10.

Upper Floors

Contents

Introduction

This section provides guidance on meeting the performance requirements for the following types of timber upper floors:

- Traditional solid timber joists
- I-joists
- Metal web joists

Throughout this section, both I-joists and metal web joists will collectively be referred to as 'Engineered Joists'.

10.1.1 Compliance

The design, specification and installation of timber upper floors shall satisfy the performance requirements of this section.

10.1.2 Information to be provided

The Designer shall provide sufficient design details to demonstrate it meets the requirements of this section.

A full set of design drawings and specifications shall be made available to the Warranty provider and all other interested parties prior to the associated works starting on site. This may include:

1. Details of proposed floor joists to be used including floor joist layouts and structural calculations (for engineered joists this should be provided from the joist manufacturer).
2. Where engineered joists are proposed, details of the manufacturer relevant accreditation (TRADA, STA, etc.). The accreditation must confirm the manufacturers has been assessed for the design of joists.
3. Details of proposed services to be constructed within the floor void.
4. Details of any proposed underfloor heating systems to be incorporated.
5. Details of insulation be used within the floor construction.
6. The following should be provided for the structural floor boarding:
    a. Details of the proposed structural floor boarding including evidence the boards are suitable for the intended purpose.
    b. Details of the type, size, spacing and method of fixing the boards.
7. The following should be provided for the proposed plasterboard to be used:
    a. Details of proposed plasterboards to be used; type of board, thickness, number of boards to create the layer.
    b. Details of mechanical fixings of plasterboards.

The Warranty surveyor, at their discretion, may also request supporting information that demonstrates suitability for use of any materials or systems contained within the above.

10.1.3 Structural design

Timber upper floors shall be durable and safely support and transmit intended loads to the supporting structure without undue movement.

General requirements

All timber upper floors should have loads calculated in accordance with BS EN 1991-1-1.

Deflection

For timber upper floors, designers and Engineers must observe our tolerance requirements for levelness and deflection limits of floors. Please refer to the 'Tolerances' section for further guidance.

There may be an instance where a joist might be designed to meet permissible deflections within a relevant British Standard; however, our tolerance requirements will take precedence.

Traditional solid timber joists

Specification

BS EN 338 should be used by the designer to determine the suitable strength class for the traditional solid timber joists.

All traditional solid timber joists should be:

- Machine graded to BS EN 14081 or, visually graded to BS 4978 for softwoods or BS 5756 for hardwoods.
- Dry graded.
- Marked in accordance with BS EN 14081.

Sizing

For advice on sizing of certain timber members of floors, the Designer should refer to the following sources:

- Span tables for solid timber members in floors, ceilings and roofs (excluding trussed rafter roofs) for dwellings. Published by BM TRADA. Note: Reference should be made to the version of the BM TRADA document current at the time of construction of the floor/ceiling or roof.
- BS 8103-3, Structure design of low rise buildings, Code of Practice for timber floors and roofs for dwellings.
- BS EN 1995, Eurocode 5 design of timber structures. General. Common rules and rules for buildings.

Engineered joists

Engineered joists should be designed in accordance with BS EN 1995, Eurocode 5 design of Timber Structures. General: Common rules and rules for buildings. Engineered joists should be appropriately UKCA / CE marked and comply with ETAG 011 or have an appropriate third party product conformity certificate.

10.1.4 Storage and protection of timber joists

Timber joists shall be appropriately stored and protected on site so as to not effect the performance or durability of the timber joists.

Timber upper floors should be protected from the elements and supported on suitable bearers over a free draining surface. Levels of exposure, which are more severe than those encountered during a normal uninterrupted build programme should be addressed by the provision of suitable protection.

10.1.5 Installation and workmanship

Timber joists shall be installed in a manner which does not affect their durability or performance.

Where Engineered joists are specified, their installation shall also be in accordance with the manufacturer's recommendations and the site specific specification.

All workmanship shall satisfy the 'Tolerances' section.

It is essential that joists are not overloaded during construction. Joints in joists should only be in place over a load-bearing support, or the joint be designed by an Engineer.

Levelling

Floors should be level in accordance with the 'Tolerances' section.

Where hard packing is proposed to ensure the floor is level, it should be specified in accordance with the Engineers specification or Engineered joist manufacturer's recommendations. Loose or soft packing should not be used.

Bearing on supporting structure

The floor joists must be laid reasonably level and onto suitable solid and level bearings.

Minimum bearing for timber joists:

Type of timber joist	Minimum bearing
Traditional solid timber joist on masonry wall	90mm
Traditional solid timber joist on a timber wall plate	75mm
I-Joist	90mm
Metal web joist	90mm

Bearing on joist hangers

Where joist hangers are specified to support timber joists, the end bearing should be in accordance to an Engineers design and hanger manufacturer's recommendations. Additional fixings may also be required to secure joist ends into the hanger.

Joists should be restrained at supports using tightly fitted strutting.

Notching and drilling

Traditional solid timber joists

Requirements for notching and drilling of solid timber joists can be found in BS 8103, TRADA span tables, BS EN 1996 and PD 6693 – 1.

This guidance is for joists up to 250mm deep, notching and drilling for joists exceeding this depth should be designed by the Engineer.

- Notches should be made in between 0.1 and 0.2 x span. Notches should be no deeper than 0.15 x depth of the joists in this area e.g. for a 250mm deep joist, the maximum notch depth should not exceed 35mm.
- Holes should be drilled on the centre line of the joist. Holes should be between 0.25 and 0.4 x the span. Holes should be a maximum diameter of 0.25 x the joists depth and kept apart by at least 3x the diameter. The maximum hole diameter should not exceed 65mm.

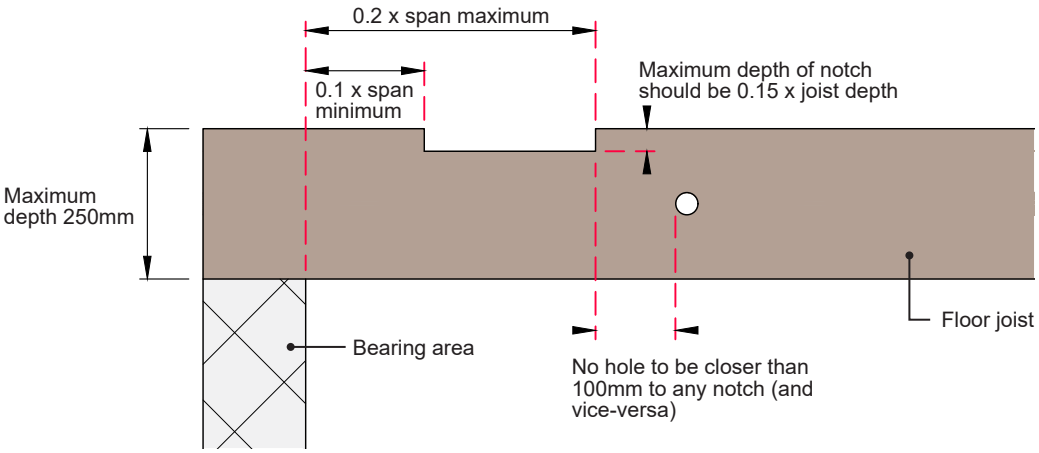
Note: Notches and holes should be a minimum of 100mm apart.

The table below gives an indication of the areas in a joist which are suitable for notching and drilling.

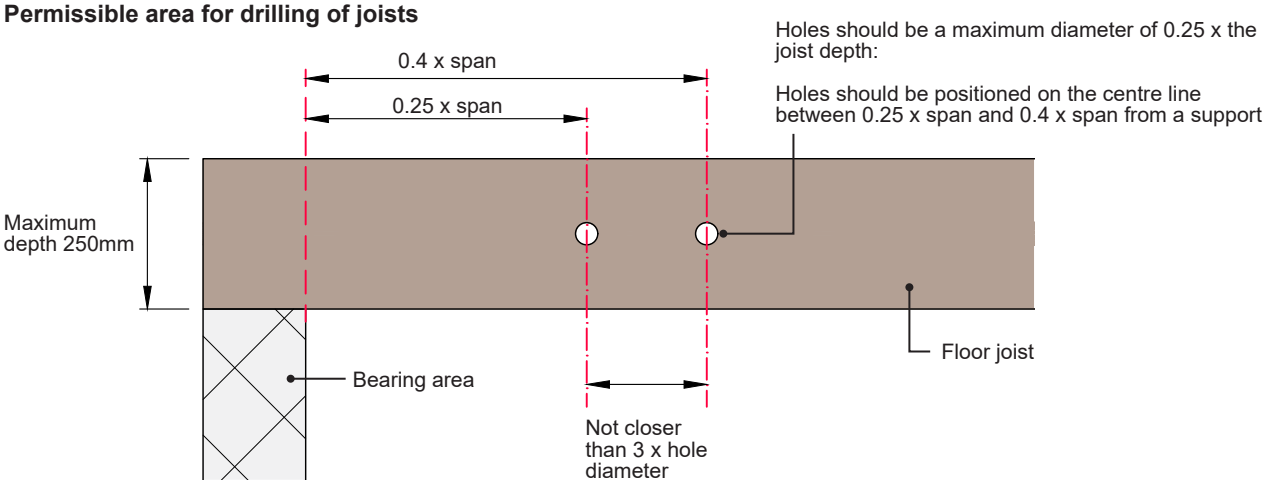
Typical permissible zones for notching and drilling of solid timber joists

Span	Notches to be taken out only within these zones		Holes only to be drilled within these zones	
1.5m	0.15m	0.3m	0.375m	0.6m
2.0m	0.2m	0.4m	0.5m	0.8m
2.5m	0.25m	0.5m	0.625m	1m
3m	0.3m	0.6m	0.75m	1.2m
3.5m	0.35m	0.7m	0.875m	1.4m
4m	0.4m	0.8m	1m	1.6m
4.5m	0.45m	0.9m	1.125m	1.8m
5m	5m	1m	1.25m	2m

