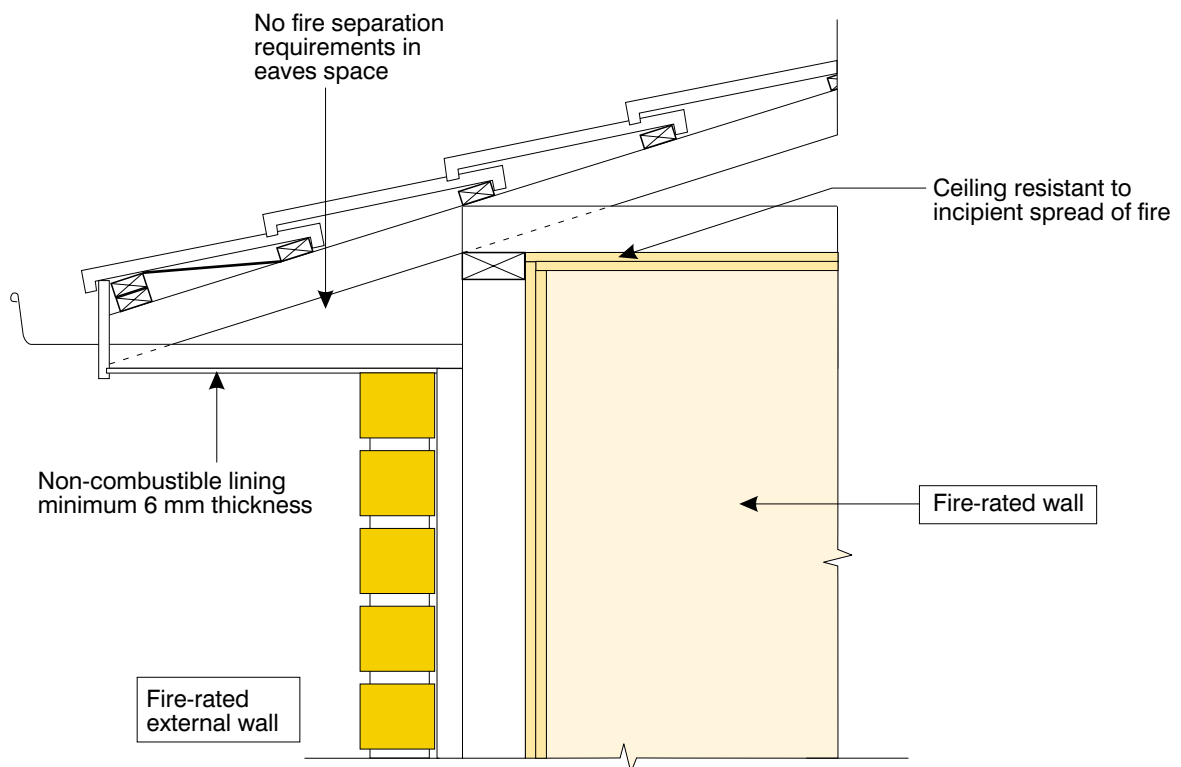
NOTE: The intent of blocking the void formed at the eaves is to restrict the travel of fire through hidden passages.

(b) Open Eaves

Where eaves are open or where eaves soffit linings are fixed to rafter or truss projections, there is no requirement to provide fire separation at the eaves.



**FIGURE 31 -
EAVES DETAIL AT THE JUNCTION BETWEEN FIRE-RATED WALL
AND NON-FIRE-RATED EXTERNAL WALL
WHERE THE CEILING IS NON-FIRE-RATED**



**FIGURE 32 -
EAVES DETAIL AT THE JUNCTION BETWEEN FIRE-RATED INTERNAL WALL,
FIRE-RATED EXTERNAL WALL AND INCIPIENT SPREAD OF FIRE CEILING**

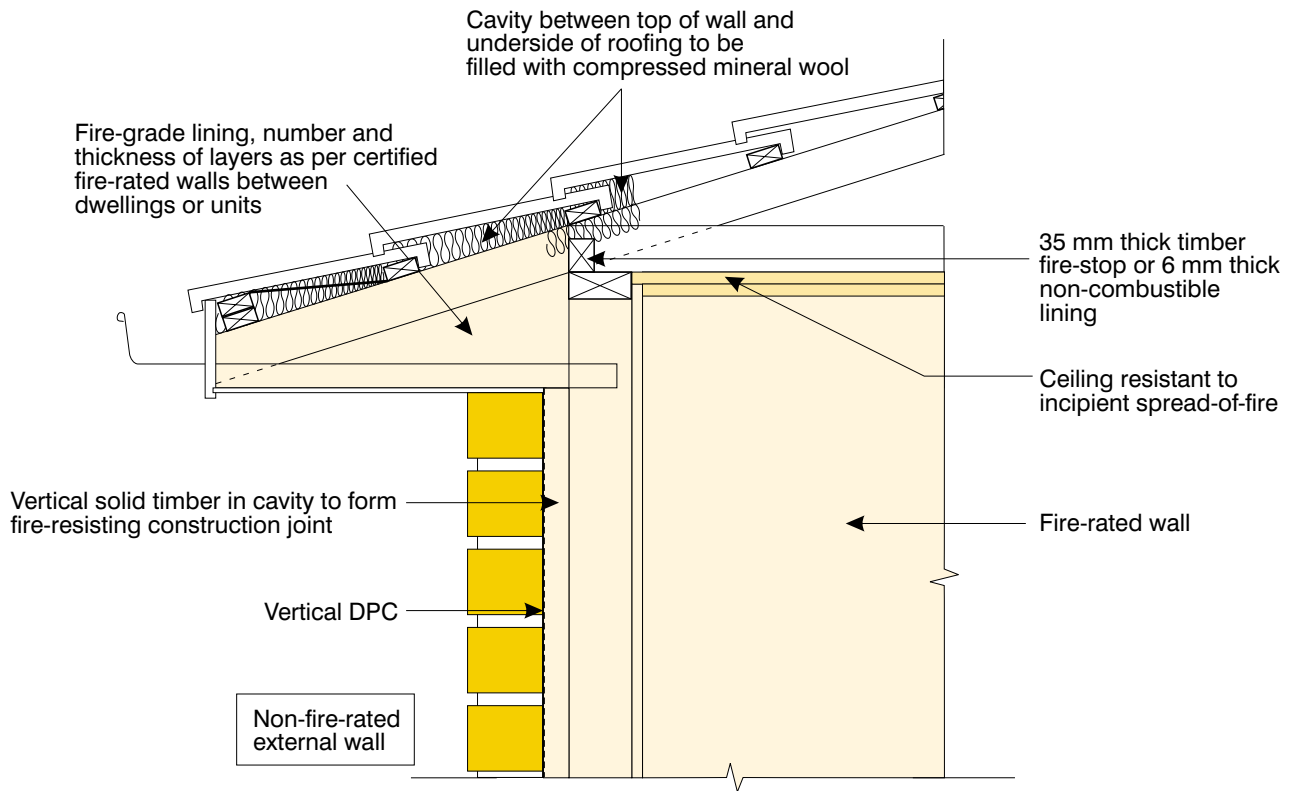


FIGURE 33 - EAVES DETAIL AT THE JUNCTION BETWEEN FIRE-RATED INTERNAL WALL, NON-FIRE-RATED EXTERNAL WALL AND INCipient SPREAD-OF-FIRE CEILING

(c) Fire-Rated External Walls and Incipient Spread-of-Fire Ceiling

Where fire-rated walls stop at the underside of a ceiling with resistance to Incipient Spread-of-Fire and the external wall is fire-rated, there is no requirement to block off the eaves (refer Figure 32).

(d) Non-Rated External Walls and Incipient Spread-of-Fire Ceiling

Where the external wall is non-fire-rated, fire separation must be provided at the eaves (refer Figure 33).

9.5.9 Top of Fire-Rated Wall taken to Underside of Non-Combustible Roofs

Where fire-rated walls are carried up to the underside of non-combustible roof sheeting, the only members allowed to travel through or over the fire-rated wall are roof battens. The BCA limits the size of these battens to 75 x 50 mm. Other members such as roof trusses and roof beams cannot pass through or over a fire-rated wall.

The cavity formed above the wall, between the roof battens and non-combustible roof cladding (tiles or sheet roof) must be filled with fire-resisting material (e.g. mineral wool) (refer Figure 34). Alternatively, solid timber can be used:- 45 mm thick for FRL 60/60/60 and 90 mm thick for FRL 90/90/90.

NOTE: It is generally accepted that sound-ratings are not required for fire-rated walls in ceiling spaces, therefore, these walls need only be single stud construction.

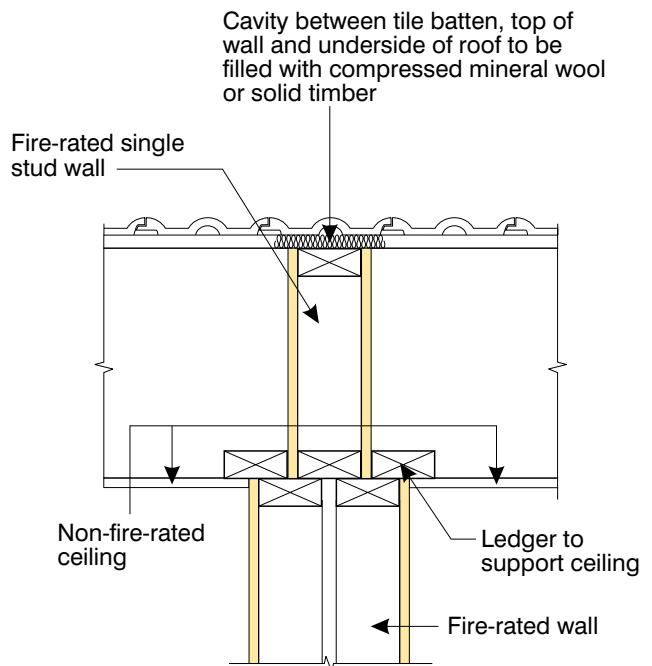


FIGURE 34 - JUNCTION FORMED BETWEEN TOP OF FIRE-RATED WALL AND UNDERSIDE OF NON-COMBUSTIBLE ROOF CLADDING

9.5.10 Intersection of Fire-Rated Walls with Exterior Non-Rated Wall

Internal fire-rated walls are required to continue until they abut the inside surface of the exterior cladding. Figures 35 and 36 describe various methods that can be used for brick veneer and lightweight-clad buildings.

The timber thickness is dependent on the FRL required and the reinforcement used (refer 9.5.1 and 9.5.2).

NOTE: Where the cavity is bridged ensure that the effect of moisture ingress is accounted for. Timber blocks in these locations should have damp-proof course between the timber and the masonry. Where this is not possible, preservative treated timber should be used. Mineral wools should be wrapped in plastic or a damp-proof course used.

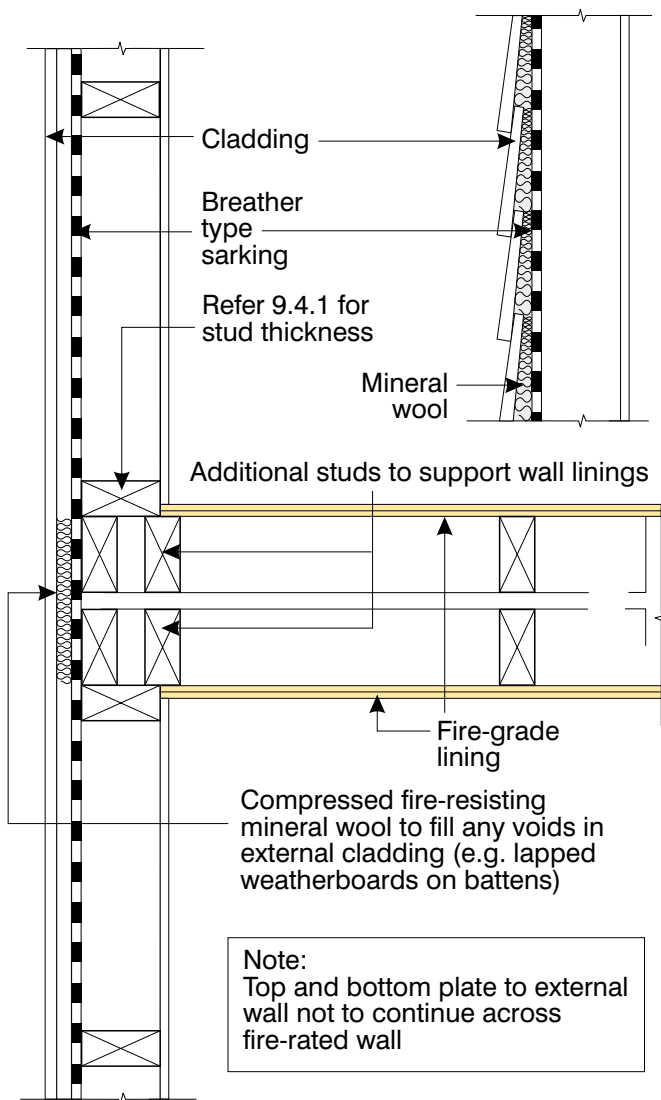
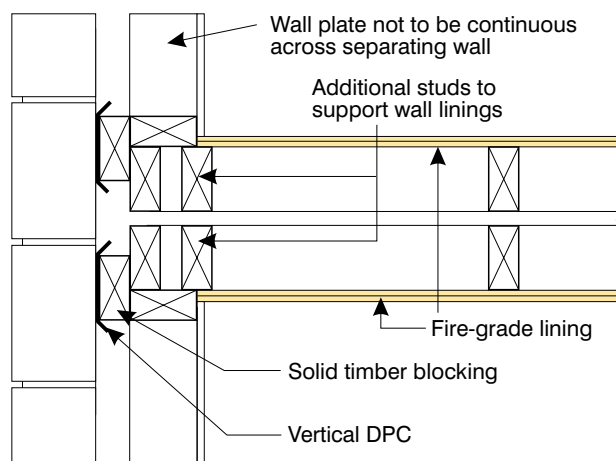
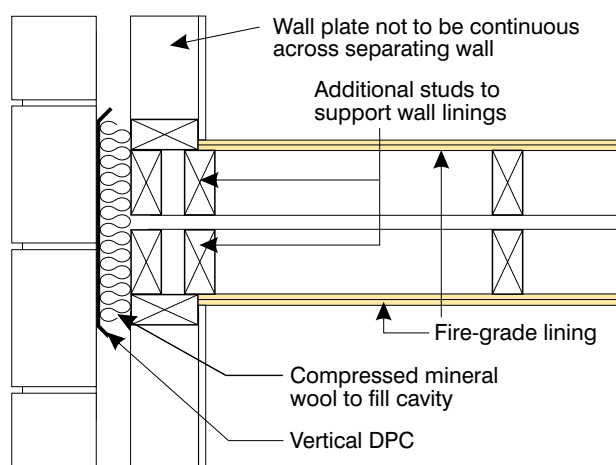


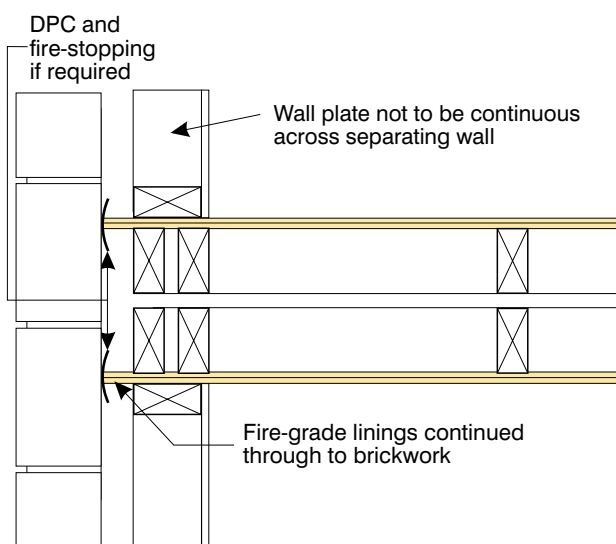
FIGURE 35 - JUNCTION BETWEEN FIRE-RATED INTERNAL WALL AND NON-FIRE-RATED LIGHTWEIGHT-CLAD EXTERNAL WALL



(a) - Cavity blocked with timber



(b) - Cavity filled with mineral wool



(c) - Fire-grade linings continued across cavity

FIGURE 36 - JUNCTION BETWEEN FIRE-RATED INTERNAL WALL AND NON-FIRE-RATED BRICK VENEER EXTERNAL WALL

9.5.11 Intersection between Internal Walls and External Walls with Same Rating

Where fire-rated internal walls intersect with fire-rated exterior walls having the same fire-rating, the only requirement is that the fire-resisting linings must be closely butted or sealed with fire-grade sealant to maintain the fire resistance.