Permissible area for notching of joists

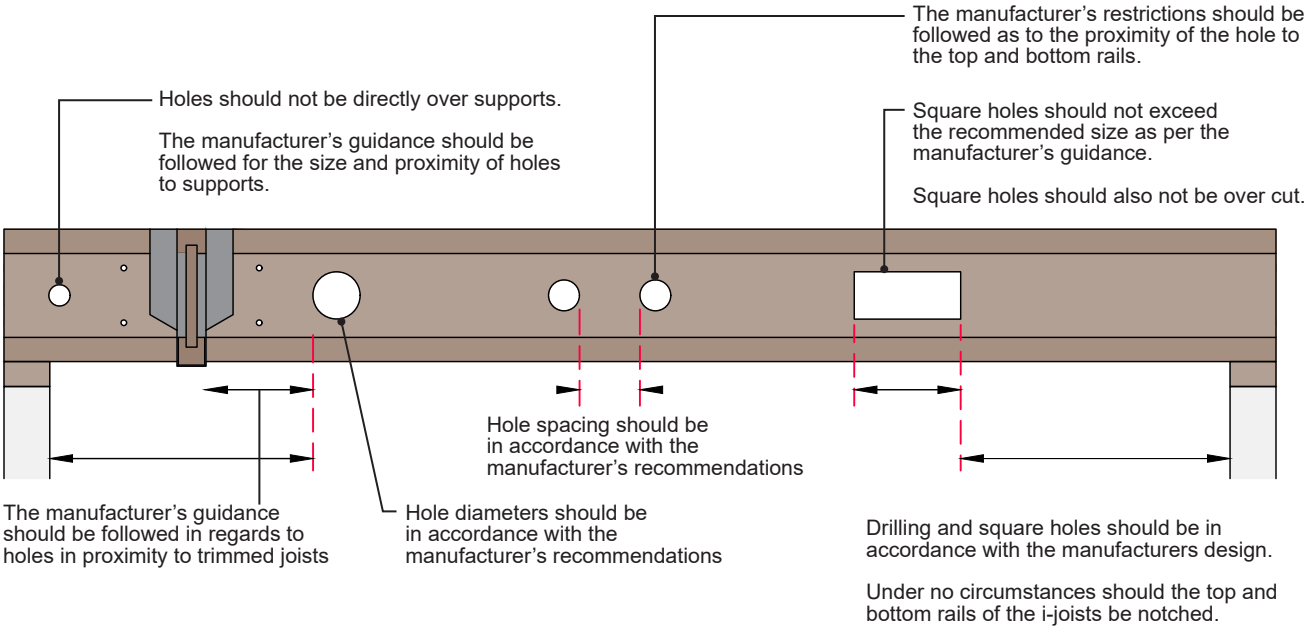


Permissible area for drilling of joists



I-Joists

I-joists should be notched and drilled in accordance with the manufacturer's recommendations.



Support of light-weight non-load bearing partitions

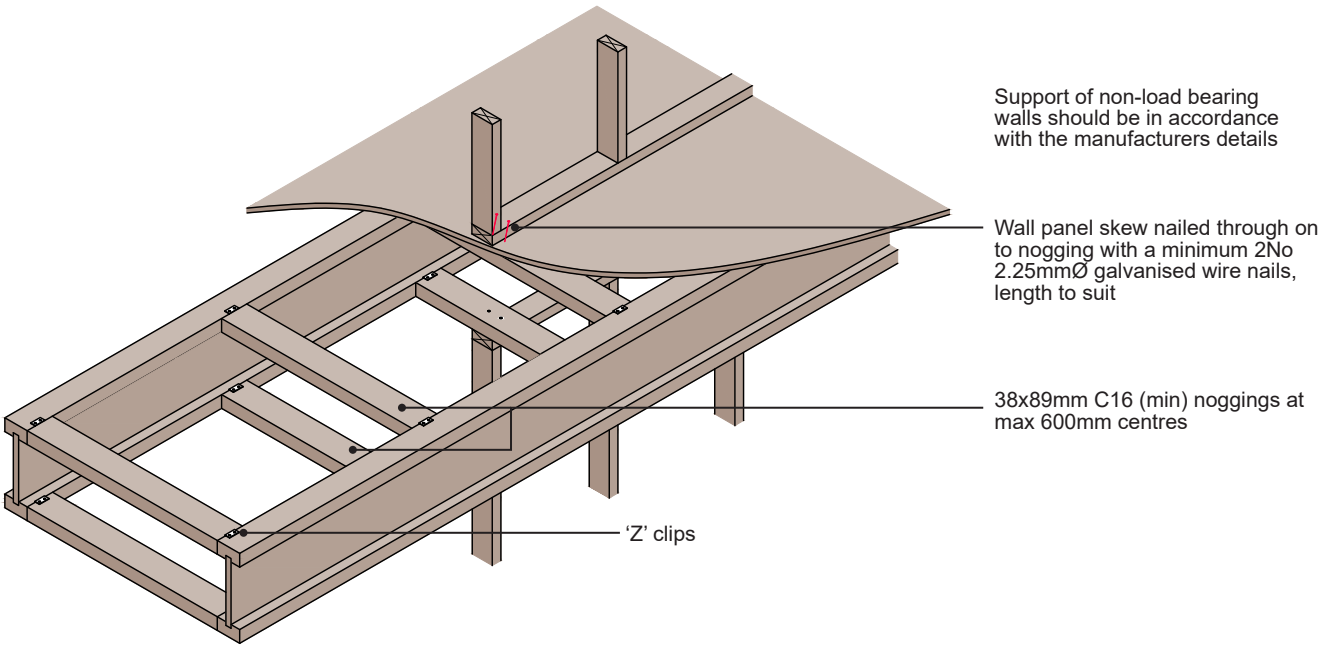
Where light weight non load bearing partition are parallel to the joists, they should be suitably supported with in accordance with the design. Sole plates should be fixed to the noggins or joists.

Where traditional solid timber joists or Engineered joists run parallel to non-load bearing partitions above:

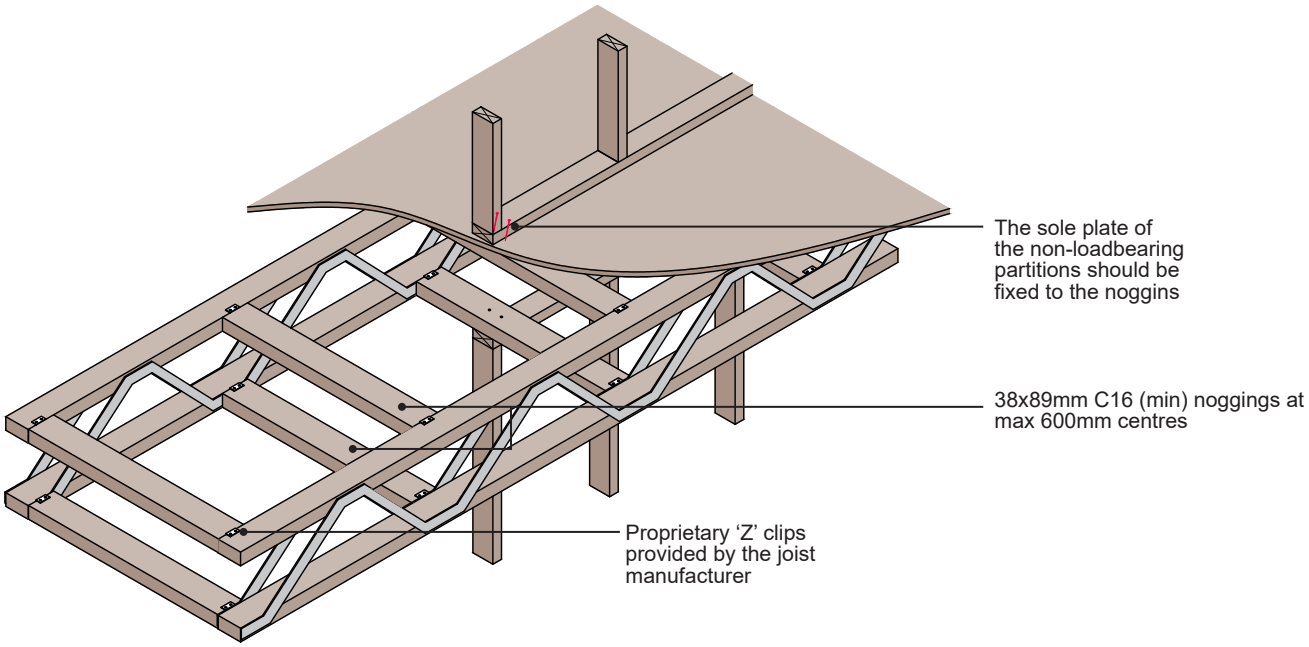
- The joists should be positioned centrally below the non load bearing partitions. Double or triple joists should be provided in accordance with the Engineers design, **or**
- The partition should be supported by noggins or bearers fixed to joists in accordance with the Engineers specification or Engineered joist manufacturer's specification.

In all circumstances, where engineered joists are specified, the joist manufacturers specification should be followed.

I-Joists supporting non-load bearing partition on noggins



Metal web joists supporting non-load bearing partition on noggins



General detailing for traditional solid timber joists

Floor joists bearing on to masonry walls

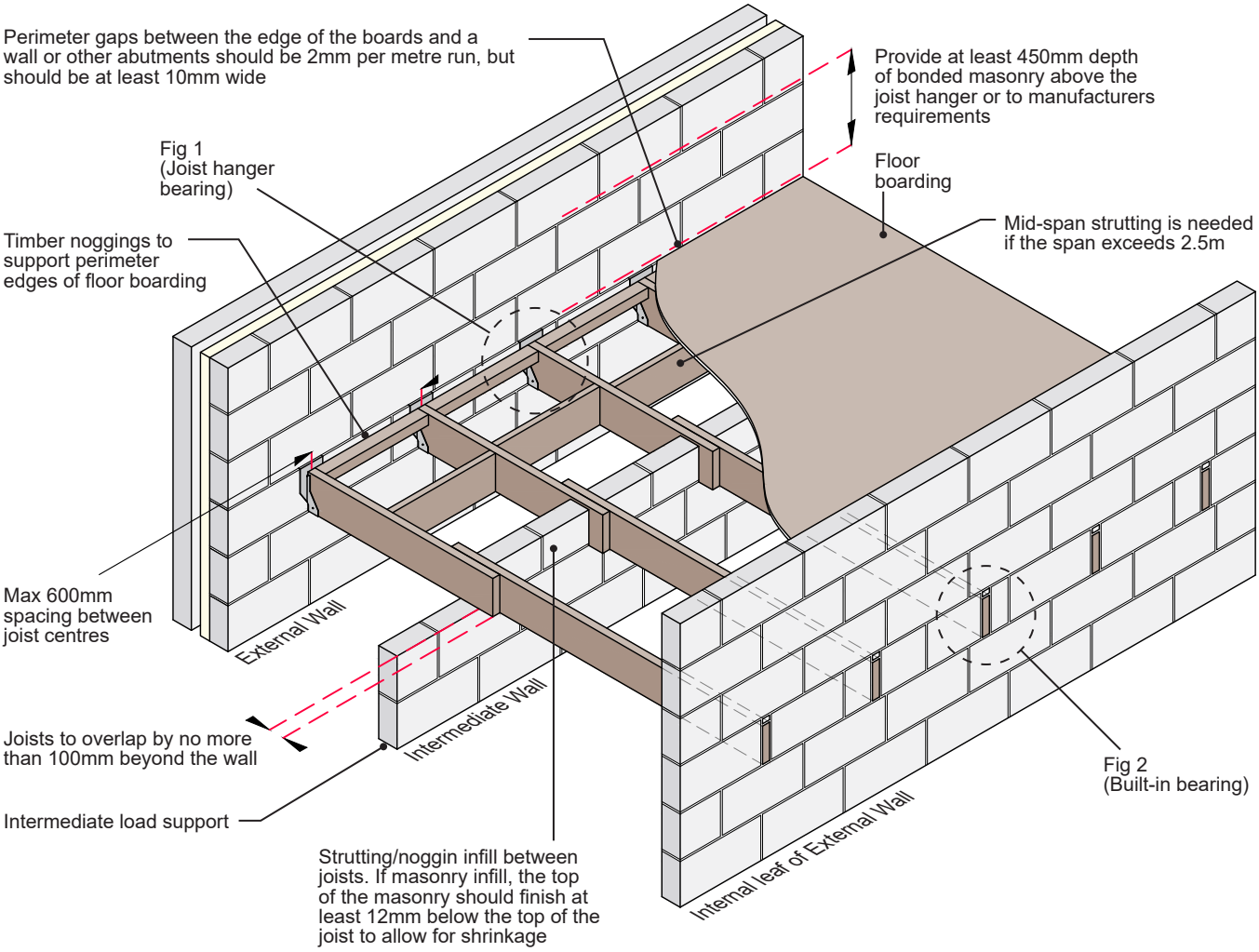


Fig 1 Joist hanger bearing

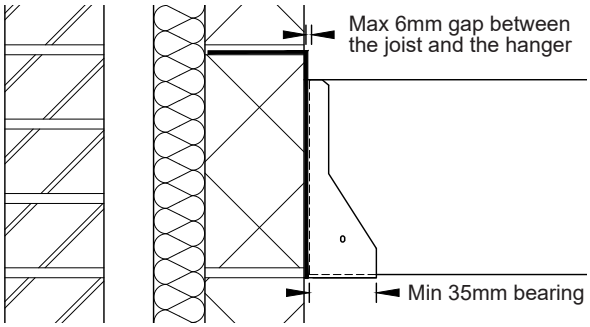
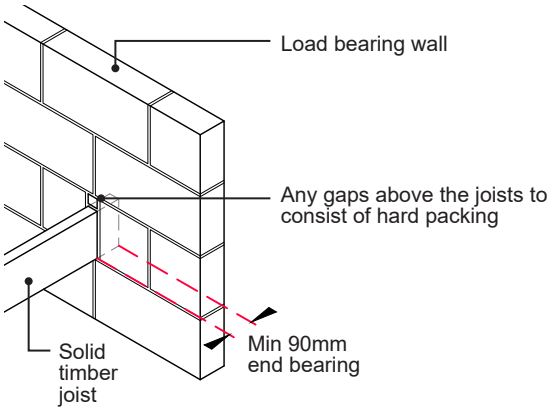


Fig 2 Built-in bearing



Floor joists bearing on to a timber frame

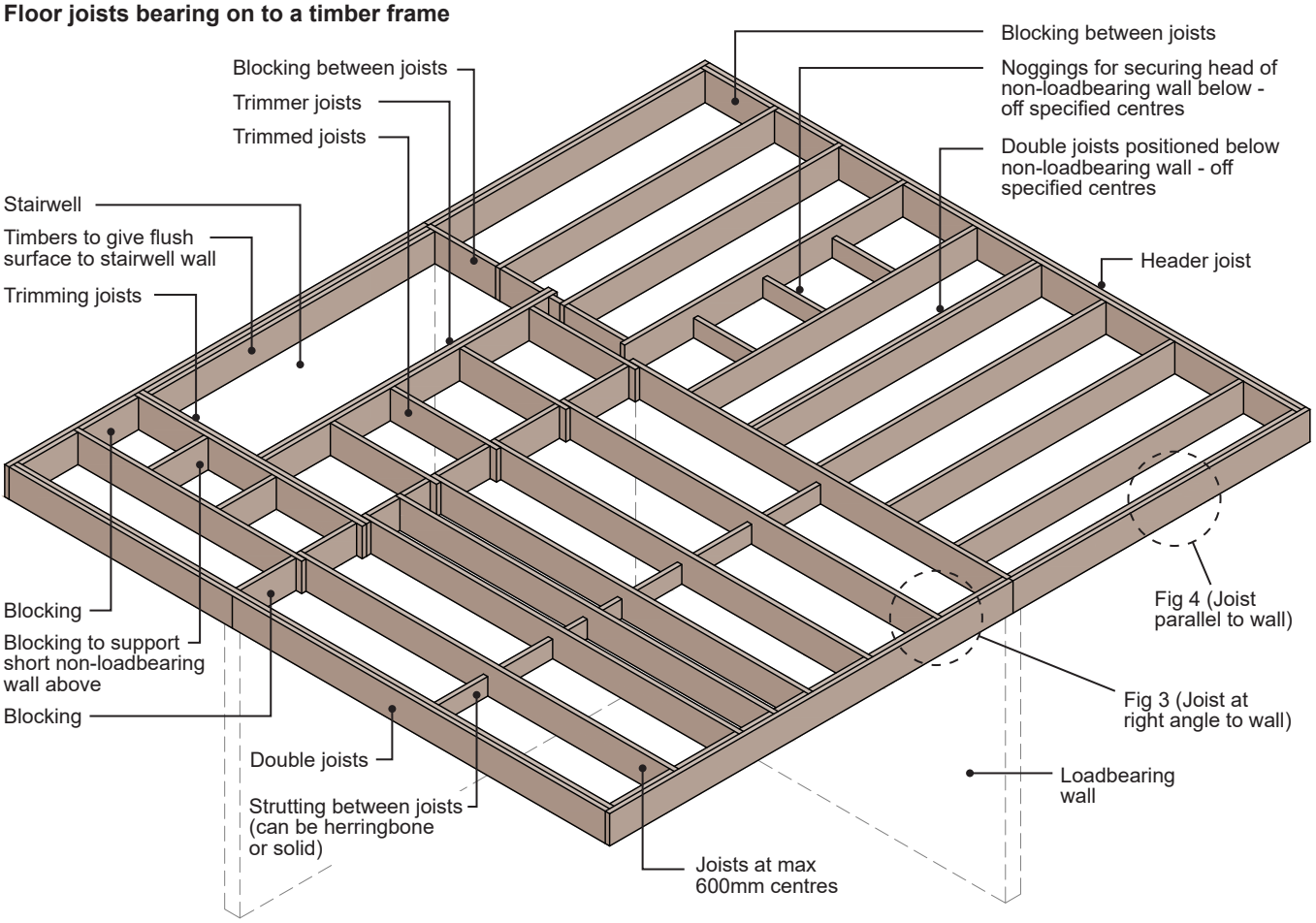


Fig 3 Joist at right angle to wall

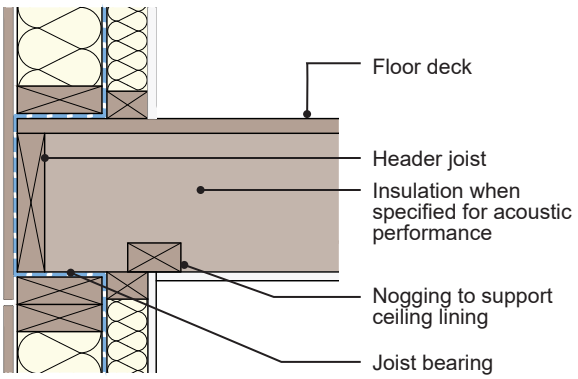
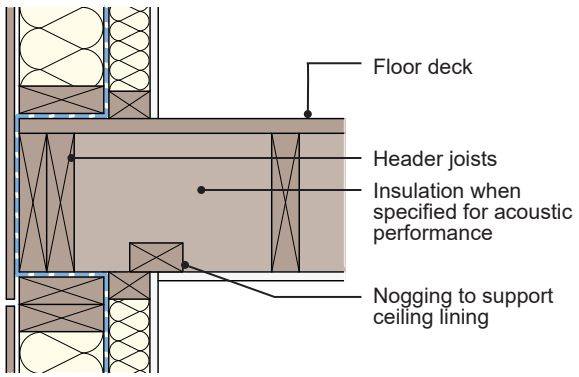


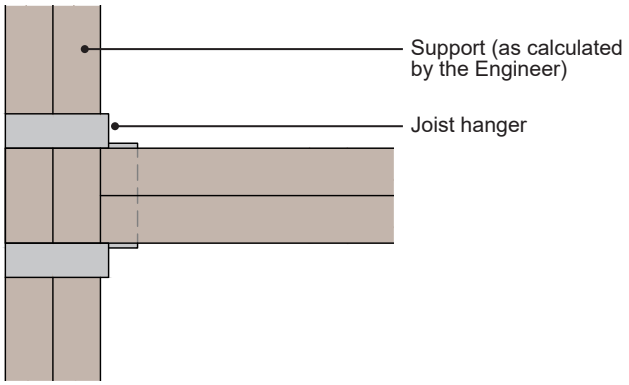
Fig 4 Joist parallel to wall



Typical trimming detail (plan)