NOTE: Cavity barriers are recommended at these intersections (refer Section 9.8).

9.6 Fire-Stopping – Deemed-to-Satisfy Method BCA: Spec C3.15

Where the fire-grade linings in fire-resisting wall or floor/ceiling systems are breached by services, the BCA requires these penetrations to be fire-stopped so that the fire resistance is maintained during a fire. Fire-stopping materials must be used to close a gap or imperfection of fit between a service and a fire-resisting system, component or construction in a building. They are required to be an equivalent fire resistance to the element that has been breached.

There are two ways of satisfying the requirements of the BCA with respect to fire-stopping:-

- (a) Use the BCA's deemed-to-satisfy method as described in this section.
- (b) Use manufacturer's certified systems and materials (refer Section 9.7)

9.6.1 General

In general, all openings for pipes, ducts, conduits or cables passing through fire-resisting constructions should be:-

- fire-stopped
- kept to a minimum
- kept as small as practicable
- designed in a way which will allow thermal or shrinkage movement to be catered for.

NOTE: It is strongly recommended that no service pipes or electrical wiring be contained in the cavity of walls between sole-occupancy units. It is recommended that services are placed in non-fire-rated walls contained within the unit or behind false walls battened out in front of fire-rated walls. Where penetrations for services through linings of walls separating dwellings or units cannot be avoided, the integrity of the wall must be maintained for both fire resistance and sound insulation.

The deemed-to-satisfy methods described in the BCA are acceptable for fire-rated wall and floor/ceiling systems but not for penetrations in incipient spread-of-fire ceilings and pipes that contain flammable liquid or gas.

NOTE: Where deemed-to-satisfy solutions are not acceptable, manufacturer's certified systems must be used. (Refer 9.7)

9.6.2 Fire Stopping Materials

The materials used for the fire-stopping of service penetrations must be one of the following:-

- concrete
- high-temperature mineral fibre
- high-temperature ceramic fibre

NOTE: Other materials can be used as long as they do not flow at temperatures below 1120°C when tested in accordance with AS 1038.15, and must not impair the fire-resisting performance of the element in which it is placed.

Fire-stopping material must be packed into the gap between the service and wall, floor or ceiling. When using a fire-resisting product, it is necessary to refer to the manufacturers' instructions for correct installation procedures. The material must be compressed to the same degree as used in the relevant fire test.

9.6.3 Plumbing

Pipes that penetrate a cavity in a fire-rated wall or a cavity in a floor/ceiling system must be adequately supported and packed in the cavity with a fire-stopping material. The fire-stopping should be a thickness of 25 mm all round the service for the full length of the penetration (refer Fig 38). The fire-stopping should also be restrained independently of the service and prevented from moving or parting from the surfaces of both the service and the wall, floor or ceiling.

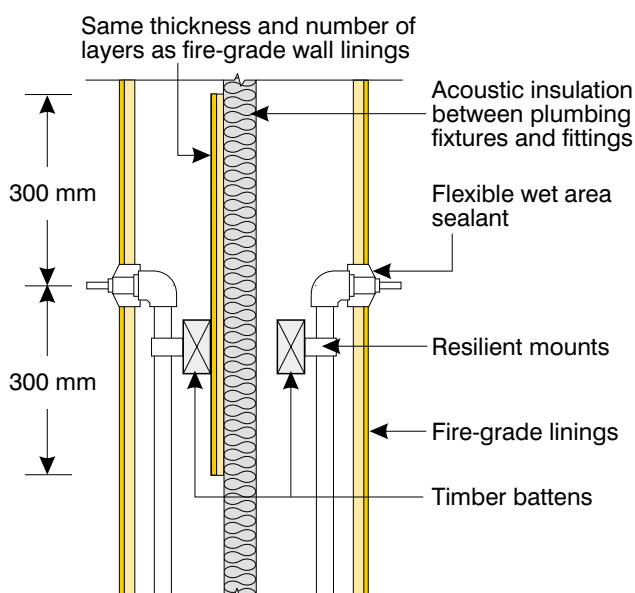
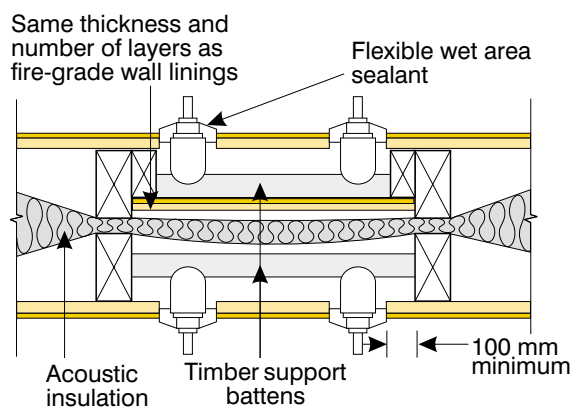
Plumbing fittings should preferably not be back-to-back. Where this is unavoidable a fire-grade plasterboard baffle must be provided (refer Figure 37).

All pipes must be kept clear of the fire-grade linings and baffles and not be connected to the adjacent wall's construction. Pipes must not be supported by wall lining material.

A metal pipe that is not normally filled with liquid must not penetrate a fire-rated wall, floor or ceiling within 100 mm (at the point where the lining is penetrated) of any combustible material such as a stud, joist or roof member.

Metal pipes which penetrate a fire rated wall must be made of:-

- a) copper alloy or stainless steel with a wall thickness of at least 1 mm; or
- b) cast iron or steel with a wall thickness of at least 2 mm.



**FIGURE 37 -
BAFFLE AND INSULATION BETWEEN
BACK-TO-BACK PLUMBING OUTLETS**

An opening in fire-grade lining for a metal pipe must:-

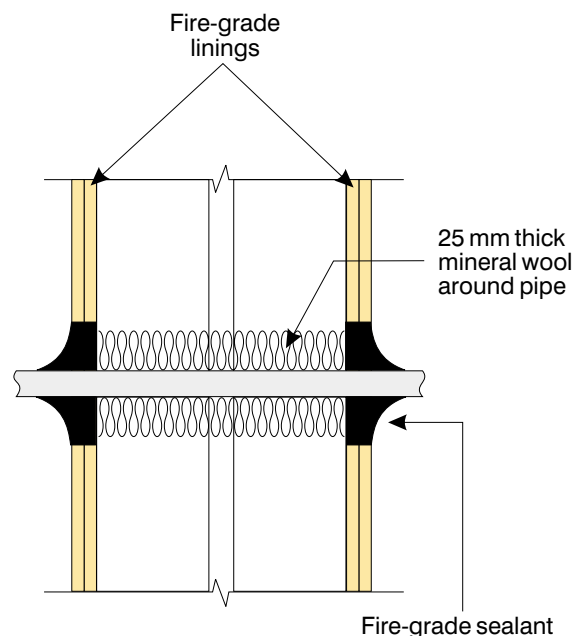
- a) be neatly formed, cut or drilled; and
- b) be no closer than 200 mm to any other service penetration; and
- c) accommodate only one pipe.

A metal pipe must not be lagged or enclosed in thermal insulation over the length of its penetration of a fire-rated wall, floor or ceiling unless the lagging or thermal insulation is a recognised fire-stopping material.

All gaps between the metal pipe and the wall, floor or ceiling sheeting it penetrates must be fire-stopped (refer Figure 38).

If a pipe (metal or UPVC) penetrates the floor of a sanitary compartment:-

- a) the opening must be neatly formed and no larger than is necessary to accommodate the pipe or fitting; and
- b) the gap between the pipe and floor must be fire-stopped.



**FIGURE 38 -
FIRE-STOPPING OF A PIPE PENETRATION**

9.6.4 Switches and Outlets

If a non-fire-rated electrical switch, outlet, socket or the like is accommodated in an opening or recess in a wall or ceiling:-

- a) it should not extend beyond half the overall thickness of the wall
- b) the gap between the service and the wall, floor or ceiling sheeting must be fire-stopped.

If switches or outlets are back-to-back (i.e. within 300 mm horizontally or 600 mm vertically of a service in the opposite face) then either:-

- a) the cavity immediately behind the services must be framed and packed with fire-stopping material, or
- b) the back and sides of the services must be protected with fire-grade lining identical with and of the same thickness as that through which the services penetrate. Figure 39 illustrates a baffle between non-fire-rated power outlet installations.

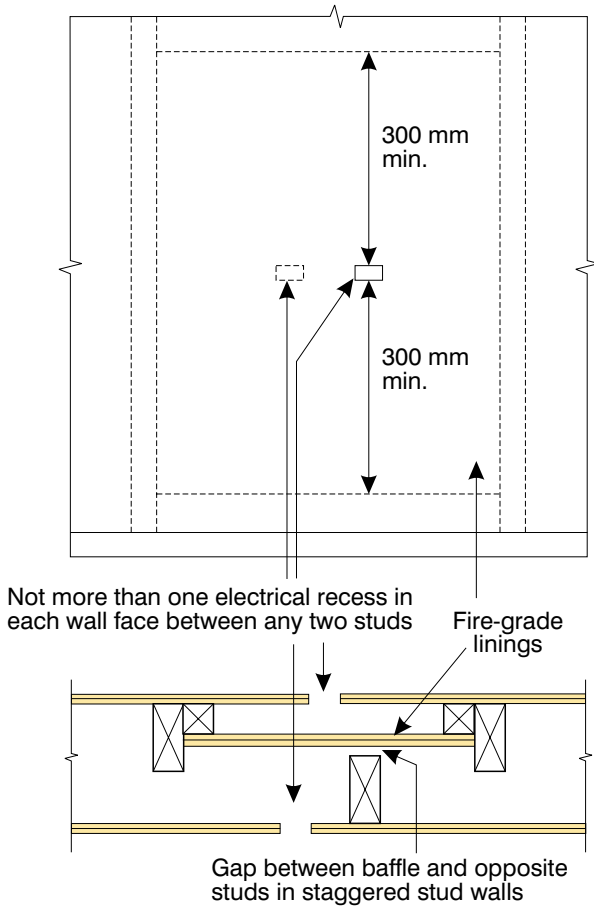


FIGURE 39 - NON-FIRE-RATED POWER OUTLET BAFFLE DETAIL

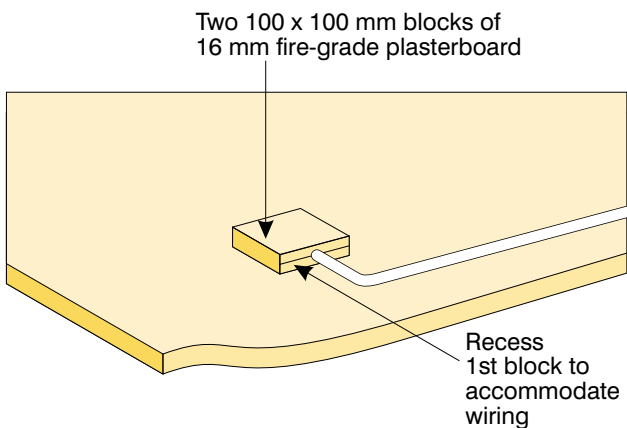


FIGURE 40 - WIRE PENETRATION OF CEILING

9.6.5 Wires and Cables

If a wire or cable, or cluster of wires or cables penetrates a fire-rated floor, wall or ceiling, the opening must be neatly formed, cut or drilled and be no closer than 50 mm to any other service opening.

The opening must be no larger in cross-sectional area than:-

- a) 200 mm² if only a single cable is accommodated and the gap between cable and wall, floor or ceiling is no wider than 15 mm; or
- b) 500 mm² in any other case.

The gap between the service and the wall, floor or ceiling sheeting must be fire-stopped (refer Figure 40).

9.7 Fire Stopping- Manufacturer’s Certified Systems and Materials

An alternative method is to use manufacturer’s certified systems to fire stop penetrations in fire-rated walls of floor/ceilings.

NOTE: Certified systems generally use intumescent sealers which expand when exposed to fire conditions and close off any gaps in linings etc.

9.7.1 PVC Pipe Penetration through Ceilings

Where a PVC pipe penetrates a fire-rated ceiling, intumescent pipe collars should be used. These must be installed in accordance with manufacturer’s instructions (refer Figure 41).

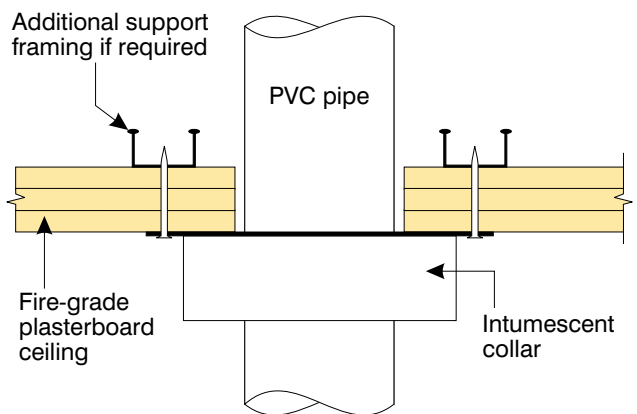


FIGURE 41 - FIRE-RATED PIPE COLLAR

9.7.2 Fire-Rated Electrical Outlets

It is recommended that fire-rated electrical boxes be used for all power outlets, light fittings and switches, which are installed in any fire-rated wall, or ceiling (refer Figure 42). These must be installed in accordance with the relevant manufacturer's instructions.

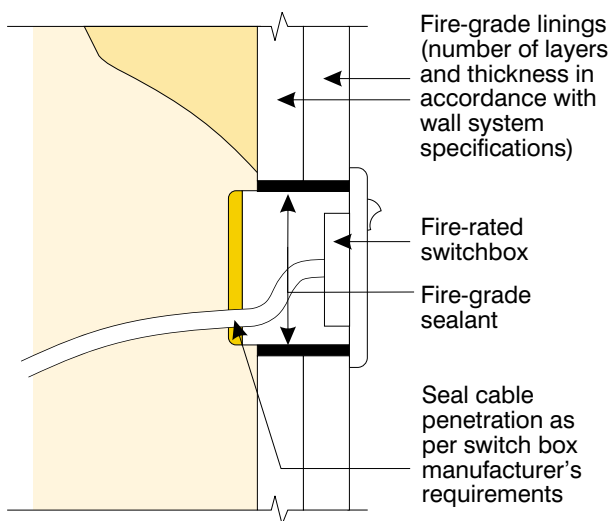


FIGURE 42 - FIRE-RATED ELECTRICAL BOX

9.8 Cavity Barriers

Cavity Barriers are obstructions which should be placed in concealed air spaces in fire-rated systems to limit the spread of smoke and hot gases. They are not mandatory under the BCA, but are a recommended practice.

COMMENTARY: Due to the practice of creating cavities within the fire-rated wall or floor/ceiling system for maximising sound transmission loss (double stud walls, floor/ceiling systems) or to retard moisture ingress (brick veneer cavity), there may be many voids within fire-rated elements in a MRTFC building. These voids may travel the entire length, width and height of the building.

During a fire within a unit, fire could breach the barriers (linings) and smoke and hot gases could get into these cavities and possibly travel through these voids. As an extra precaution and to limit damage to the entire structure, it is recommended that cavity barriers are placed within these voids at regular intervals to limit this spread of fire and hot gases.

9.8.1 Materials Used as Cavity Barriers

There is no Fire Resistant Level applicable to cavity barriers. Solid timber, plywood, particleboard, plasterboard or mineral wool can be used. The timber frame itself can also be used.

NOTE: Some of the materials used to form cavity barriers, may form bridges that will degrade the sound performance of the wall or floor/ceiling system. It is recommended for these locations, flexible products such as fire-resisting mineral wools be used.

9.8.2 Locations for Cavity Barriers

Generally, barriers should be provided at the corners of each compartment, i.e. intersection of floors and walls or walls to walls (refer Figure 43).

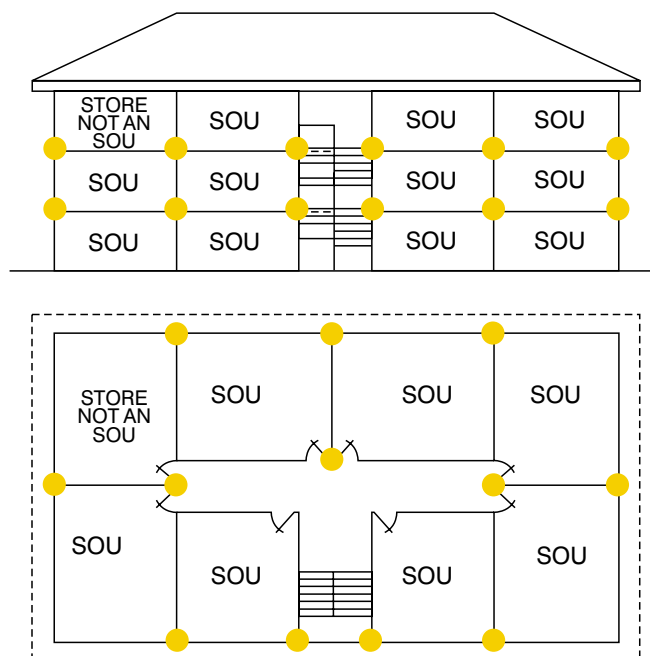


FIGURE 43 - CAVITY BARRIER LOCATIONS

Following are typical details showing where cavity barriers should be installed:-

- Junction between fire-rated floor and fire-rated internal bounding walls (Figures 44, 45 and 46)
- Non-aligned floors – (Figure 47)
- Junction between fire-rated internal bounding walls – (Figure 48)
- Junction between fire-rated floor/ceiling and fire-rated external wall - (Figure 49)
- Junction between fire-rated internal walls and fire-rated external walls – (Figures 50 and 51)

NOTE: Refer figure 21 and 22 for non or lower-fire-rated floors

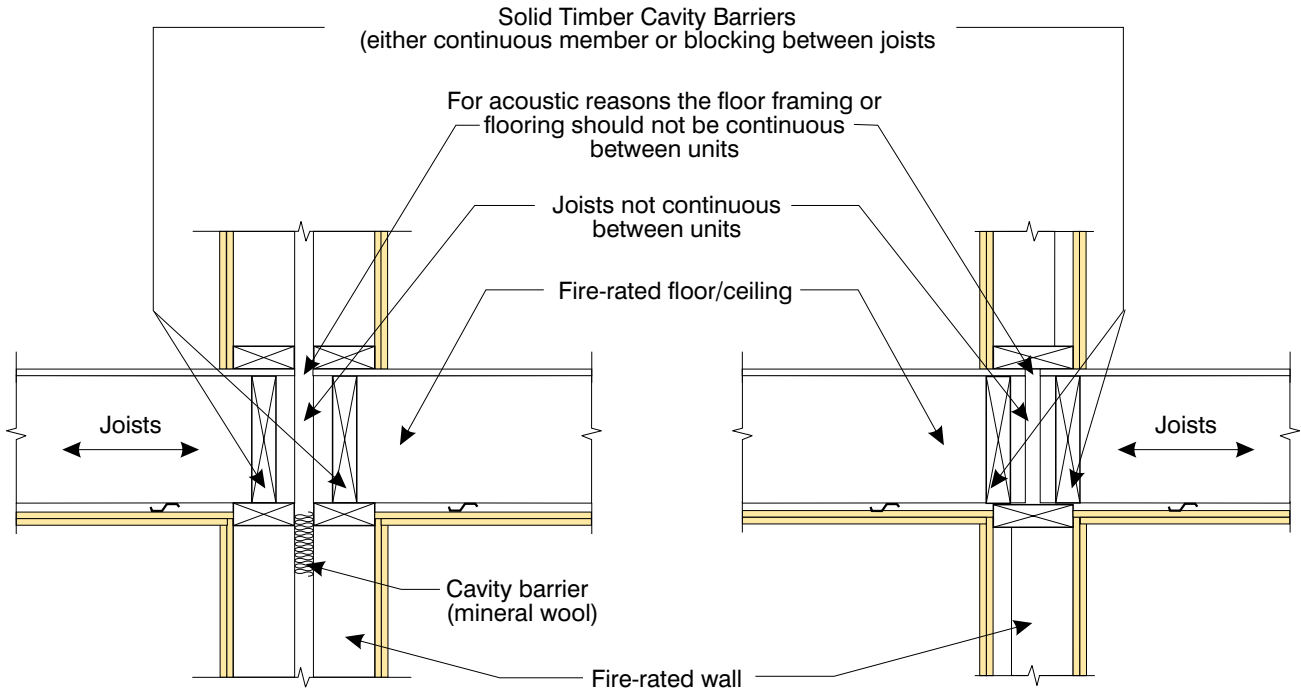


FIGURE 44 - CAVITY BARRIERS AT JUNCTION BETWEEN FIRE-RATED FLOOR AND EQUALLY-FIRE-RATED INTERNAL BOUNDING WALLS - JOISTS PERPENDICULAR TO WALL

NOTE: Refer figure 21 and 22 for non or lower fire rated floors

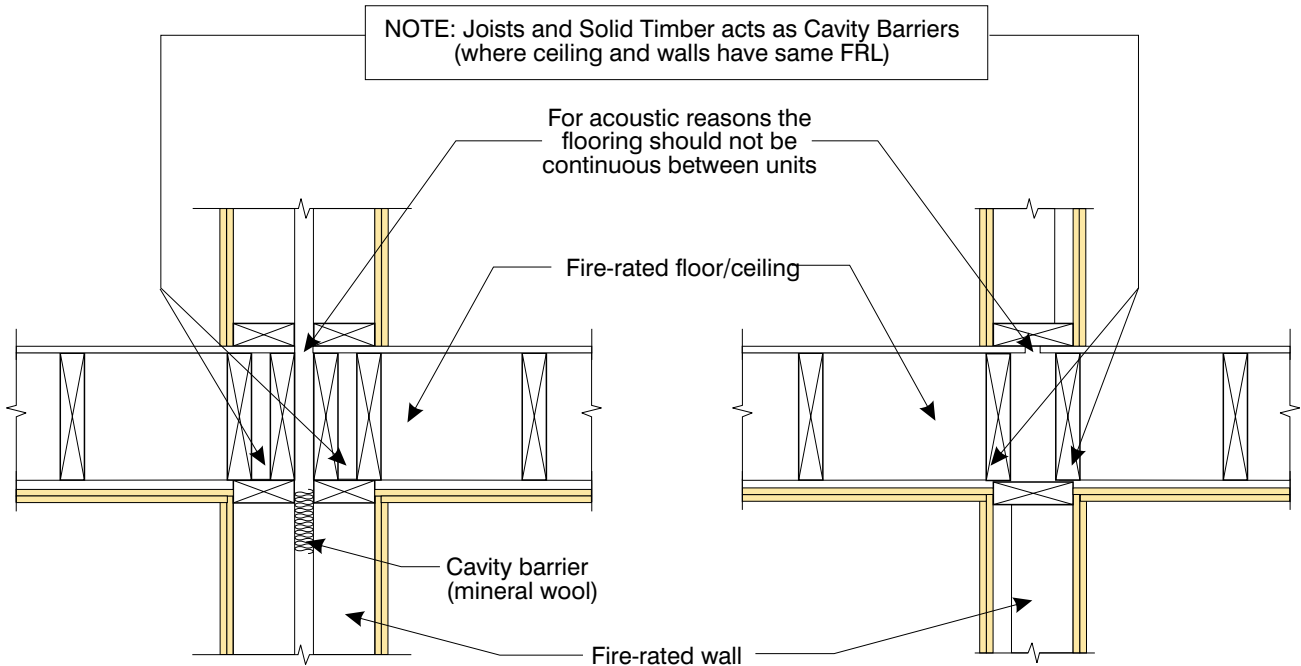
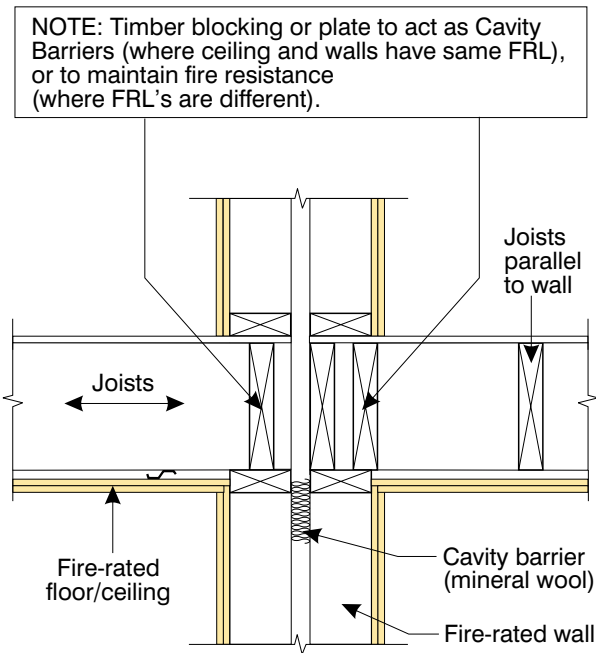
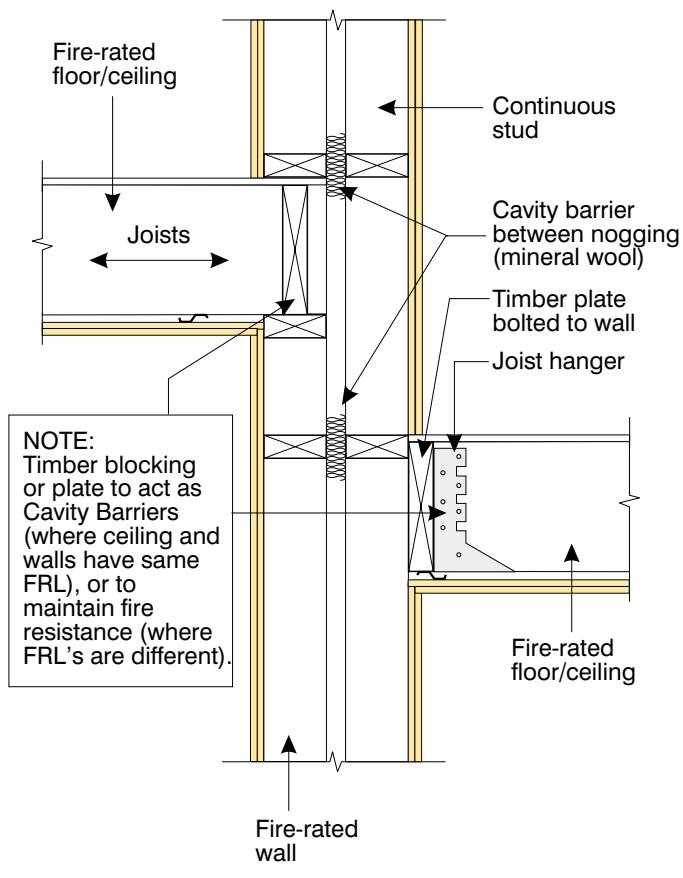


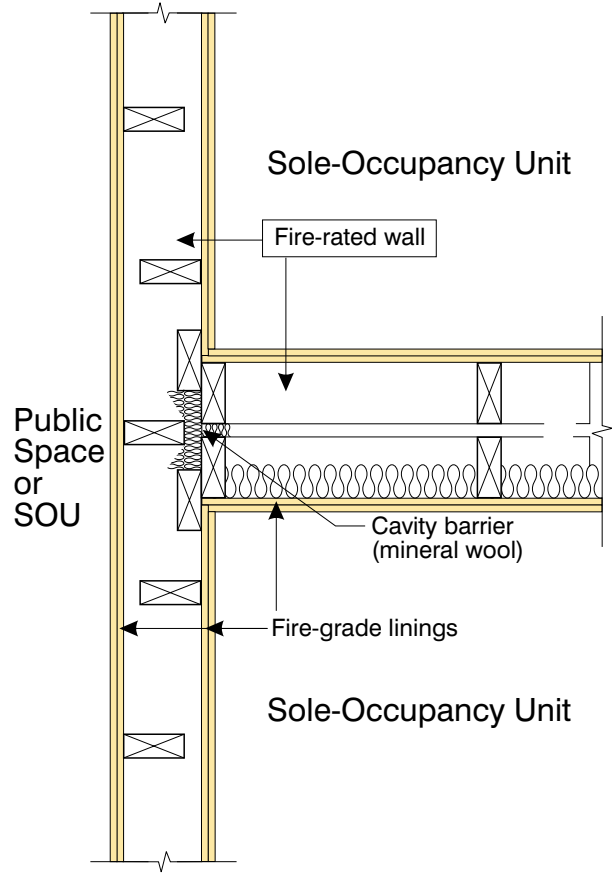
FIGURE 45 - CAVITY BARRIERS AT JUNCTION BETWEEN FIRE-RATED FLOOR AND EQUALLY-FIRE-RATED INTERNAL BOUNDING WALLS - JOISTS PARALLEL TO WALL



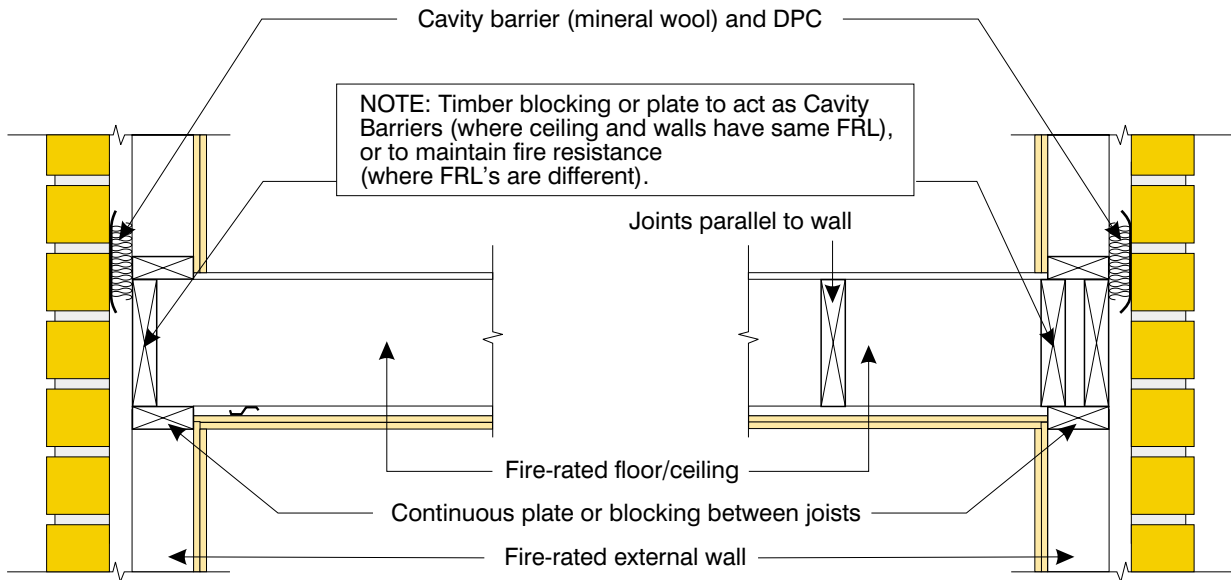
**FIGURE 46 -
CAVITY BARRIERS AT JUNCTION BETWEEN
FIRE-RATED FLOOR AND FIRE-RATED
INTERNAL BOUNDING WALLS
- JOISTS CHANGE OF DIRECTION**