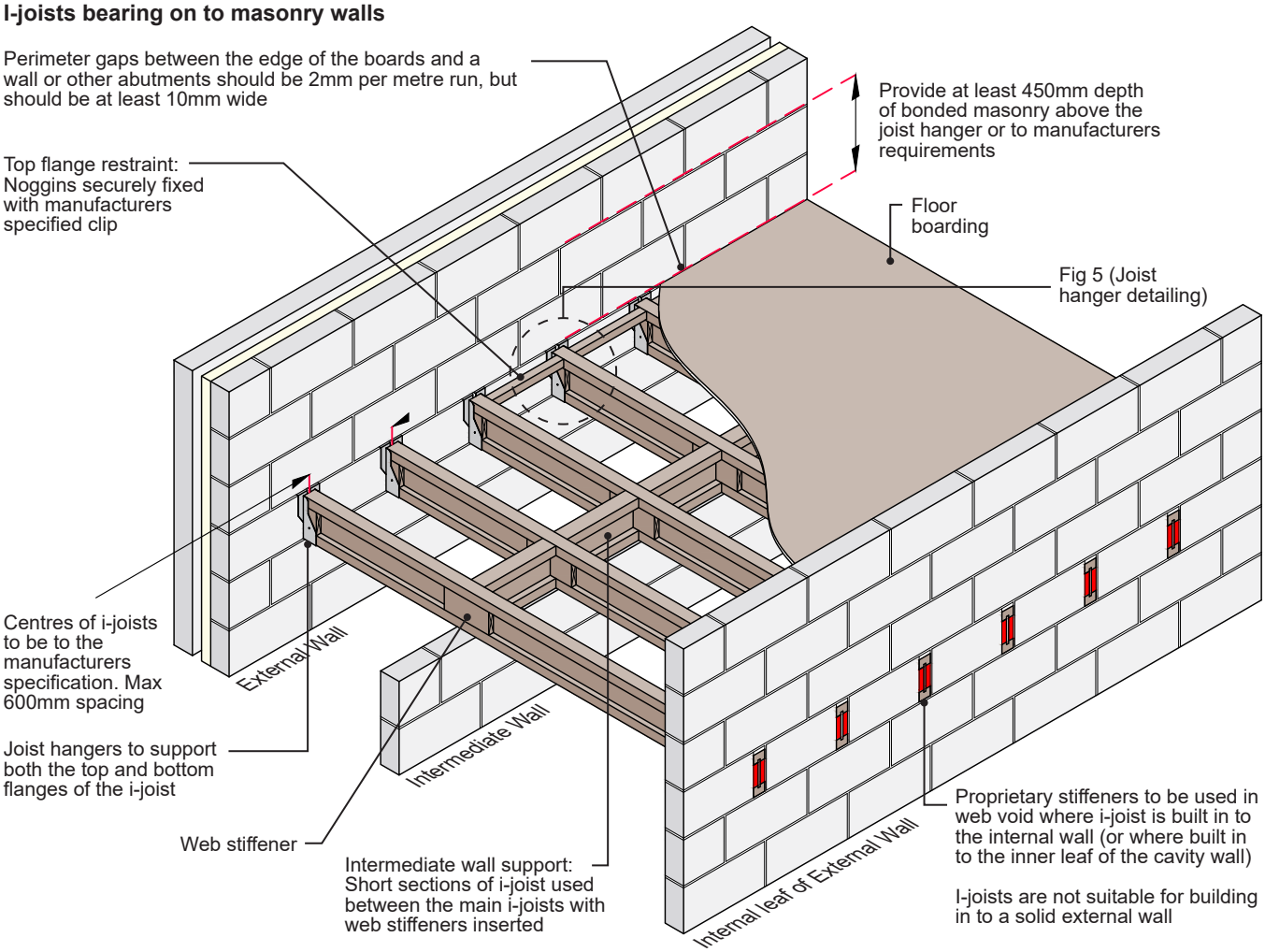
Double joists should be bolted together at 600mm centres using minimum 10mm diameter bolts with large washers that will prevent the bolt head and nut from penetrating the joist. It is recommended that the bolting of double joists is along the centre line of joists. Suitably sized trimmer joists shall be provided around floor openings.

Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using either joist hangers or a structurally designed connection; timber trimmers around openings should consist of at least two members and be designed by the Engineer.

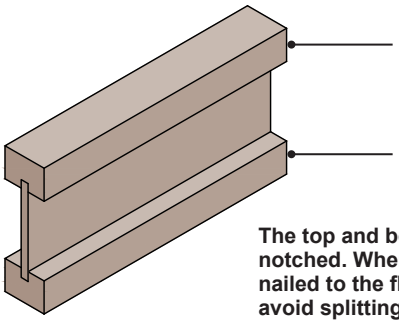


General detailing for I-Joists

I-joists bearing on to masonry walls

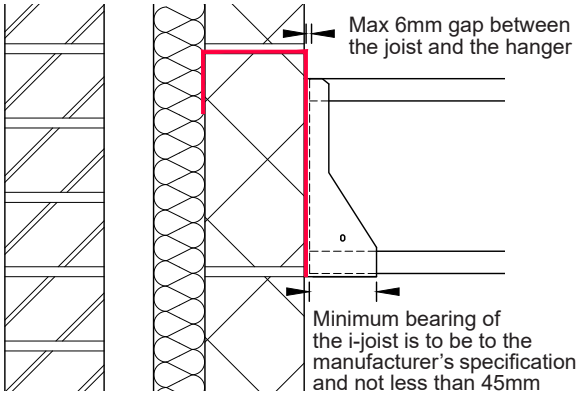


Top and bottom flange



The top and bottom flanges must not be notched. Where ceiling and floor boards are nailed to the flanges, care must be taken to avoid splitting the flange member.

Fig 5 Joist hanger detailing



Where hangers are specified they should be either:

- Full depth of the joist and restrain top flange, **or**
- At least 0.6 x depth of the joist and have web stiffeners specified for the full depth of the joist (to both sides of the web).

I-joists bearing on to a timber frame

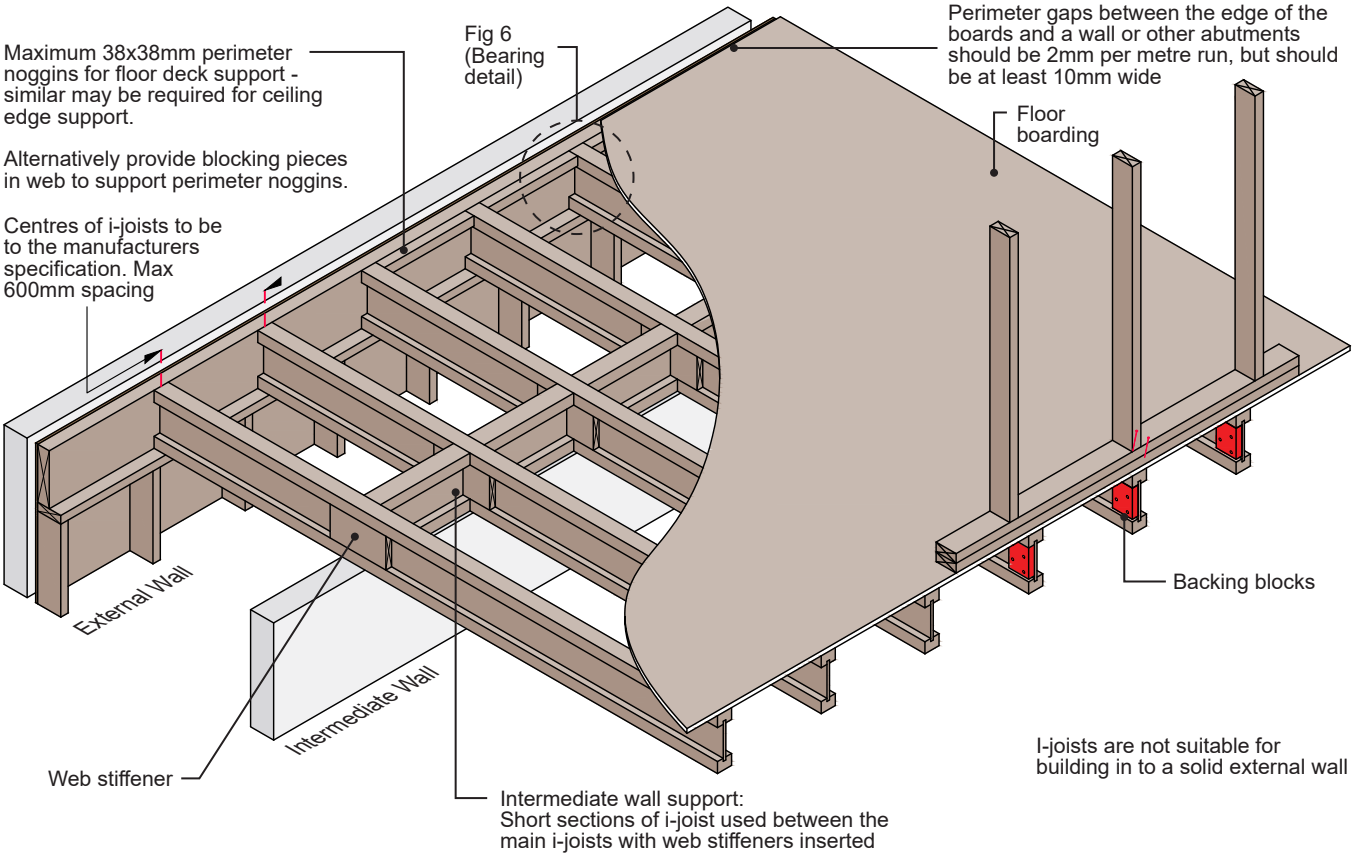
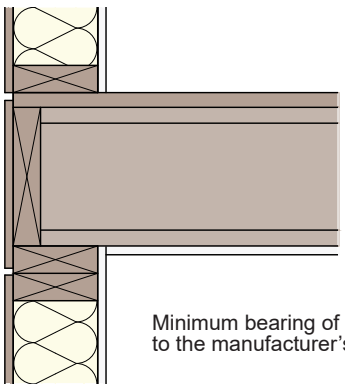
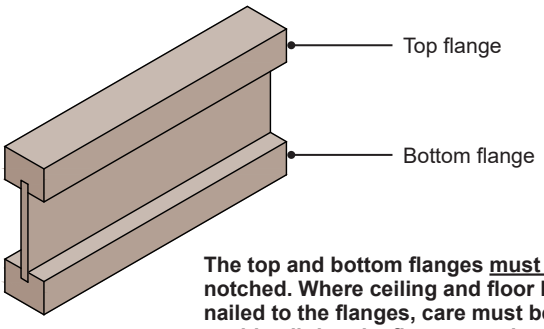


Fig 6 Bearing detail



Top and bottom flange

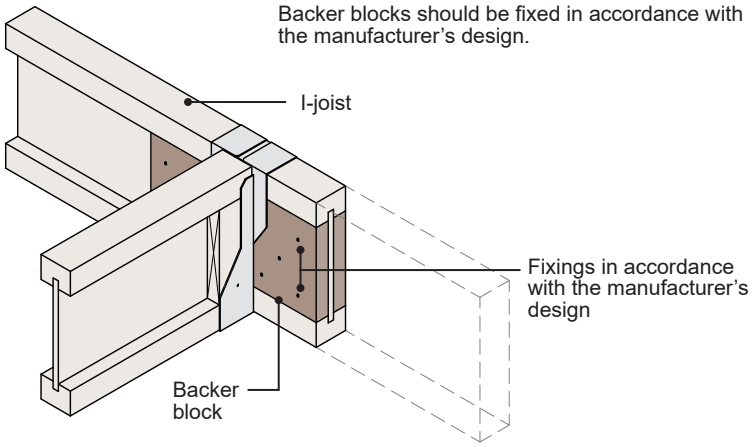


The top and bottom flanges must not be notched. Where ceiling and floor boards are nailed to the flanges, care must be taken to avoid splitting the flange member.