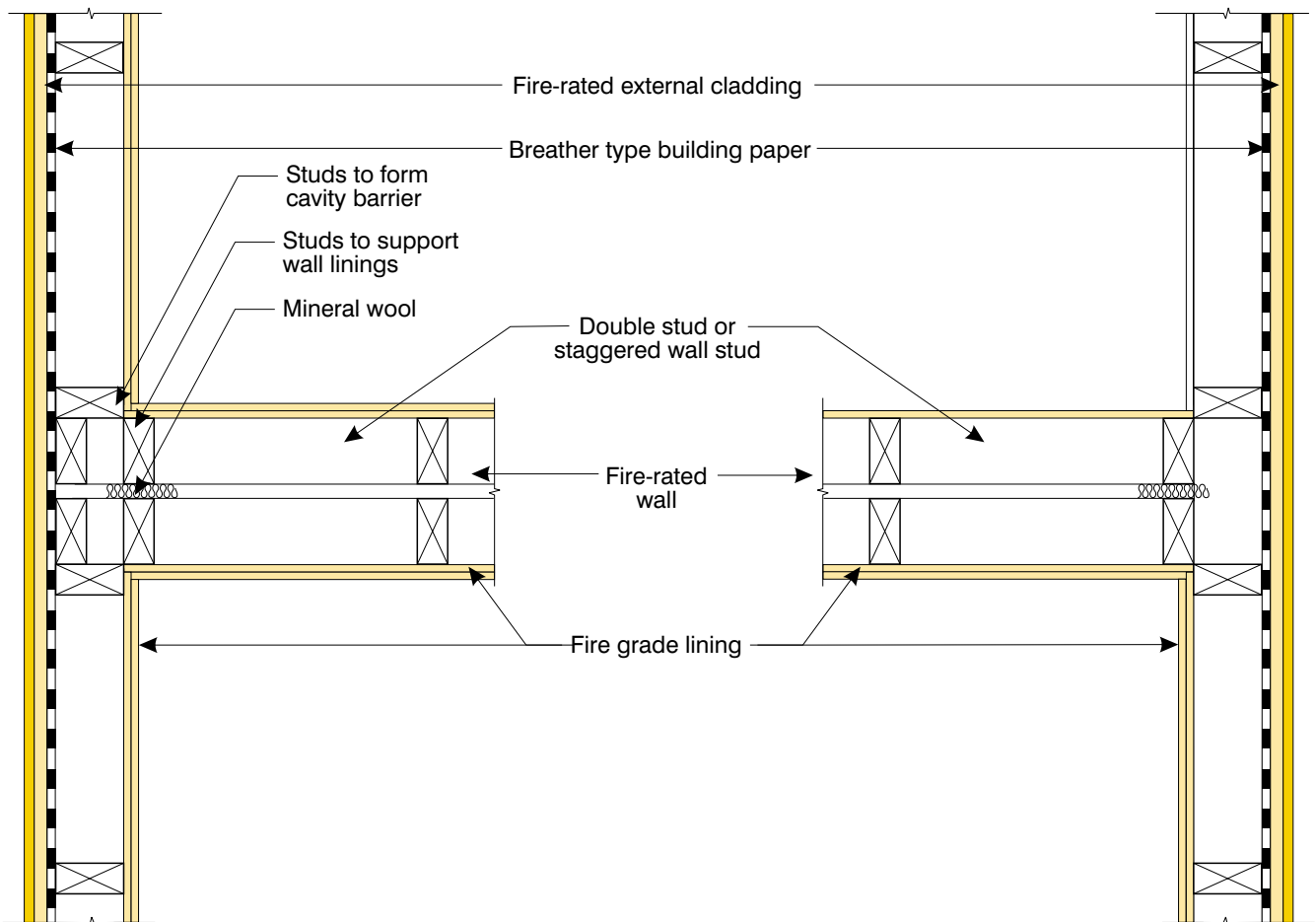
**FIGURE 47 -
CAVITY BARRIERS AT JUNCTION BETWEEN
FIRE-RATED FLOOR AND FIRE-RATED
INTERNAL BOUNDING WALLS
- NON ALIGNED FLOORS**



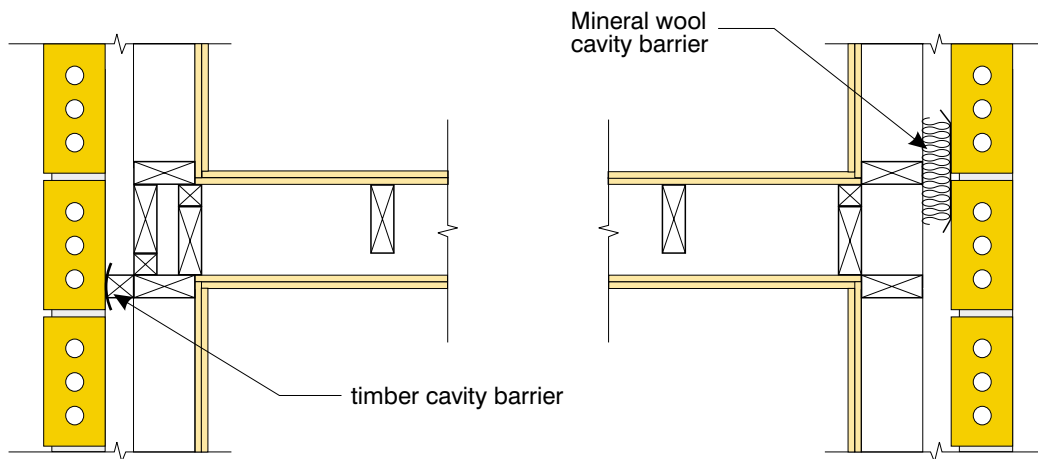
**FIGURE 48 -
CAVITY BARRIERS AT JUNCTION BETWEEN
FIRE-RATED INTERNAL BOUNDING WALLS**



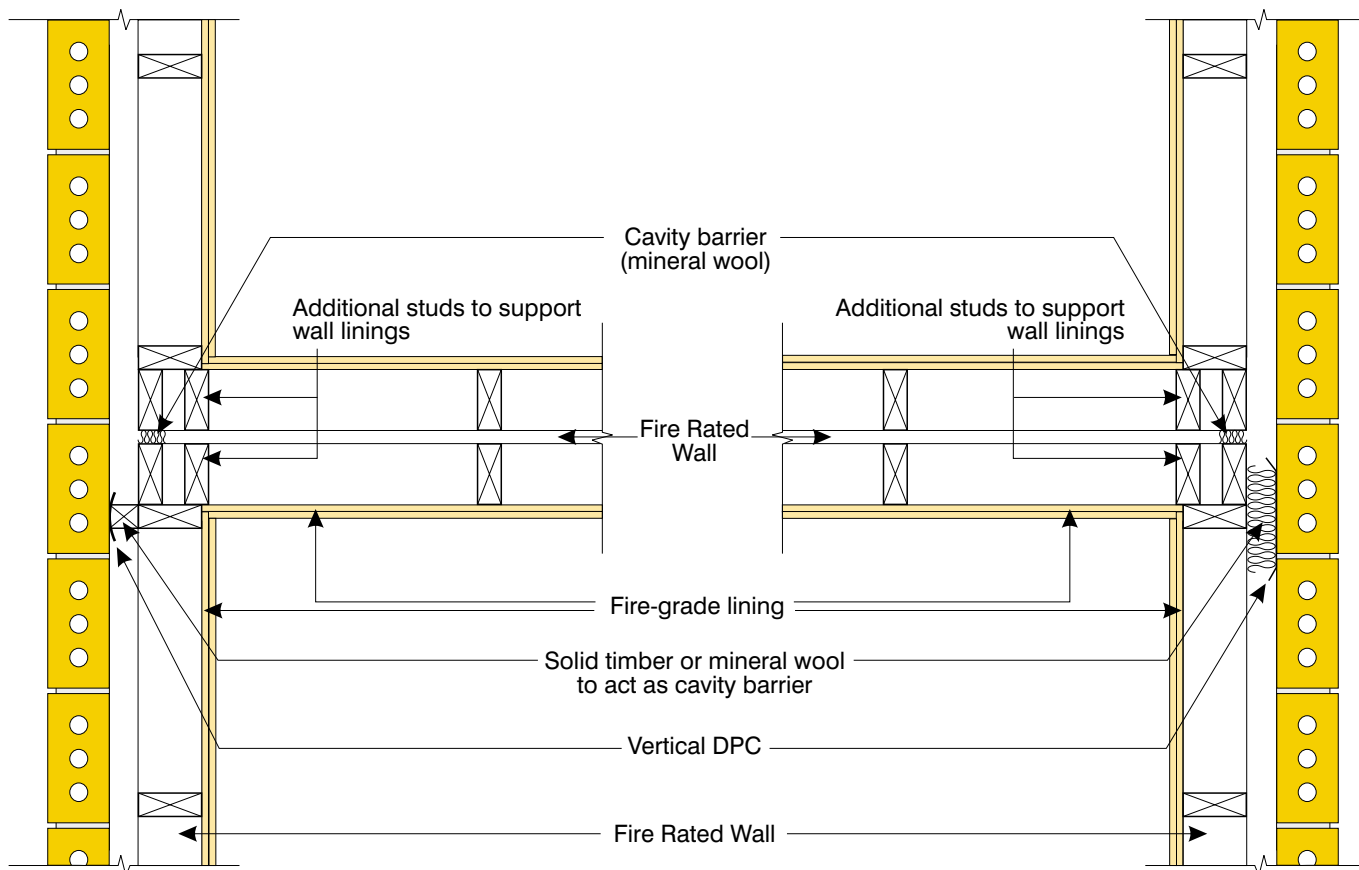
**FIGURE 49 -
CAVITY BARRIERS AT JUNCTION BETWEEN FIRE-RATED FLOOR/CEILING
AND FIRE-RATED EXTERNAL WALL - BRICK VENEER**



**FIGURE 50 -
CAVITY BARRIERS AT JUNCTION BETWEEN FIRE-RATED INTERNAL WALL AND
FIRE-RATED LIGHTWEIGHT-CLAD EXTERNAL WALLS**



Options for staggered studs



**FIGURE 51 -
CAVITY BARRIERS AT JUNCTION BETWEEN FIRE-RATED INTERNAL WALLS
AND FIRE-RATED BRICK VENEER EXTERNAL WALLS**

10 CONSTRUCTION PRACTICES - SOUND CONTROL

10.1 General

Any wall or floor, which separates one sole-occupancy unit from another, must provide adequate resistance to the passage of sound.

There are two types of sound which need to be resisted. These are:-

- (a) from airborne sources such as speech, musical instruments and loudspeakers and
- (b) from impact sources, such as footsteps and the moving of furniture.

This section describes methods and the associated building practices that can assist in achieving and maintaining adequate sound insulation (sound transmission loss).

10.2 Principal Methods to Improve Sound Transmission Loss

10.2.1 Isolation

One of the most effective ways of increasing sound transmission loss is to isolate the opposing wall surfaces or to separate the floor from the ceiling (i.e. no structural couplings between the layers).

NOTE: Structural connections between the layers allows sound vibrations to transfer through the structure, equivalent of an electrical short circuit.

For lightweight wall construction, there are several practical ways of reducing mechanical connections between wall surfaces. These include staggered studs, separate rows of studs (double, dual or twin walls) or a single row of studs with resilient metal channels or mounts to support the wall linings (refer Figure 52).

For floor/ceiling systems the use of independent supported ceilings (resilient channels or mounts) will provide this isolation (refer Figure 53).

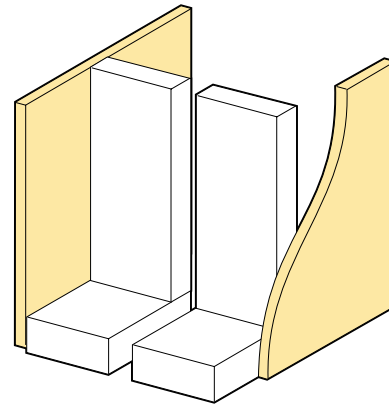
10.2.2 Mass

An increase in transmission loss is expected with increasing mass. The heavier the panel, the less it vibrates in response to sound waves. Less sound energy therefore radiates from the other side.

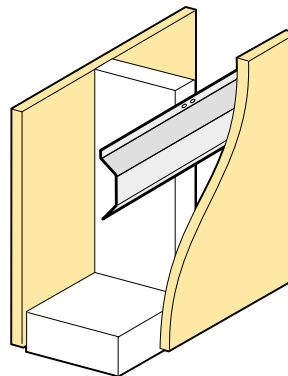
An increase in mass can be achieved either by increasing the material's thickness or by selecting denser material, e.g. fibre cement linings instead of plasterboard.

The general rule used for lightweight systems is that for each doubling of the surface mass, transmission loss will increase by approximately 6 dB.

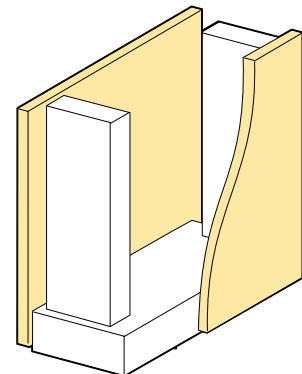
NOTE: Minimum lining thickness and combinations must also meet the Fire Resistance Level (FRL) nominated.



(a) Double studs



(b) Single stud with resilient channel or mount



(c) Staggered studs

FIGURE 52 - WALL SYSTEMS

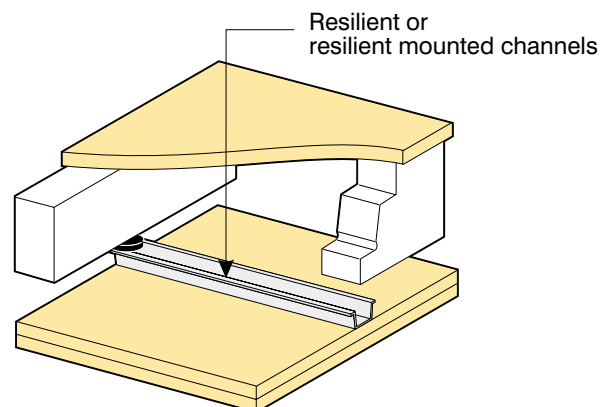


FIGURE 53 - RESILIENT SUPPORT FLOOR/CEILING SYSTEM

10.2.3 Absorptive Insulation Material

Filling the wall or ceiling cavity with absorptive insulation material (cellulose fibre, glass fibre or mineral wool) can increase the transmission loss substantially, especially when the cavity is large.

The sound-absorbing material should be a minimum of 50 mm thick and a minimum density of 12 kg/m³. Insulation thicker than two-thirds of the overall cavity depth provides little additional increase in R_w rating.

NOTE: Adding absorptive material to the cavity is beneficial only if structural connections between the surfaces do not transmit the vibrational energy. For example, adding insulation between the studs of a single stud wall (a timber stud wall with linings attached directly to both faces of the studs) has little effect because it does not alter the dominant transmission path, through the studs.

10.3 Sound Control by Building Design

There are many aspects of the building design that could assist to improve sound transmission loss without the need for any additional construction. The following principles should be considered during the design of a building.

10.3.1 Room Layout

One of the simplest means of controlling sound is to isolate sound sources from sensitive receiving areas (refer 6.3.1 and Figure 13).

10.3.2 Public Corridors

Public corridors could serve as sound buffer zones between apartments, however doors into corridors often permit sound to intrude, especially if the doors are poorly sealed, with large gaps at the bottom. To improve sound problems associated with corridors:-

- (a) seal around doors
- (b) offset doors along the corridor and / or
- (c) add sound-absorbing materials to the surfaces within the corridor to reduce noise reflection.

10.3.3 Windows

There are two forms of sound problems associated with windows.

- a) airborne sound from one unit to the next, and
- b) sound from outside.

NOTE: Windows normally have a lower sound transmission loss value than the surrounding wall, even when closed. Many high sound-rated wall systems have become ineffective by the windows being the dominant sound path.

Locating windows so that they do not face noisy areas and providing adequate separation between windows in adjoining units will improve the sound transmission loss.

Where noise is unavoidable, one or a combination of the following will enhance the sound performance of the windows:-

- (a) use thicker or laminated glass
- (b) reduce the window area
- (c) use double glazing
- (d) provide weather stripping of windows
- (e) use fixed glazing in lieu of opening windows.

10.3.4 Doors

Sound-rated walls may become ineffective by the inclusion of a door within the wall. Generally, doors do not have the same transmission loss as the wall and may become the dominant sound path.

Where sound control is desired, solid core doors should be used. Door tops and sides should have gaskets with soft weather stripping. Threshold closures at the bottom of the door or air seals will also reduce sound transmission.

Sliding doors should be avoided where optimum sound control is expected.

10.4 Sound Leaks

Sound leaks can easily occur in sound-rated systems. This could be at the periphery of walls and floors, where caulking is absent or improperly installed, or where a hole is made for electricity or plumbing services etc.

The higher the acoustical isolation required, the more important it is to eliminate all sound leaks.

To reduce sound leaks:-

- all holes and fissures in a wall or floor must be thoroughly caulked
- all windows and doors must be tightly weather stripped (i.e. sealed) and
- holes for services properly repaired.

NOTE: Sound leaks can significantly reduce the effectiveness of a system. A wall with a potential R_w of 60, which has a hole of only 0.001% of the total wall area (10 x 10 mm hole in a 2.4 x 4.2 m wall), can be reduced to an effective R_w of 50. As the hole area increases, eventually the rating will be determined entirely by the hole area.

Rule of Thumb: If a construction is not airtight, then there is a good chance it is not 'sound-tight' because if air can pass from one room to the other, then sound will also be transmitted.

10.5 Services

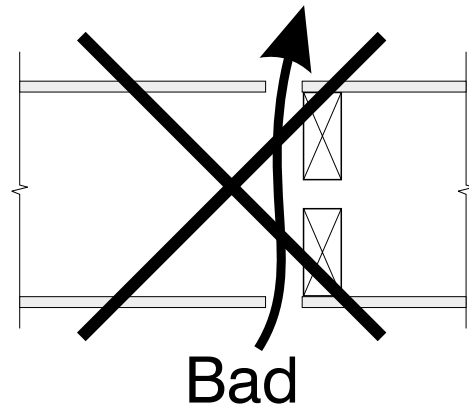
The location and detailing of services are two of the most important considerations in controlling sound transmission in residential buildings.

Generally, services or services penetrations should not be located in walls between units. Plumbing and electrical services should preferably be installed into internal walls of the unit, service shafts, or false wall construction on the face of sound-rated wall (refer Figure 62a).

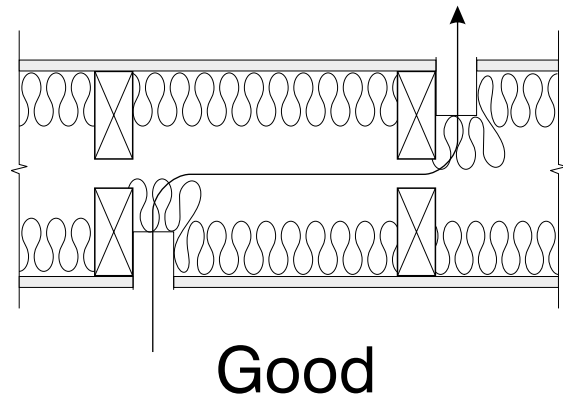
10.5.1 Electrical and Other Wiring Outlets

Gaps around electrical and other wiring outlets are a common problem, especially when the outlets are back-to-back, refer Figure 54. One recommended solution is to offset the outlets as shown in Figure 55, (i.e. outlets in opposite faces not between the same studs).

Offsetting is especially effective when the wall is filled with sound-absorbing material.



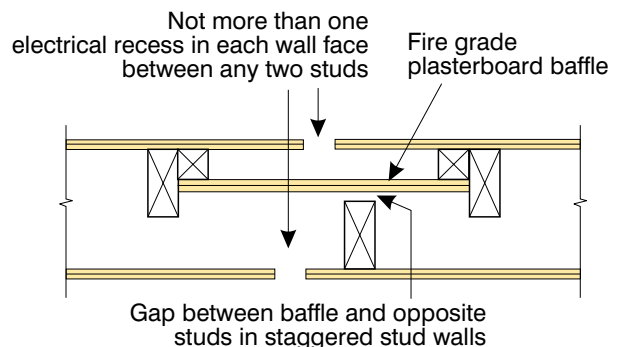
**FIGURE 54 -
BACK-TO-BACK POWER POINTS**



**FIGURE 55 -
OFFSET POWER POINTS IN
DOUBLE STUD WALLS WITH INSULATION**

NOTE: Gaps and holes usually permit only high-frequency sound to pass through. Sound-absorbing material is most effective at high frequencies.

Where back-to-back power points cannot be avoided, blocking panels similar to those required to maintain fire resistance provides some sound insulation. These panels however are generally less effective than offsetting (with insulation), and expensive to construct (refer Figure 56).



**FIGURE 56 -
BLOCKING PANELS TO IMPROVE
SOUND TRANSMISSION LOSS**

10.5.2 Plumbing

Pipes should be isolated from the structure using resilient sleeves and hangers, and flexible connections. Where pipes penetrate sound barriers, the holes should be carefully sealed. Contact with lightweight surfaces (which radiate sound easily), must be avoided.

NOTE: Plumbing noise is almost always transmitted as structure-borne vibrations which eventually radiate from lightweight surfaces. The most common error is to connect the water supply, waste pipes and other fixtures rigidly to a neighbouring unit structure.

As with other sound sources, the layout in the building is important for control of plumbing noise. Where possible, pipes should not be installed in walls or in floor/ceiling systems adjoining areas where quiet is important to the residents. In critical situations pipes should be enclosed in service shafts incorporating sound-absorbing materials on the inside.

Generally, to reduce plumbing noise:-

- (a) do not install plumbing fixtures back-to-back in sound-rated walls
- (b) all openings made in wall and floor surfaces for plumbing penetrations should be sealed to ensure optimum acoustic integrity
- (c) pipe runs should be designed with swing arms so that expansion or contraction can occur without binding
- (d) vertical pipe travel should be carried out in a service shaft, located in bathrooms, laundries or kitchens (never in bedrooms or lounge rooms)
- (e) where plumbing services are required on sound-sensitive walls, a false wall should be built in front of the fire and sound-rated wall and the plumbing placed into this false wall.

NOTE: Where pipe noise is a problem, adding extra linings or insulation will reduce the noise, but fixing linings to resilient metal channels is more effective. This provides some margin for error if construction results in accidental solid contact between pipes and structure.

Different pipe materials transmit sound energy differently. For supply systems, plastic pipes are significantly quieter than the copper pipes. The opposite occurs for waste systems, where metal pipes provide better sound performance than plastic pipes. When pipes and wastes are resilient mounted there is little difference between the performance of the different materials.

10.6 Floor/Ceiling Systems

In the design of floors, both impact and airborne sound should be controlled.

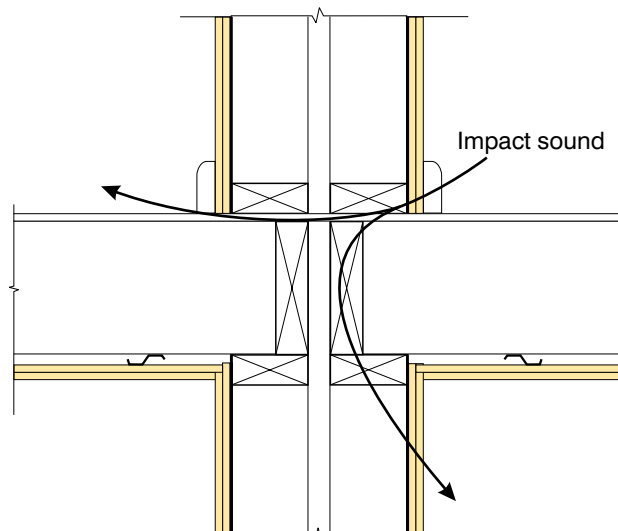
For many floors, the main cause of sound transmission is through the structural connections between the surfaces of the floor and the ceiling below. For maximum sound transmission loss, the floor and ceiling surfaces should be separated. Providing independent joists to support the ceiling would be the best solution. This could be used in bathrooms or laundries, where drop ceilings are traditionally used to allow for plumbing.

Where an independent framing system is not possible, the use of resilient channels or mounts, to attach the ceiling linings to the bottom of the floor joists is the next best alternative.

If rigid structural connections between the surfaces are avoided, adding absorptive material to the spaces between the floor joists can further improve sound transmission loss.

Sound transmission along the floor to adjacent rooms on the same level or the transmission down the supporting walls (refer Figure 57) cannot be controlled by the resiliently suspended ceiling or the use of cavity absorption. For these situations control of impact sound at the source is required.

NOTE: From an acoustical point of view, the material used for the joists, whether solid timber, I-beam or truss construction is not important.



**FIGURE 57 -
IMPACT SOUND PATHS**

10.6.1 Control of Impact Sound in Floors

Impact sound (e.g. footstep noise), is one of the most difficult forms of energy to control. The transfer of energy when a solid object strikes a floor is a much more efficient process than occurs with airborne sound (refer Figure 58).

NOTE: Walking on lightweight floors causes them to vibrate and resonate at low frequencies.

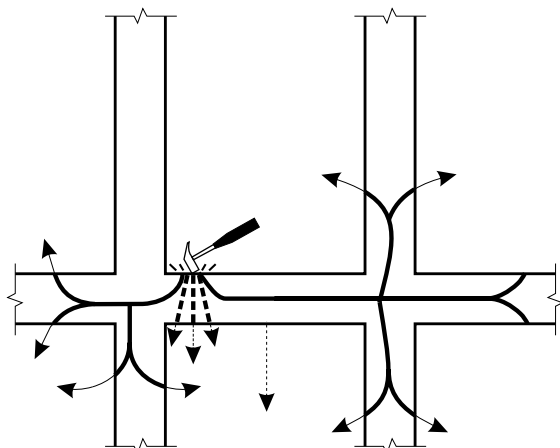


FIGURE 58 - IMPACT SOUND TRANSMISSION PATHS

The best way of controlling impact sound is at the source. The most cost effective method is to lay a soft resilient layer, such as a carpet, on top of the floor (refer Figure 59). The impact force is cushioned by the resilient layer, reducing the sound energy that is transferred to the floor structure.

EXAMPLE: The addition of carpet and underlay to a timber floor system that incorporates resilient channels, cavity insulation increases the impact insulation class (IIC) from about 50 to 70 or more, depending on the type of carpet. The addition of carpet and underlay will however have little effect on the airborne sound R_w rating of a floor.

Where hard floors are required, (tiles, decorative timber, etc.), an effective means of reducing the transfer of sound energy into the structure is by the use of a “floating floor” (refer Figure 59).

Ultimate performance could be achieved where all surfaces are resiliently supported. Generally, this may be too expensive or impractical.

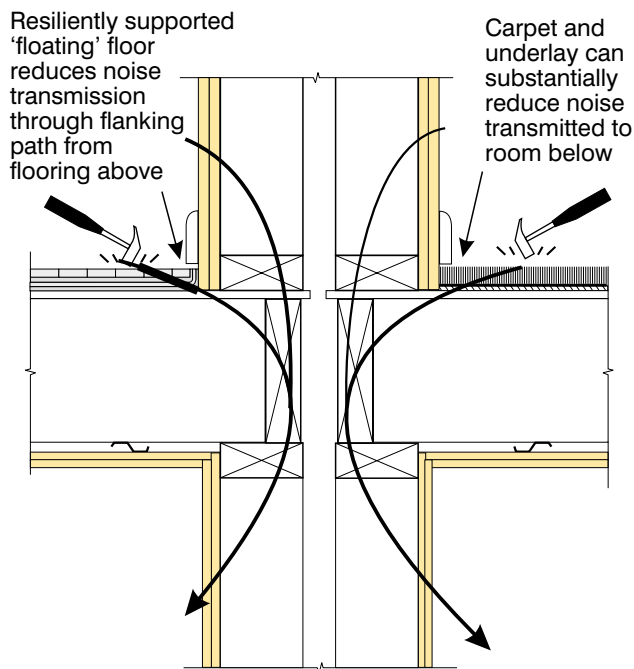


FIGURE 59 - CARPETING OR FLOATING FLOOR SYSTEMS

10.6.2 Control of Flanking Sound in Floors

To create a successful acoustic design for a building, the performance of the components selected must be considered, as well as the details of the interconnections.

For structural reasons a floor is normally rigidly connected to the adjoining and supporting walls. Where this occurs, impact and airborne sound transmission along flanking paths can be a serious problem.

To remedy horizontal flanking sound along floors, a structural discontinuity is needed to reduce the passage of vibration along the lightweight layer without compromising the structural integrity of the system. Such a break can be a saw cut in the floor (refer Figure 60).

NOTE: Research has shown that up to 6 R_w points can be lost due to the continuation of the flooring, because this allows the transmission of vibration along the top surface.

Airborne and impact sound can travel down the walls to the space below. (Refer Figure 61). Resiliently suspending the ceiling below the floor (as shown on the left hand side of Figure 61), does not reduce in any way the structure borne sound transmission paths to the rooms on the level below.

One method to reduce transmission along this path is to resiliently support both the ceiling and linings on the walls that support the floor joists (right hand side of Figure 61).

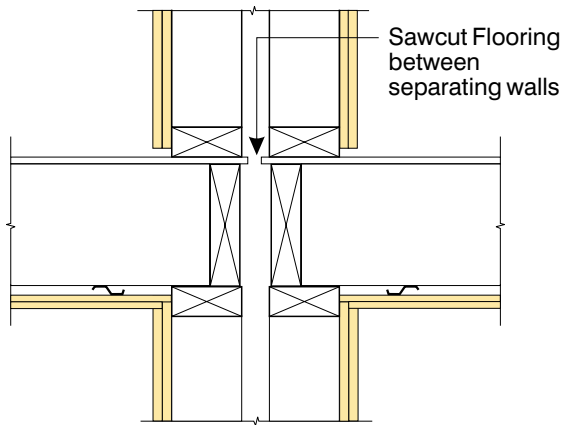


FIGURE 60 - DISCONTINUED FLOORING TO REDUCE FLANKING NOISE TRANSMISSION

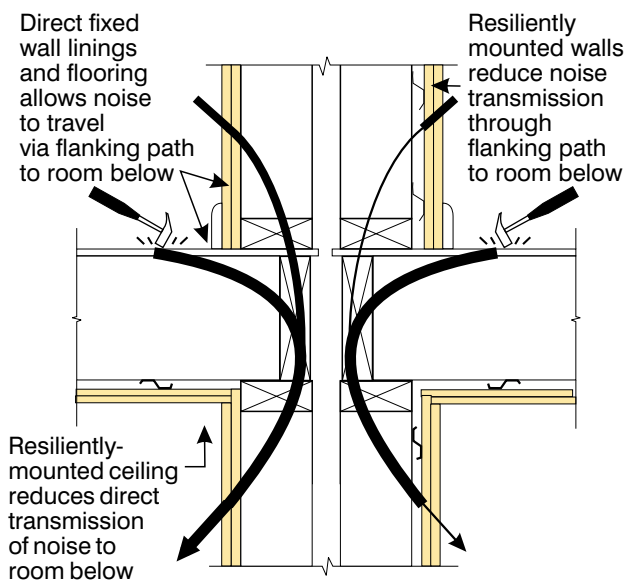


FIGURE 61 - RESILIENT SUPPORTED WALLS AND CEILING TO REDUCE NOISE TRANSMISSION BY FLANKING PATH

Impact sound transmission via flanking paths can be substantially reduced by the use of carpet and underlay. Alternatively, where hard surface floors are required (tiles, decorative timber, etc), sound transmission can be reduced by the use of a “floating floor” (refer Figure 59).