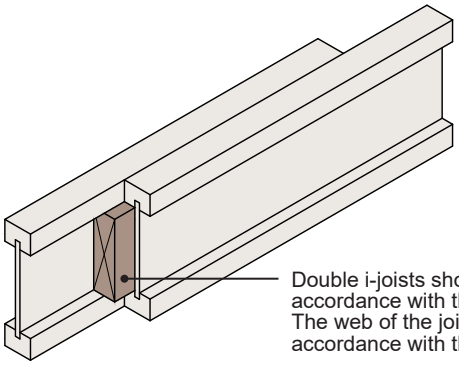
Backer blocks

Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using joist hangers. Timber trimmers around openings should consist of at least two members and be designed and installed in accordance with the manufacturer's instructions. Where an I-joist is faced fixed to another I-joists backer blocks should be provided on both sides of the web of the trimmer.

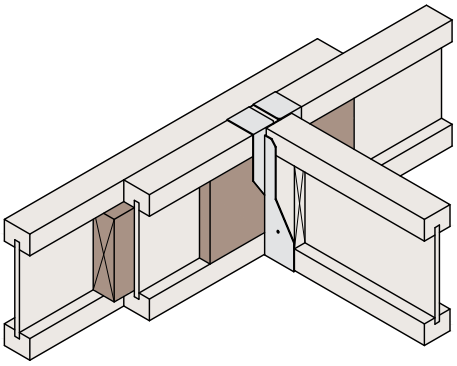
Fixing of I-joists should be in accordance with the Engineers design and specification. A timber filler block should be installed between I-joists.



Fixing of multiple I-joists

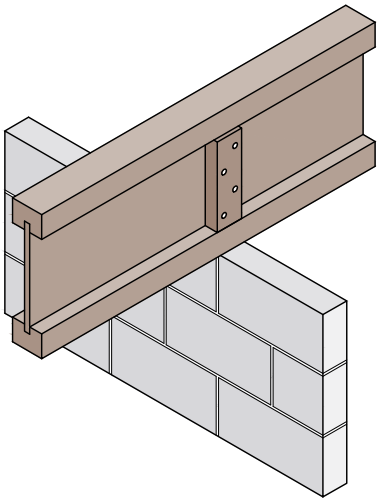


Double i-joists should be fixed in accordance with the manufacturers design. The web of the joists should be packed in accordance with the manufacturers design



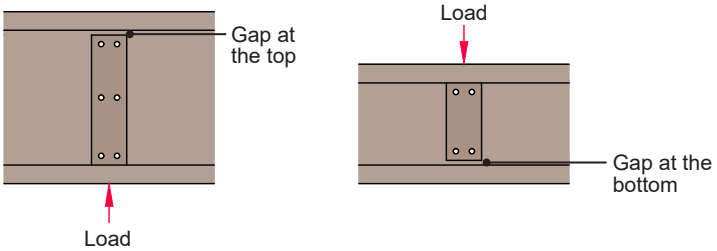
Building in of I-joists over internal walls

To reduce shrinkage, all mortar should be adequately dry and solidly packed in, but it should not be packed up tight to the underside of the top flange. Before the floor decking is fixed, all continuous joists must be packed down to the intermediate bearing wall.



Additional blocking should be installed in accordance with the manufacturer's instructions.

Generally a gap is required at the top or bottom of the packing, dependent on the direction of the load. Generally if the load comes from the bottom e.g. bearing on an internal wall the gap should be at the top. If the load is from the top the gap should be provided at the bottom.



The backing blocks should be fixed in accordance with the manufacturers design. Generally, backing blocks on deeper joists require a higher number of fixings.

General detailing for metal web joists

Metal web bearing on to masonry walls

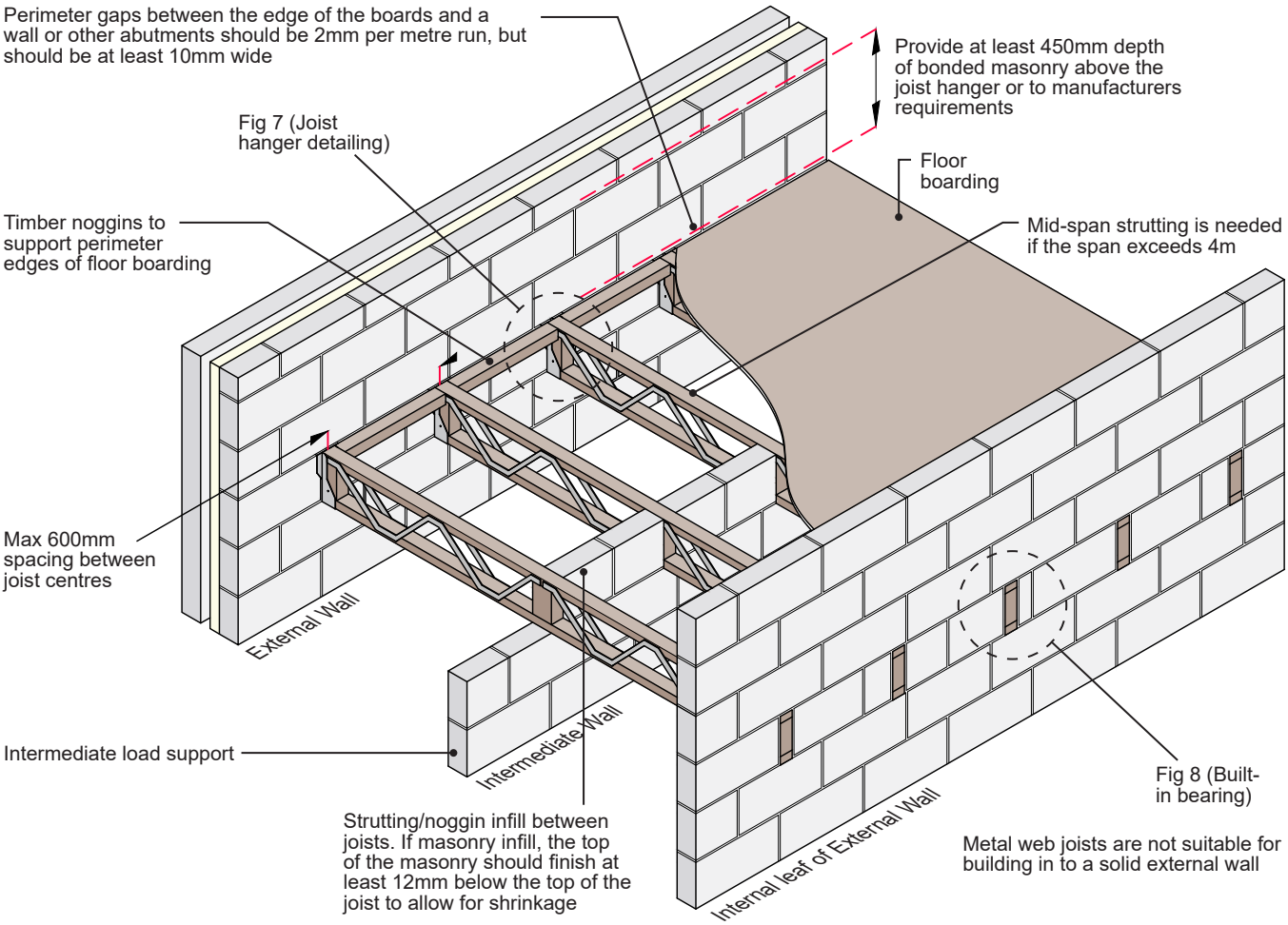
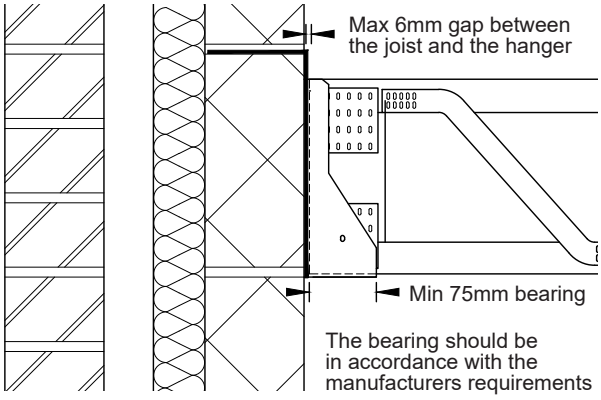
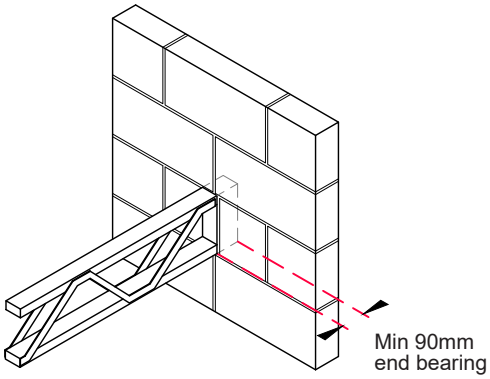


Fig 7 Joist hanger detailing



Hangers should be full depth of the joist and provide restrain to the top flange. Alternatively, there should be an alternative means of providing restrain to the top flange of the joist. Timber uprights should be fixed between the top and bottom flanges.