10.7 Washing Machines, Dishwashers, Dryers, Air-Conditioners, etc.

Washing machines, dishwashers, dryers, air-conditioners, etc vibrate and produce noise that is readily transferred into the building structure.

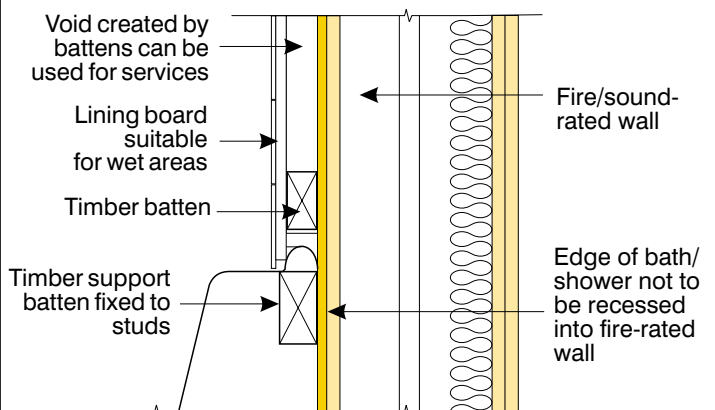
The transmission of vibrational noise can be reduced by supporting the appliance on resilient mounts or pads.

These noisy appliances should not be installed on floors directly above sound sensitive areas or adjacent to walls between units if there is a habitable room on the other side.

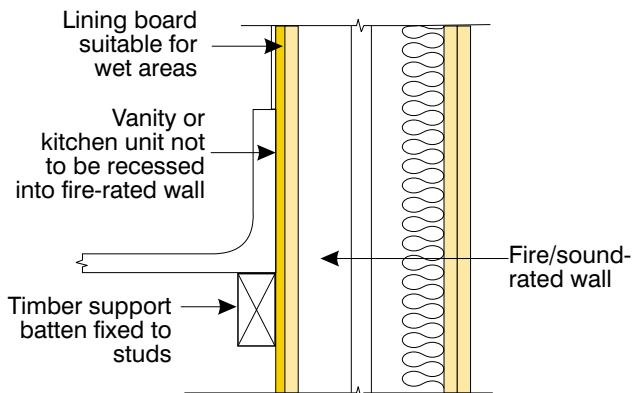
11 CONSTRUCTION PRACTICES - WET AREAS

Where fire and sound-rated walls or ceilings are required to be placed in areas that have a high humidity (such as bathrooms, laundries or the like), moisture-resistant fire-grade plasterboard or fibre cement lining should be used on the exposed face.

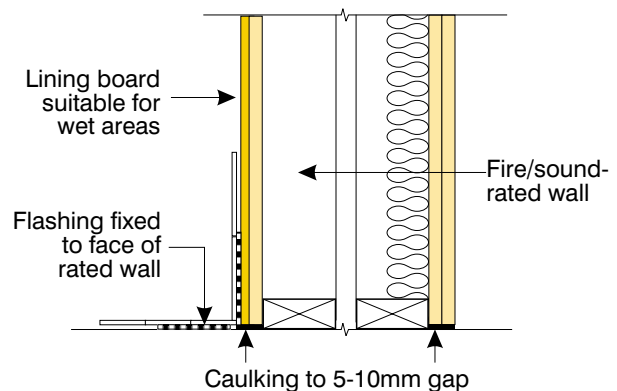
Bath tubs, vanity units, sinks or shower bases must not be recessed into the studs or linings as this will compromise the fire rating of the wall. The fire-rated lining must be installed and caulked etc prior to placement of these units (refer Figure 62).



(a) Bath/shower adjacent to fire-rated wall



(b) Vanity/kitchen sink adjacent to fire-rated wall



(c) Flashing to wet area floor

FIGURE 62 - WET AREA DETAILS

12 CONSTRUCTION PRACTICES - ROOF CONSTRUCTION

12.1 General

MRTFC buildings can be constructed with roof trusses, coupled, non-coupled pitched roofs or any combination of these. Limitations could be placed on roof members and roofing materials depending upon whether or not fire-rated walls are extended into the roof void.

NOTE: Internal walls required to have an FRL must extend to either:-

- a) the underside of a non-combustible roof or
- b) to a ceiling that has a resistance to incipient spread-of-flame of not less than 60 minutes.

12.2 Fire-Rated Walls in Roof Spaces

Where fire-rated walls are continued up to the underside of the roof, no timber roof member is allowed to cross these fire-rated walls except roof battens not greater than 75 x 50 mm. Any void between roof battens must be filled with fire-resisting material (e.g. mineral wool).

12.2.1 Single Stud Walls

There is no sound requirement for walls within a roof space. Walls in these locations may be reduced to single stud from the usually sound-rated, double or staggered studs between units (refer Figure 64).

NOTE: The same Fire Resistance Level must be maintained.

12.2.2 Fire-Rated Truss Framing in lieu of Fire-Rated Walls

Where roof trusses are parallel to fire-rated walls, an alternative to constructing a fire-rated wall above the ceiling line is to nail together two gable trusses and sheet both sides with the required fire-grade lining (refer Figure 63). The trusses must have vertical members spaced at no more than 600 mm centres.

The combined width of the vertical nail-laminated gable truss members must not be less than the stud size required for a single stud fire-rated wall (generally minimum 70 mm).

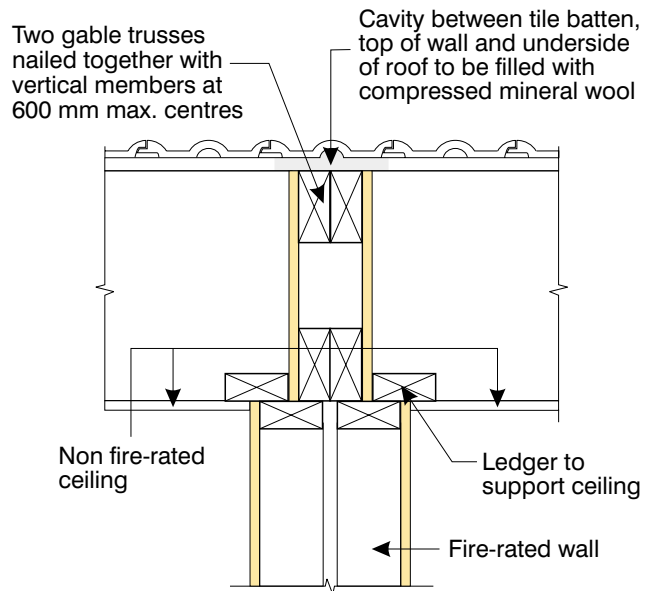


FIGURE 63 - FIRE-RATED NAIL LAMINATED GABLE TRUSSES

12.3 Roof Members Supported off Fire-Rated Walls

There are several ways of supporting roof framing members or trusses on the fire-rated walls.

NOTE: Trusses or roof framing members (except roof battens) must not continue across or through fire-rated walls, unless above a ceiling with resistance to the incipient spread-of-fire.

12.3.1 Roof Members or Trusses Supported off Ledge (created by reduced wall width)

The ledge that is formed when a single stud wall or sheeted trusses are used in the roof space, may allow adequate bearing for the trusses or roof frame member (refer Figure 64). Adequate bearing and fixing for trusses is to be determined by the truss manufacturer.

COMMENTARY: 40 mm is regarded as a minimum bearing for conventional roof framing members.

12.3.2 Roof Members or Truss Supported off Timber Ledgers

The use of timber ledgers may be used to maintain the fire rating and also to support trusses. Figure 65 shows timber ledgers bolted to the fire-rated wall with trusses supported by truss boots.

In these details the timber ledger must be considered as a substitute for the fire-grade linings and the timber thickness should be as per Table 8. The lining must also be edge supported with plasterers angle, intumescent sealer or fibre cement as described in Section 9.4.2.

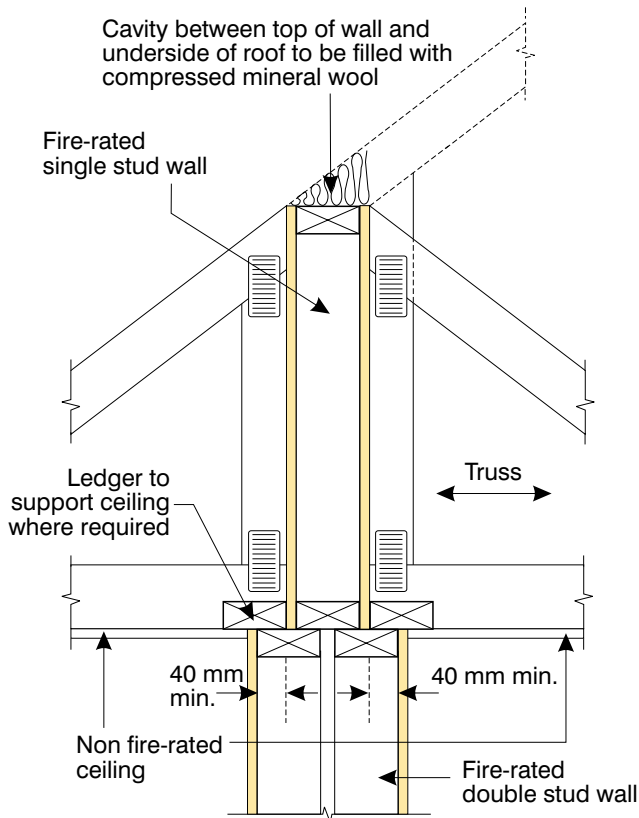


FIGURE 64 - ROOF TRUSSES SUPPORTED OFF DOUBLE STUD WALL

NOTE: Care is required to ensure the bearing capacity of the timber plate is adequate, particularly when large truss spans are used.

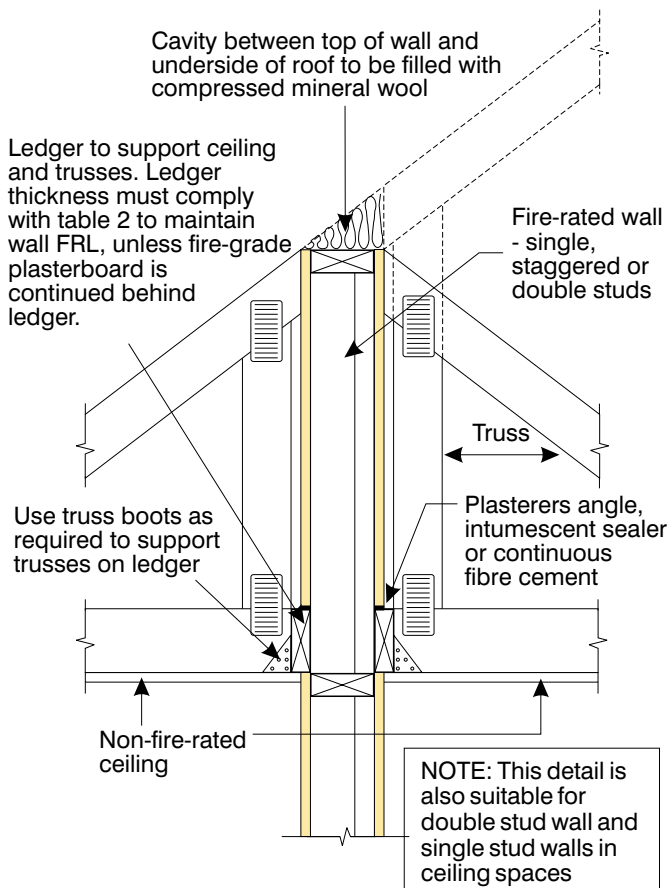


FIGURE 65 - ROOF TRUSSES SUPPORTED OFF TRUSS BOOTS AND TIMBER LEDGERS

TABLE 8 THICKNESS OF TIMBER LEDGERS TO MAINTAIN FIRE RESISTANCE LEVEL (FRL)

Fire Resistance	35 mm	45 mm
60 / 60 / 60 or - / 60 / 60	2 x 35	1 x 45
90 / 90 / 90 - / 90 / 90	3 x 35	2 x 45

NOTE: Figure 68 & 69 may require the fire-grade lining to be fixed prior to erecting the trusses. This generally is an "out of sequence" trade activity but cannot be avoided. It is suggested that any plasterboard that may be left for a period of time exposed to the elements should be moisture resistant as well as fire-resistant and covered until the roofing is installed.

12.4 External Walls

Fire-rated external walls are required to extend to the underside of non-combustible roof covering or to the underside of non-combustible eaves linings (refer to Figure 66).

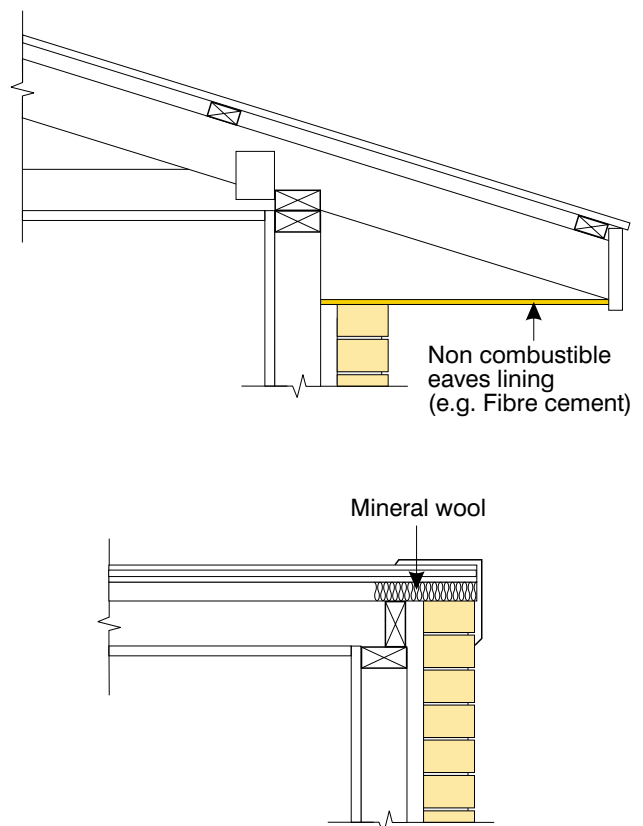


FIGURE 66 - INTERFACE BETWEEN EXTERNAL WALLS AND ROOFS

APPENDIX A - BUILDING CODE OF AUSTRALIA TYPE OF CONSTRUCTION

A1 INTRODUCTION

The following appendix describes the various types of fire-resisting construction required for Class 2 and 3 residential buildings. This information is required to determine the Fire Resistant Level (FRL) and other building regulations contained in the BCA.

A2 TYPE OF CONSTRUCTION

The Type of fire-resisting construction required for multi-residential buildings is dependent upon the Class of the building, the rise in storeys and the number of exits.

Table A1 summarises the type of fire resisting construction required. The darker shaded area represents where MRTFC construction is permitted as a deemed-to-satisfy building solution.