Fig 8 Built-in bearing



Metal web bearing on to a timber frame

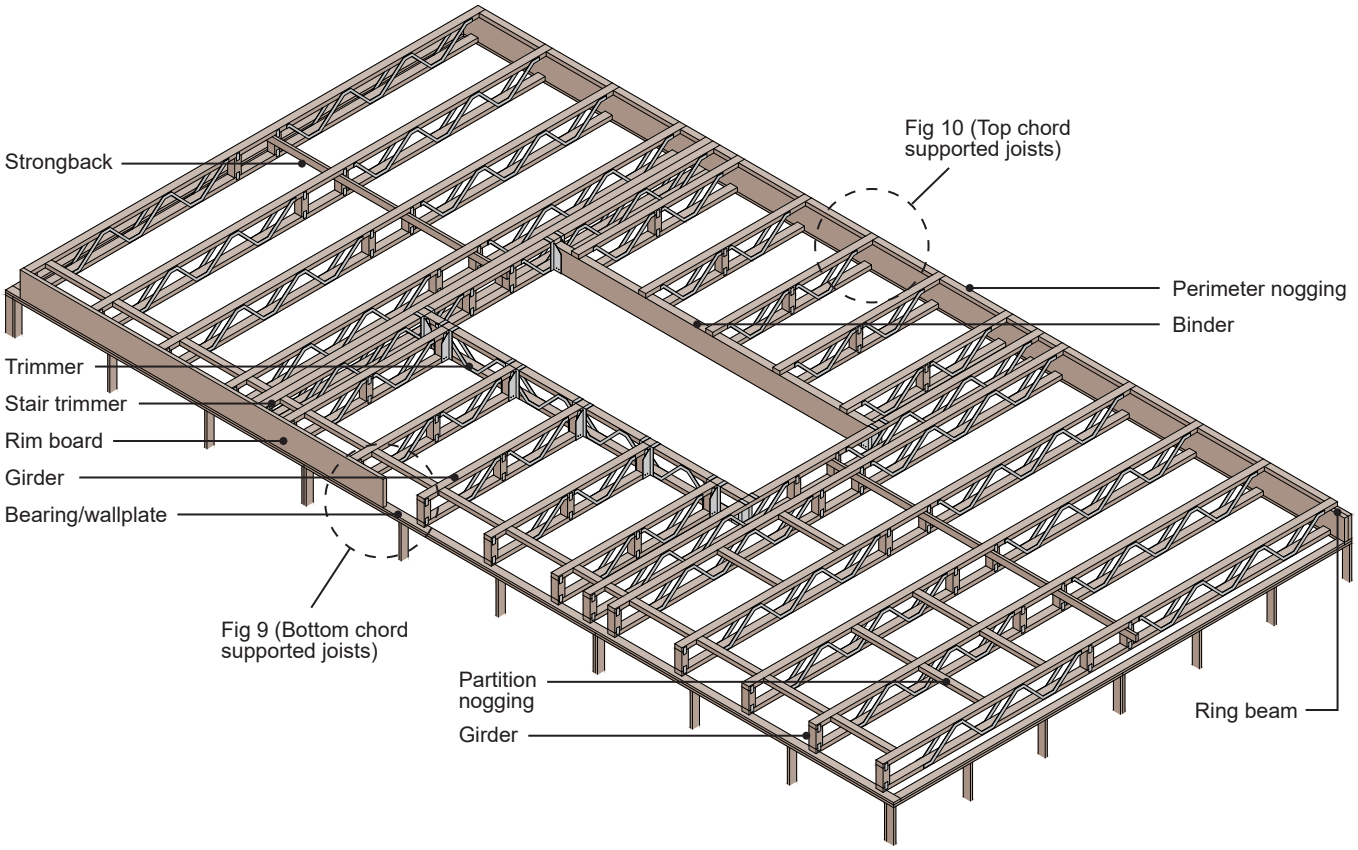
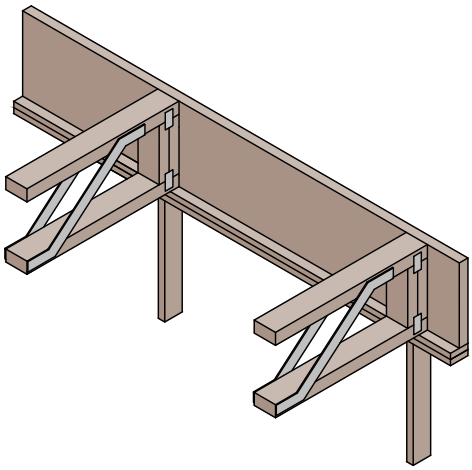


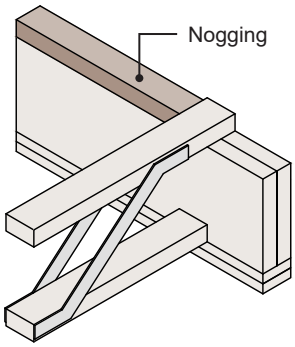
Fig 9 Bottom chord supported joists



Traditional arrangement - bottom chord supported joists on normal height panels.

The rim board around the outside closes off the floor zone. Solid timber blocking in between the joists provides support for the panel above.

Fig 10 Top chord supported joists

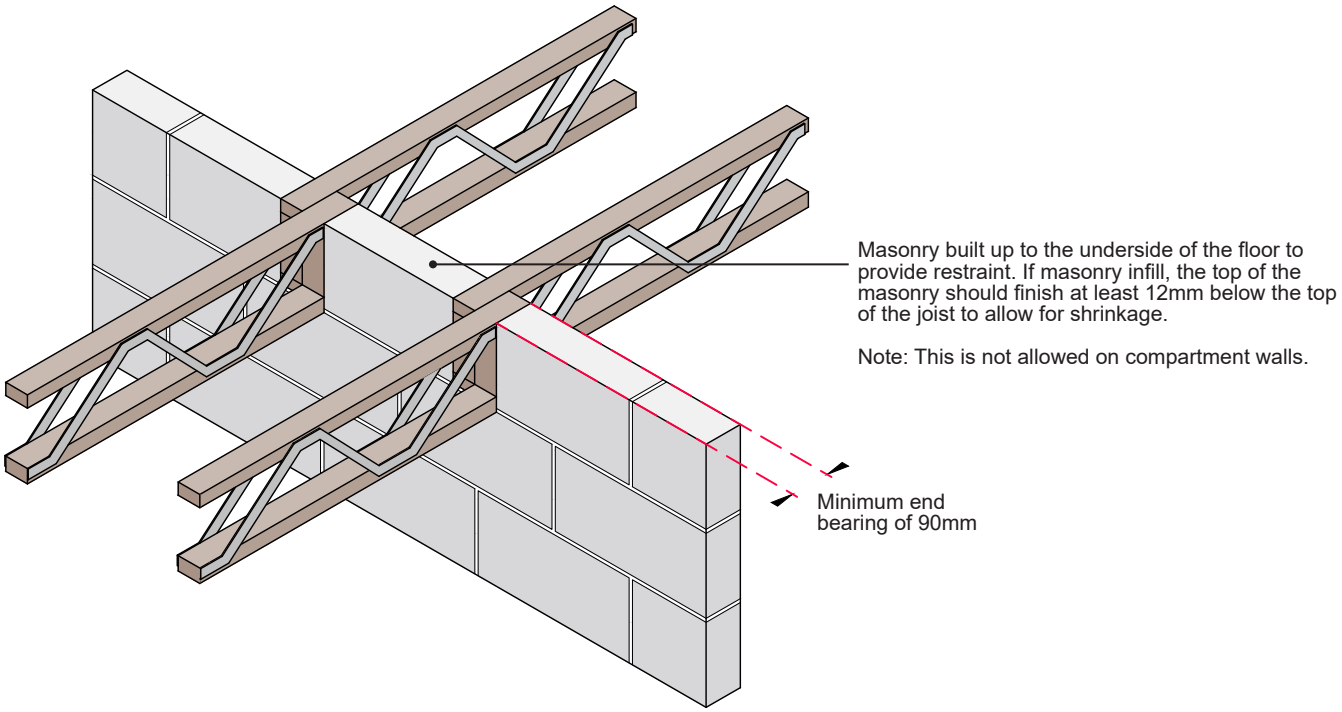


Standard height panel - top chord supported joist.

Solid noggins on top of the rim board in between the joists to provide support for the panel above.

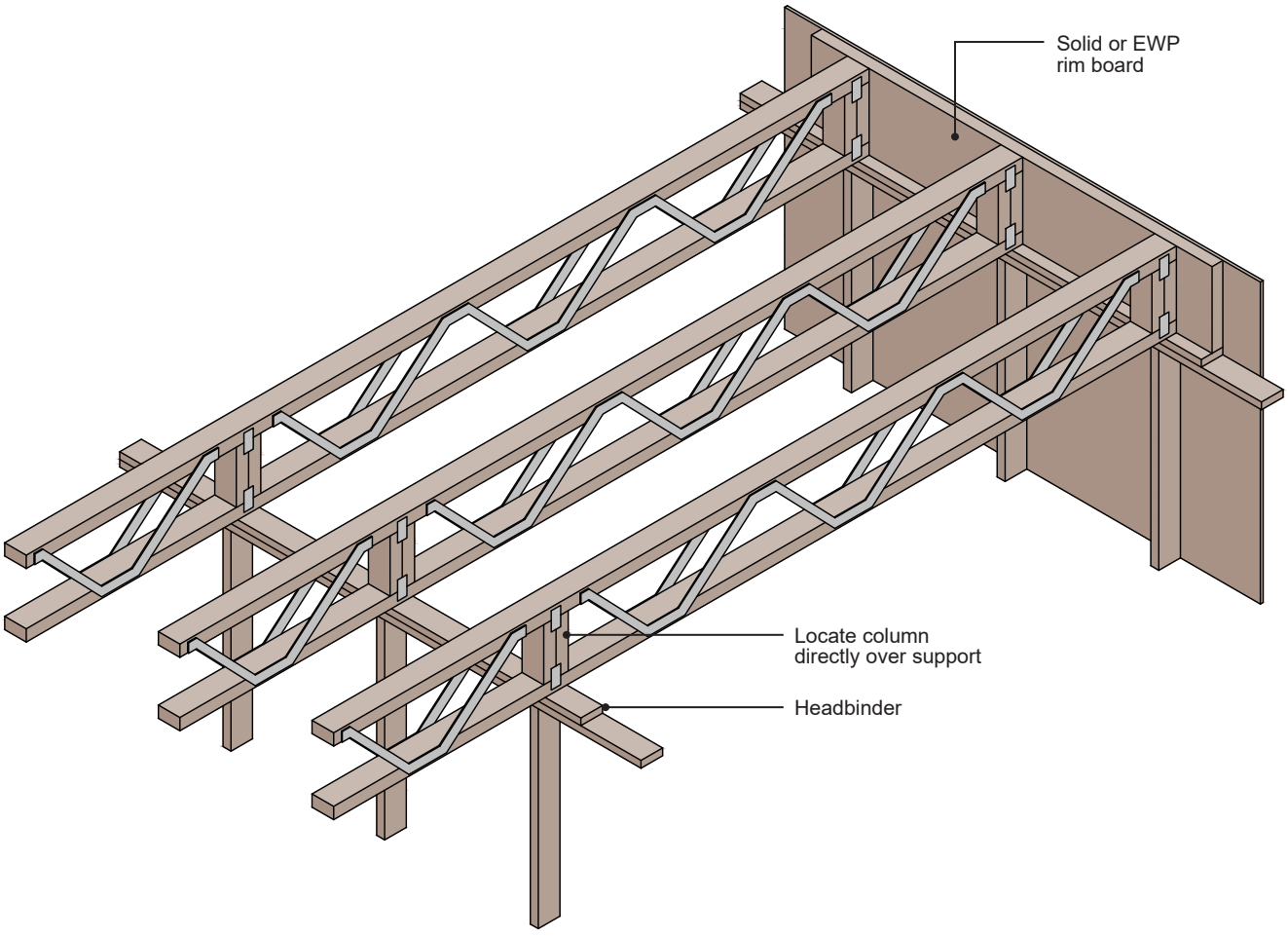
The floor decking will typically extend to the back of the noggins/end of the joist to tie the panels in with the floor.

Metal web joists supported on load bearing masonry internal wall



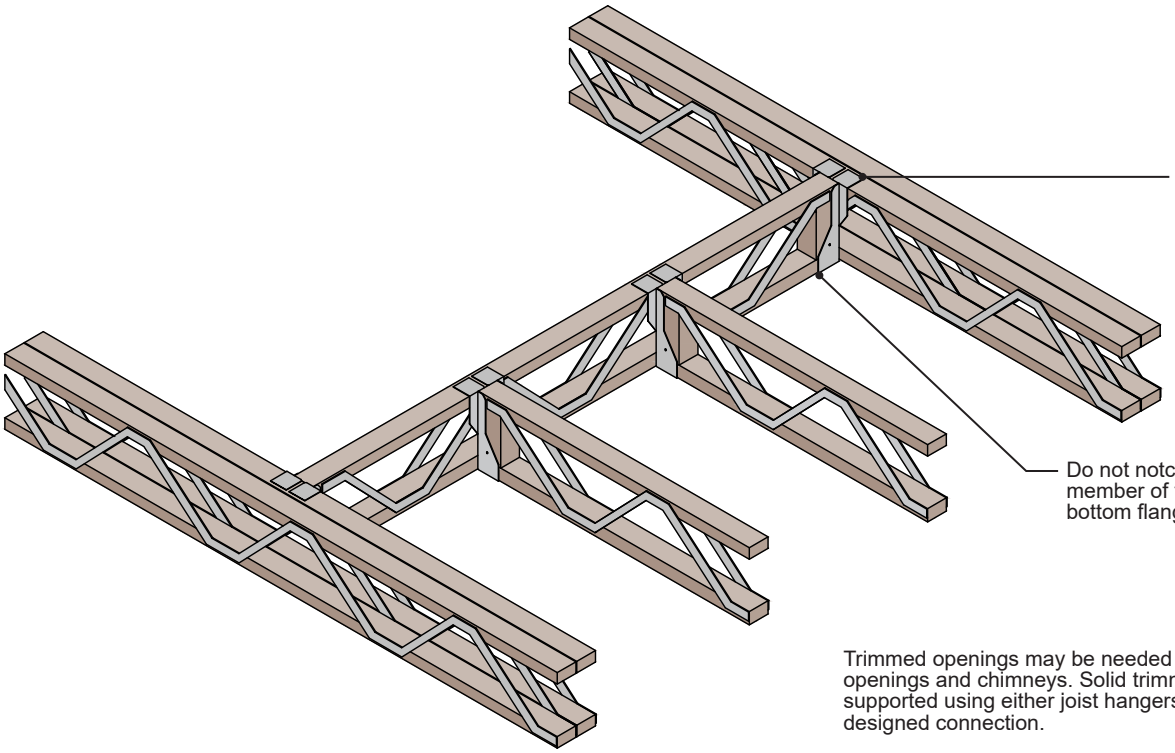
Metal web joists supported on load bearing timber internal wall

Example of metal web joists bearing on intermediate load bearing wall. Column within the metal web joist should be located directly over the support. In accordance with the manufacturers design.



Typical trimming detail

Double joists should be fixed as per the manufactures design, this can be with a propriety clip or fixed at specified centres with fixings provided by the manufacturer. It is important to ensure that the work on site is in accordance with the manufacturers design.



Trimmed openings may be needed around staircase openings and chimneys. Solid trimmed joists may be supported using either joist hangers or a structurally designed connection.

10.1.6 Steel beams supporting timber joists

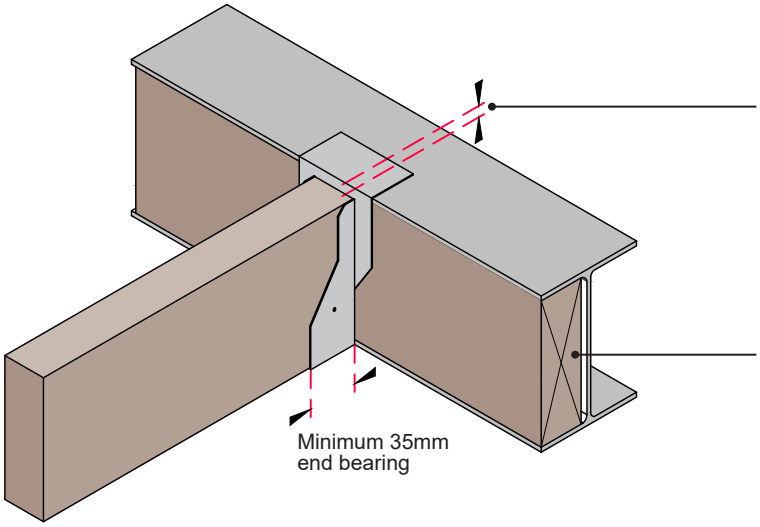
The designer shall provide detailing where timber joists are to be supported off steel beams.

Steel beams should be designed by the Engineer and should have appropriate fire resistance to meet the requirements of the relevant Building Regulations.

Where steel beams and columns are used to support the upper floor construction on a project in a coastal location, and maybe exposed to an aggressive external environment (e.g. under croft) please follow the requirements for additional corrosion protection in the 'Appendix B - Coastal Locations' and 'Appendix C - Materials, Products, and Building Systems' section.

To prevent the distortion of finishes, joists should be stopped from twisting over supports and provision provided to accommodate up to 12mm of drying shrinkage in floor joists supported by steel beams.

Traditional solid timber joists

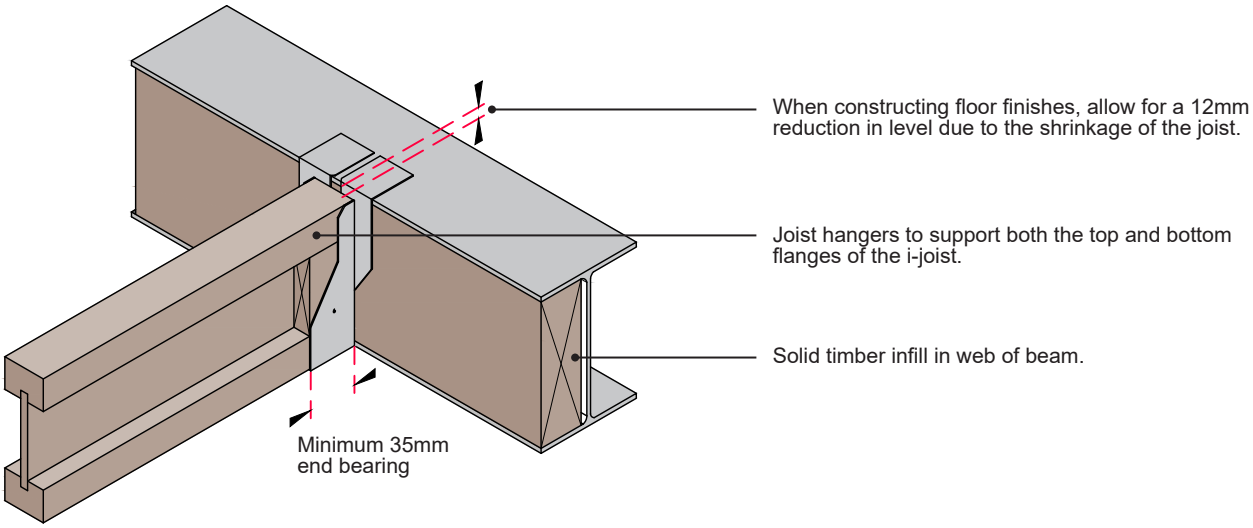


Where floor boarding continues over the floor joist and steel beam, the timber joist should finish not less than 12mm above the top of the steel beam to allow for shrinkage of the timber.

Where ceiling finishes continue across the joist and steel beam, the floor joist must extend at least 2mm below the steel beam to allow for shrinkage.

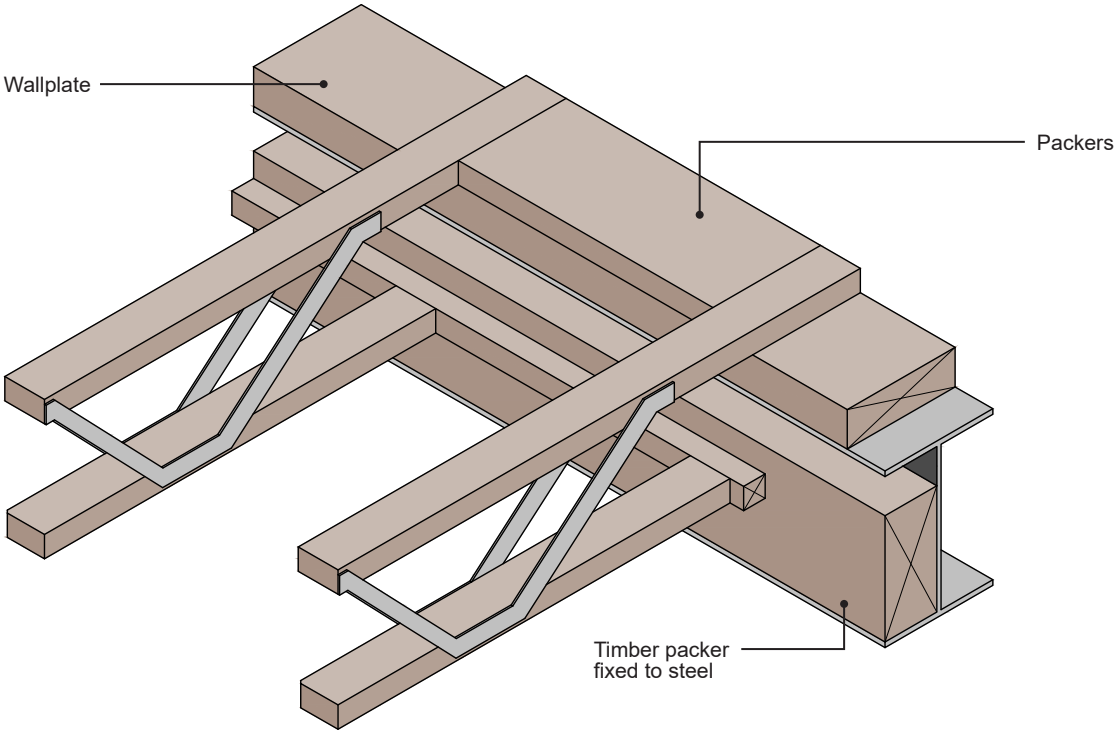
Solid timber infill in web of beam. Joists should not be notched in to the web of the steel beam.