NOTE: Types of construction above this shaded region may still allow MRTFC construction but will require the use of alternative solution path. (Refer Information Bulletin No. 2 – “Gaining Approval for MRTFC Projects under BCA 96”).

TABLE A1 TYPE OF CONSTRUCTION PERMITTED UNDER DEEMED-TO-SATISFY BCA

Rise in Storey	Type of Construction			
	Class 2 Building		Class 3 Building	
	Single Exit	2 Exits or own access to road or open space	Single Exit	2 Exits or own access to road or open space
4 or more	A	A	A	A
4*	A	A	A	A
3	A	A	A	A
2	B	C	B	C
1	C	C	C	C

A3 RISE IN STOREY BCA Part C1, C1.2

For the purpose of determining the Type of construction, the BCA defines the rise in storeys as the greatest number of storeys at any part of the external walls of the building above the finished ground level (refer Figure A1).

A storey is not counted if it is:-

- a garage that does not accommodate more than three vehicles (refer BCA C1.A1 interpretation and Figure A1)
- a basement carpark that is situated partly below finished ground and the underside of the ceiling is not more than 1 m above the average finished level of the ground at the external wall.

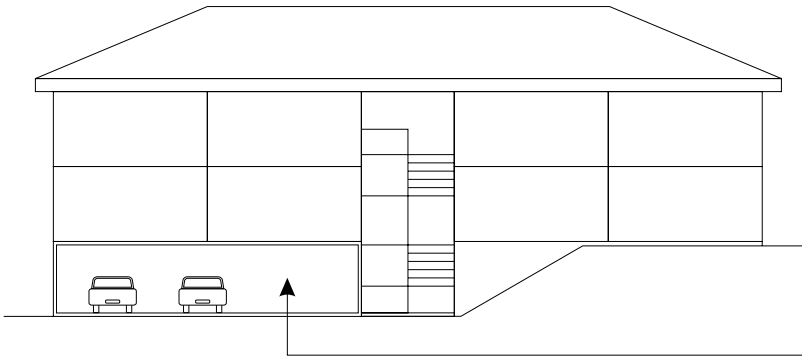
NOTE: If the external wall is more than 12 m long, the average height for the 12 m part where the ground is lowest must not exceed 1 m (refer BCA C1.C12bii and Figure A1).

- a room situated at the top of the building and contains only heating, ventilation or life equipment,
- water tanks, or similar service units or equipment. Space which only contains one or a combination of the following:-
 - a lift shaft
 - stairway
 - meter room
 - bathroom
 - shower room
 - laundry
 - water closet or any sanitary compartment.

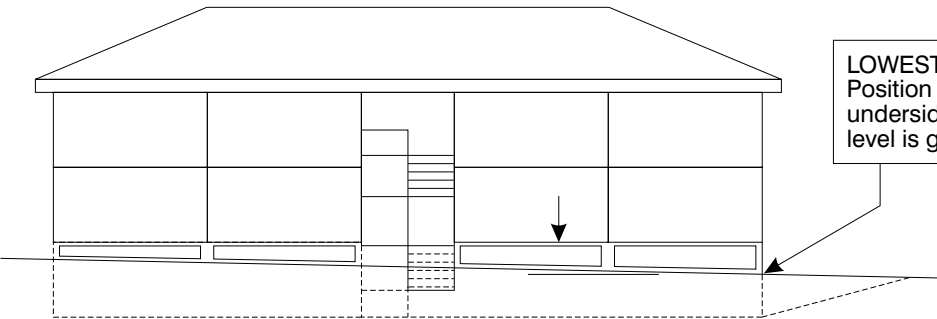
A4 FIRE RESISTANCE LEVELS (FRL)

Tables A2, A3 and A4 list the BCA's fire-resistance requirements (FRL) of various building elements for Types A, B and C construction respectively. FRL requirements vary in each Type of construction and also depend upon whether sprinklers are incorporated into the building.

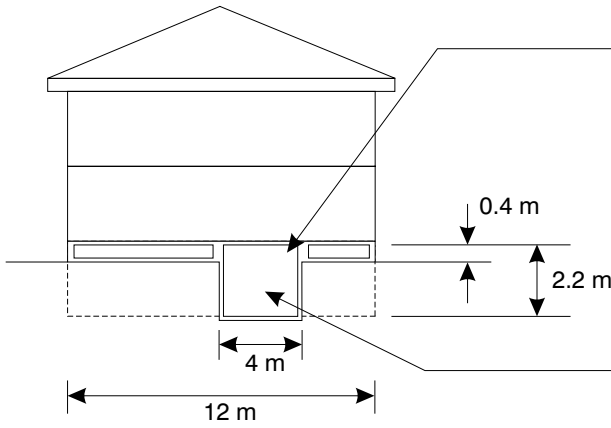
NOTE: Any insulation which is installed in the cavity of a wall which is required to have an FRL must be non-combustible.



A garage may accommodate up to 3 vehicles before it is considered a storey. Also, a space that only contains a bathroom, shower room, laundry, water closet etc (not a storeroom) is not considered a storey. (Refer BCA C1.A1.1).



LOWEST POINT:
Position where distance between underside of floor and external ground level is greatest.



For basement not to be considered as a storey - maximum distance (averaged over 12 m at lowest point) from finished ground to underside of ceiling - 1 m.

EXAMPLE:
 $8\text{ m} \times 0.4\text{ m} = 3.2\text{ m}$
 $4\text{ m} \times 2.2\text{ m} = 8.8\text{ m}$
 $\frac{12.0}{12} = 1.0\text{ m}$ therefore OK

FIGURE A1 - CALCULATING THE RISE IN STOREYS

A4.1 Type A Construction

Table A2 and Figure A2 summarise the FRL and sound-rating requirements for Type A construction – Class 2 buildings.

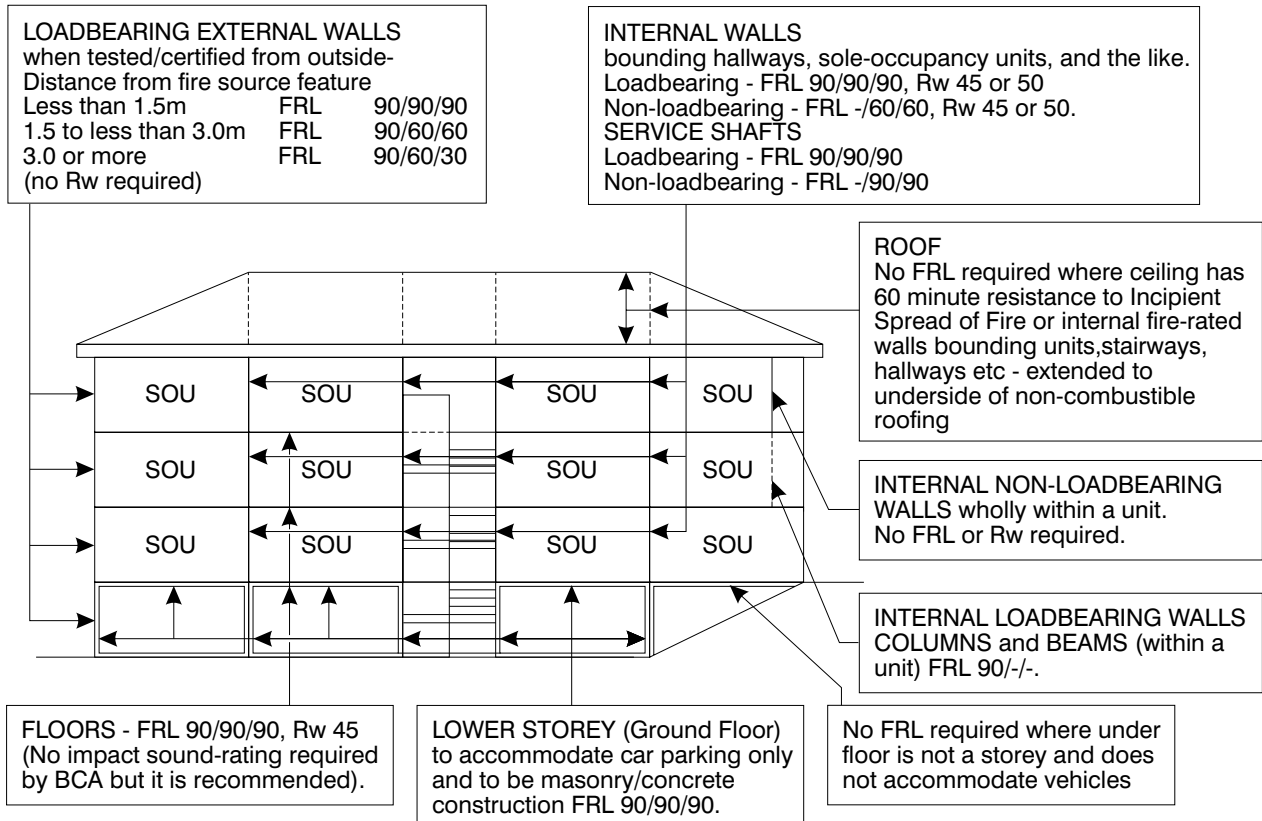
NOTE: Type A construction provides the highest level of passive fire-resistance generally with all structural elements required to withstand burnout of the contents for the specified period. Type A construction is generally referred to as “fully-compartmented” construction. In Type A construction, only certain internal non-loadbearing elements are not required to be protected with the required Fire-Resistance Level.

TABLE A2 FRL REQUIREMENTS - TYPE A TIMBER FRAMED CONSTRUCTION

BUILDING ELEMENTS	FRL		COMMENTS
	Smoke Alarms only	Smoke Alarms & Sprinklers	
External Wall (Loadbearing) less than 1.5 m 1.5 m to less than 3.0 m 3.0 m or more External Wall (Non-Loadbearing) less than 1.5 m 1.5 m to less than 3.0 m 3.0 m or more	90 / 90 / 90 90 / 60 / 60 90 / 60 / 30 - / 90 / 90 - / 60 / 60 - / - / -	60 / 60 / 60 - / - / - - / - / -	Where smoke alarms only are used FRL's apply when tested from both sides of the wall. Where a sprinkler system is fitted, FRL 90's must be maintained when tested from the outside. However, the FRL 90's may be reduced to FRL 60 when tested from the inside.
External Columns Less than 3.0 m 3.0 m or more	90 / - / - - / - / -		AS 1720.4 Timber Structures Code provides a fire rating design method for solid timber beams and columns.
Common Wall and Fire Walls	90 / 90 / 90		
Internal Walls Fire-resisting lift and stair shafts - Loadbearing - Non-Loadbearing bounding public corridors, hallways and the like or between SOU - Loadbearing - Non-Loadbearing Service Shafts - Loadbearing - Non-Loadbearing	90 / 90 / 90 - / 90 / 90 90 / 90 / 90 - / 60 / 60 90 / 90 / 90 - / 90 / 90	60 / 60 / 60 - / - / - 60 / 60 / 60 - / - / - 60 / 60 / 60 - / - / -	Where a sprinkler system is fitted, the FRL is not required for non-loadbearing walls if lined with 13 mm standard-grade plasterboard and walls extend to the floor above or the underside of a 60 minutes Incipient Spread of Fire ceiling.
Floors Separating units or above garages, storerooms, etc.	90 / 90 / 90	60 / 60 / 60	Where a sprinkler system is fitted, the FRL 90 for floors may be reduced to FRL 60. No FRL is required for floors built within a SOU.
Other Loadbearing Internal - wall, columns, - beams and trusses	90 / - / - 90 / - / -	60 / - / - 60 / - / -	
Roofs	- / - / -	- / - / -	No fire rating is required for Class 2 or 3 buildings - BCA Specification C1.1 & C1.3.5

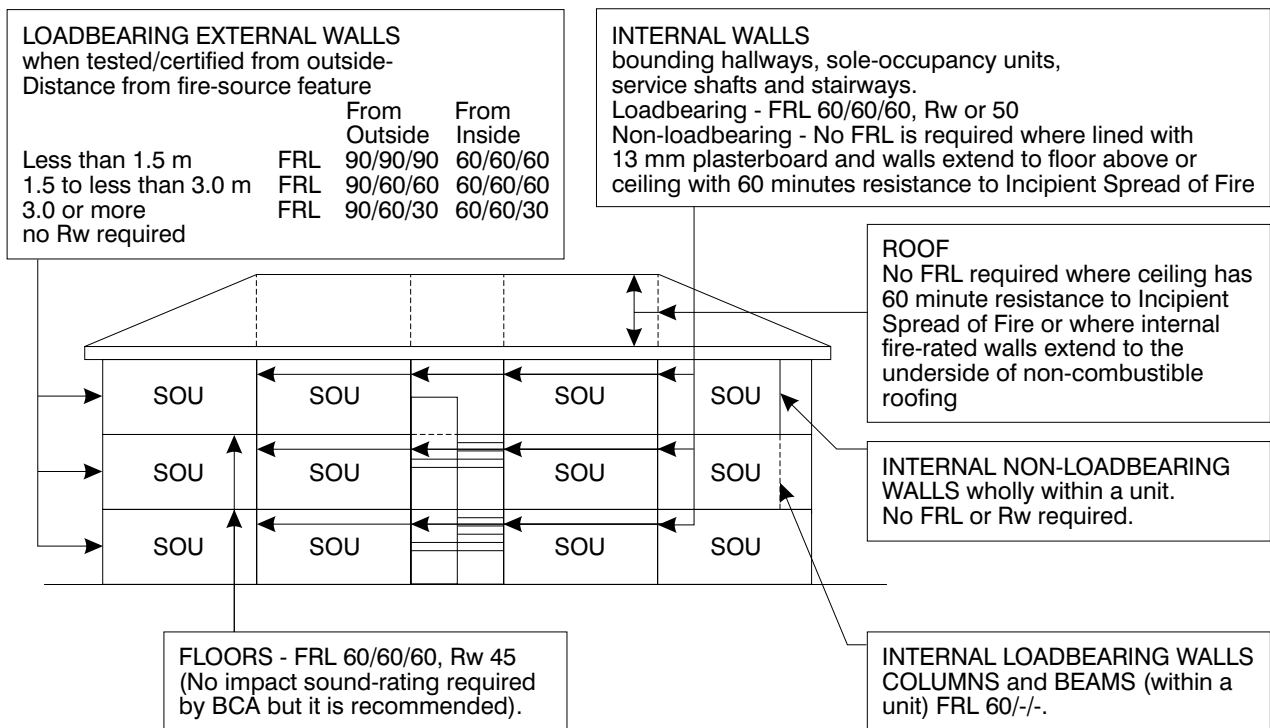
- NOTES:
1. FRL = Fire Resistance Level: Structural adequacy / integrity / insulation (Refer BCA CI A.1)
 2. A dash (- / - / -) in the above table means no FRL requirements
 3. Automatic smoke alarm/detector system must comply with BCA CI E1.7
 4. 'Incipient Spread of Fire' ceiling, is the ability of the ceiling membrane to insulate the space above the ceiling so the temperature rise is no more than 140° K.

SOU = Sole-Occupancy Unit



(a) Without sprinklers (must have smoke alarms)

SOU = Sole Occupancy Unit



(b) With sprinklers and smoke alarms

FIGURE A2 - CLASS 2 BUILDING - TYPE A CONSTRUCTION

A4.2 Type B Construction

Table A3 and Figure A3 summarise the FRL and sound rating requirements for Type B construction – Class 2 buildings.

NOTE: Type B construction provides a lower level of passive fire resistance than Type A construction with only the structural elements other than the

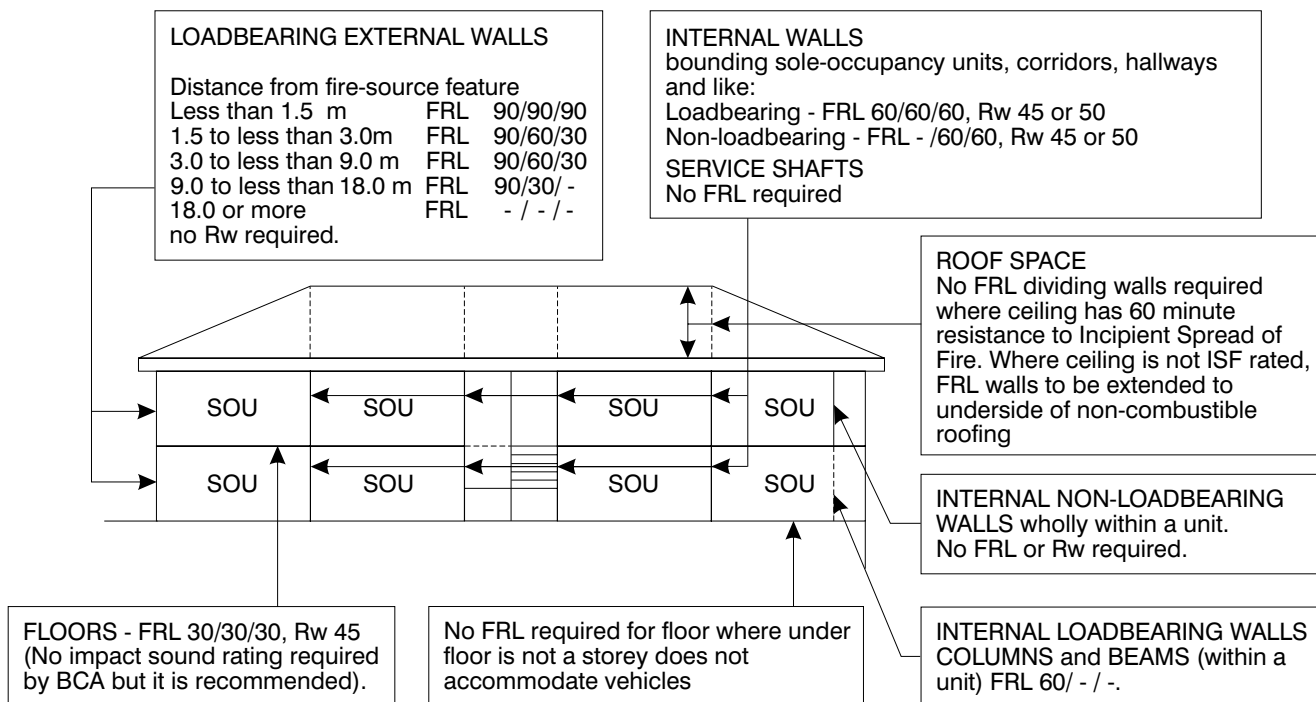
floor and roof designed to withstand the burnout of the contents for the specified periods. As Type B construction is referred to as “tubular or externally protected” construction but is not considered as “fully compartmented”. Many internal elements are only required to satisfy the “structural adequacy” FRL requirement (not integrity or insulation) and to provide support to other elements such as external walls for the prescribed periods.

TABLE A3 FRL REQUIREMENTS - TYPE B TIMBER FRAMED CONSTRUCTION

BUILDING ELEMENTS	FRL		COMMENTS
	Smoke Alarms only	Smoke Alarms & Sprinklers	
External Wall (Loadbearing) less than 1.5 m 1.5 m to less than 3.0 m 3.0 m or more External Wall (Non-Loadbearing) less than 1.5 m 1.5 m to less than 3.0 m 3.0 m or more	90 / 90 / 90 90 / 60 / 30 90 / 30 / 30 - / 90 / 90 - / 60 / 30 - / - / -	90 / 90 / 90 60 / 60 / 60 - / - / - 60 / 60 / 60 - / 60 / 60 - / - / - - / - / -	Where smoke alarms only are used FRL's apply when tested from both sides of the wall. Where a sprinkler system is fitted, FRL 90's must be maintained when tested from the outside. However, the FRL 90's may be reduced to FRL 60 when tested from the inside.
External Columns Less than 3.0 m 3.0 m or more	90 / - / - - / - / -		AS 1720.4 Timber Structures Code provides a fire rating design method for solid timber beams and columns.
Common Wall and Fire Walls	90 / 90 / 90		
Internal Walls Fire-resisting lift and stair shafts - Loadbearing - Non-Loadbearing bounding public corridors, hallways and the like or between SOU - Loadbearing - Non-Loadbearing Service Shafts	90 / 90 / 90 - / 90 / 90 60 / 60 / 60 - / 60 / 60 - / - / -	60 / 60 / 60 - / - / - 60 / 60 / 60 - / - / - - / - / -	Where a sprinkler system is fitted, the FRL is not required for non-loadbearing walls if lined with 13 mm standard-grade plasterboard and walls extend to the floor above or the underside of a 60 minutes Incipient Spread of Fire ceiling.
Floors	30 / 30 / 30		An alternative to FRL 30/30/30 for floor is to provide a fire protective covering to the underside of the floor, including beams. No FRL is required for floors built within a SOU.
Other Loadbearing Internal - wall, columns, - beams and trusses	60 / - / - 60 / - / -		
Roofs	- / - / -		No fire rating is required for Class 2 or 3 buildings

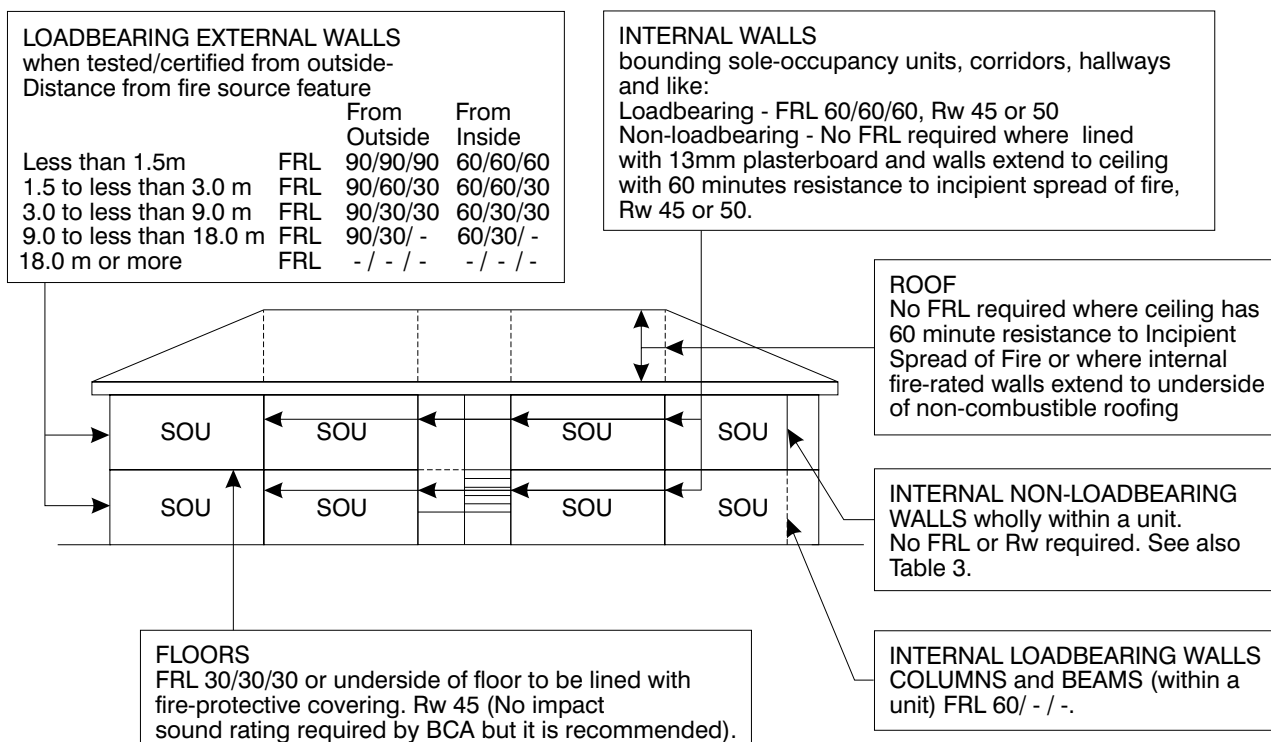
- NOTES:
1. FRL = Fire Resistance Level: Structural adequacy / integrity / insulation (Refer BCA CI A.1)
 2. A dash (- / - / -) in the above table means no FRL requirements
 3. Automatic smoke alarm/detector system must comply with BCA CI E1.7
 4. 'Incipient Spread of Fire' ceiling, is the ability of the ceiling membrane to insulate the space above the ceiling so the temperature rise is no more than 140° K.
 5. 'Fire-Protective Covering' means 13 mm fire-grade plasterboard or 12 mm cellulose fibre-reinforced cement (Refer BCA CI

SOU = Sole-Occupancy Unit



(a) Without sprinklers (must have smoke alarms)

SOU = Sole-Occupancy Unit



(b) With sprinklers and smoke alarms

FIGURE A3 - CLASS 2 BUILDING - TYPE B CONSTRUCTION

A4.3 Type C Construction

Table A4 and Figure A4 summarise the FRL and sound rating requirements for Type C construction – Class 2 and 3 buildings.

NOTE: Type C construction provides the lowest level of passive fire resistance with the structural elements not required to withstand the burn-out of the contents. Only some elements have specified levels of fire resistance (intended to restrict horizontal spread of fire) and these are generally less than the corresponding elements in Type A or B construction.

TABLE A4 FRL REQUIREMENTS - TYPE C TIMBER FRAMED CONSTRUCTION

BUILDING ELEMENTS	FRL	COMMENTS
	Smoke Alarms only	
External Wall (Loadbearing) less than 1.5 m 1.5 m or more	90 / 90 / 90 - / - / -	Outer part or face of wall only, is required to have the FRL. Example, only brick veneer in the external wall is required to be rated from the outside. Lightweight systems are also available.
External Wall (Non-Loadbearing) Less than 1.5 m 1.5 m or more	- / 90 / 90 - / - / -	
External Columns Less than 1.5 m 1.5 m or more	90 / - / - nil	AS 1720.4 Timber Structures Code provides a fire rating design method for solid timber beams and columns.
Common Wall and Fire Walls	90 / 90 / 90	
Internal Walls bounding public corridors, hallways and the like or between SOU - Loadbearing - Non-Loadbearing	60 / 60 / 60 - / 60 / 60	These walls to extend to a fire rated floor of fire protective covered floor above or to a 60 minutes Incipient Spread of Fire ceiling or to an non combustible roof covering.
Floors	30 / 30 / 30	An alternative to FRL 30 for floor is to provide a fire protective covering to the underside of the floor, including beams. No FRL is required for floors built within a SOU.
Roofs	- / - / -	No fire rating is required for Class 2 or 3 buildings

- NOTES:
1. FRL = Fire-Resistance Level: Structural adequacy / integrity / insulation (Refer BCA CI A.1)
 2. A dash (- / - / -) in the above table means no FRL requirements
 3. 'Incipient Spread of Fire' ceiling, is the ability of the ceiling membrane to insulate the space above the ceiling so the temperature rise is no more than 140° K.
 4. 'Fire-Protective Covering' means 13 mm fire-grade plasterboard or 12 mm cellulose fibre-reinforced cement (Refer BCA CI A1).

SOU = Sole-Occupancy Unit

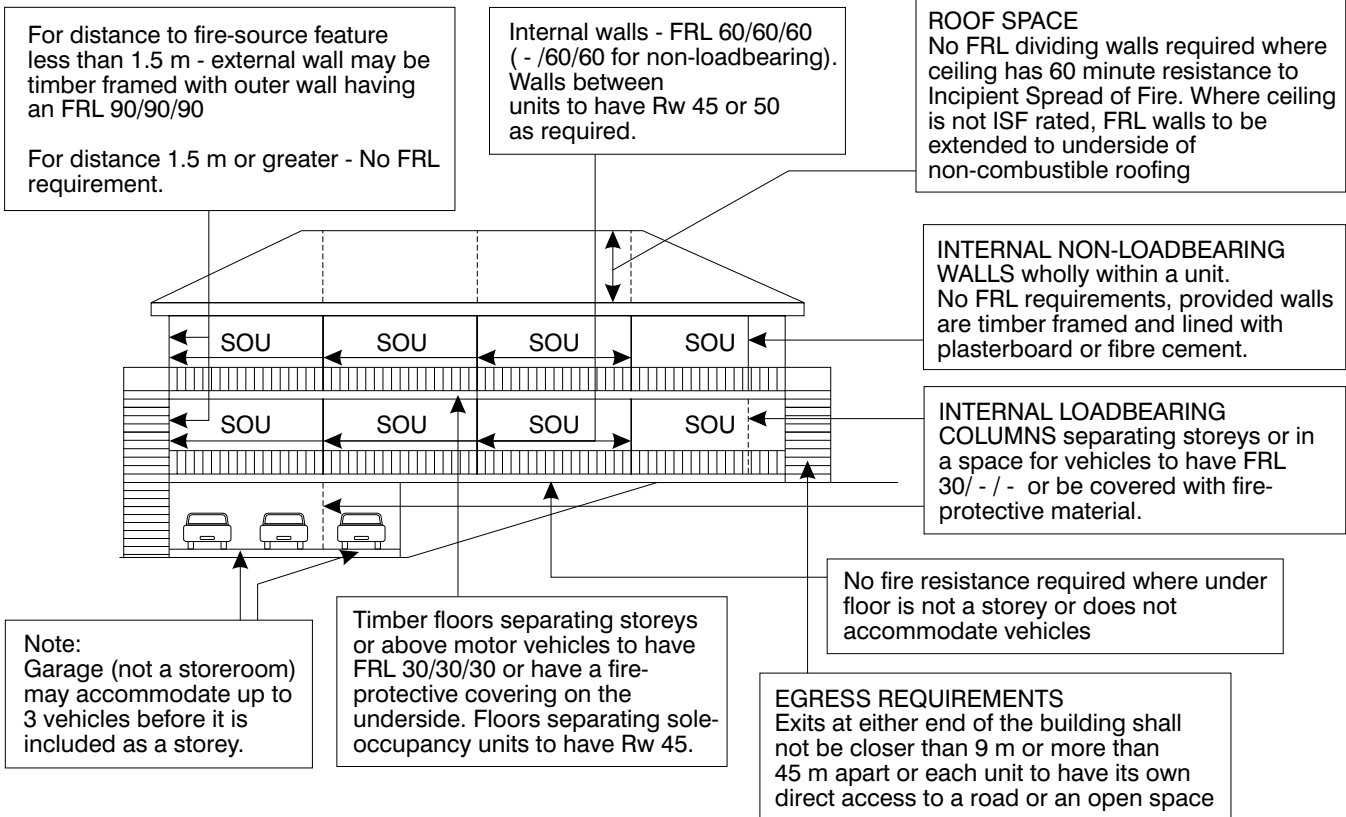


FIGURE A4 - CLASS 2 OR 3 BUILDING - TYPE C CONSTRUCTION



For information regarding MRTFC please contact:

New South Wales - TDA

Timber Development Association of NSW
13-29 Nichols Street, Surrey Hills
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Members of the National Timber Development Council

ATIF - Australian Timber Importers Federation

FIAT - Forest Industries Association of Tasmania

FIFWA - Forest Industries Federation (Western Australia) Inc.

FPA - New South Wales Forest Products Association Ltd.

FWPRDC - Forest & Wood Products Research & Development Corporation

NAFI - National Association of Forest Industries

PA - Pine Australia Ltd.

PAA - Plywood Association of Australia Ltd.

QTB - Queensland Timber Board

TDA (NSW) - Timber Development Association (New South Wales) Ltd.

TDA (SA) - Timber Development Association (South Australia) Inc.

TPC - Timber Promotion Council of Victoria

TRADAC - Timber Research and Development Advisory Council (Qld)

VAFI - Victorian Association of Forest Industries

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