I-joists



Metal web joists

Metal web joists may be top hung subject to the manufacturer's site specific design.



10.1.7 Strutting of timber joists

Strutting shall be provided in accordance with the design to distribute loads and ensure adequate rigidity of the floor structure.

Strutting for traditional solid timber joists and I-joists

Where traditional solid timber joists or I-Joists are specified, strutting should be provided in accordance with the following table. Where I-Joists are specified, strutting should also be in accordance with the manufacturer's recommendations.

Joist span	Rows of strutting
Up to 2.5m	None
2.5m - 4.5m	1 at midspan
Over 4.5	2 at 1/3 points of the joist span

Traditional solid timber joists

Where the span of a floor joist is more than 2.5m, strutting is necessary. This should be provided either by timber bridging or strutting in accordance BS 8103-3: 2009 or by a proprietary system.

Timber strutting can be in the form of solid bridging of at least 38mm basic thickness and with a depth equal to at least three-quarters of the depth of the joists; or it can consist of herringbone strutting with members of at least 38mm by 38mm basic size. Herringbone strutting should not be used where the distance between the joists is more than approximately three times the depth of the joists.

Proprietary strutting devices for I-joists

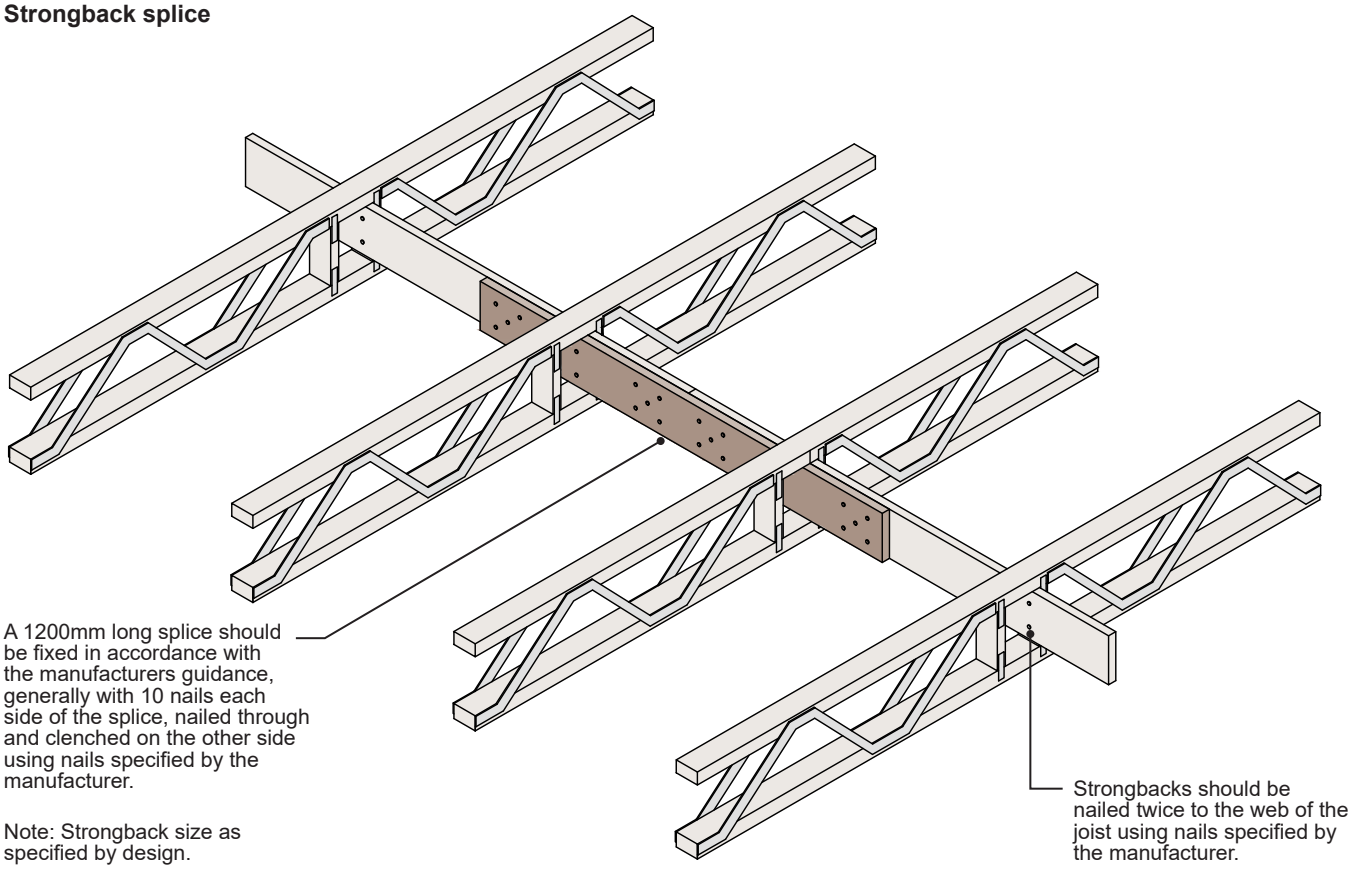
An alternative to solid strutting is Steel herringbone strutting systems, which are generally pressed lengths of galvanized mild steel, usually 1mm thickness and are produced in a variety of lengths to suit differing joist depths and spacings.

Strutting for metal web joists

Strutting to metal web joists should be provided in accordance with the manufacturer's guidance and the following table.

Joist span	Rows of strutting
4m - 8m	1 (at centre of span)
Over 8m	2 at 1/3 points of the joist span

Strongback splice



10.1.8 Lateral restraint of walls

Timber upper floors shall provide adequate lateral restraint in accordance with the design.

Walls should be adequately restrained at floors, ceilings and verges in accordance with the relevant Building Regulations. Restraint can be provided by:

- Lateral restraint straps.
- Restraint type joist hangers.
- Other forms of restraint proven by the Engineer.

Where restraint type joist hangers are specified, they should be detailed in the design, including confirmation that the joist hangers have the equivalent to restraint straps at 2m centres where required to provide restraint.

Please refer to the 'External Walls' section for further guidance.

10.1.9 Sound resistance

Internal separating floors shall, where necessary, meet the requirements for the resistance of sound in the relevant Building Regulations.

Internal separating floors shall, where necessary, meet the requirements of the relevant Building Regulations in relation to the resistance of sound and sound testing requirements.

10.1.10 Structural floor boarding

Structural floor boarding shall be:

- Suitable for the intended purpose.
- Of an adequate strength and suitably supported.
- Moisture resistant.
- Installed and fixed in accordance with the manufacturer's recommendations.

General requirements

Where structural floor boards are specified, the following should be taken into account:

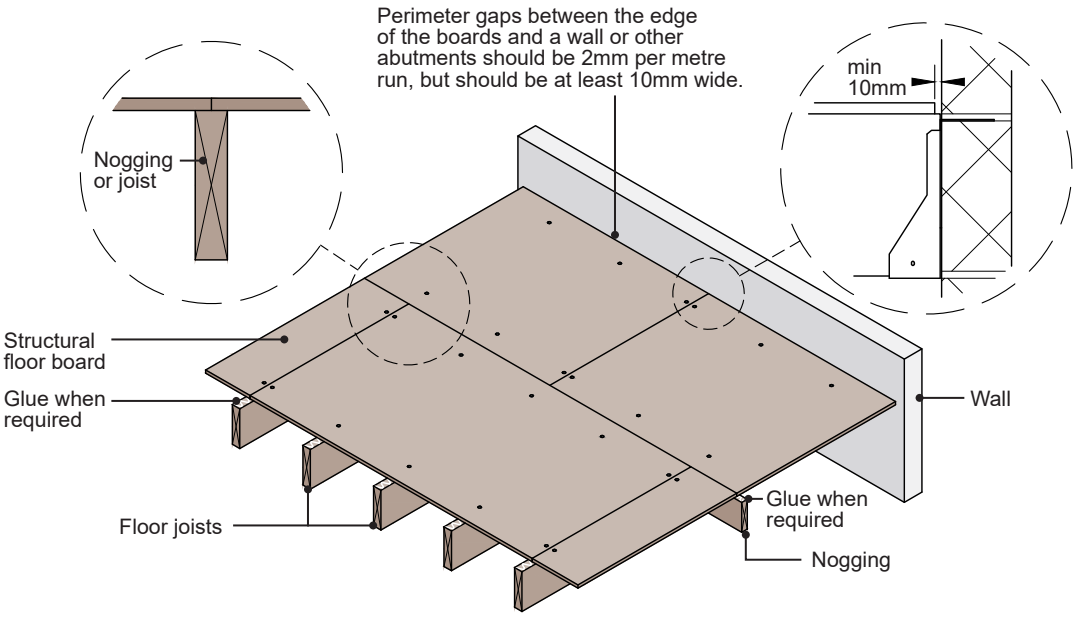
- They should be specified in accordance with the 'Minimum thickness for structural floor boards' table, guidance within this section and relevant British Standards.
- Fixings should be in accordance with the manufacturer's recommendations, where this is not provided, the guidance within this section or BS 8103-3 should be used.
- Where gluing is required, boards should be glued to the joists and between board joints, using a suitable polyvinyl acetate (PVAc) adhesive.
- Square edged boards should be supported on all edges by joists or noggings.
- Tongue and groove boards should be laid:
  - With long edges at right angles to joists.
  - So that short edges are supported on joists or noggings or they should be cut back to form a butt joint over a joist.
  - So that long edges at room perimeters are supported on a joist or noggings.
- Perimeter gaps between the edge of the boards and a wall or other abutments should be 2mm per metre run, but should be at least 10mm wide.

Protection against weather

Structural floor boards that are built in as the work proceeds and left exposed to the elements will be subjected to various issues, especially during prolonged periods of precipitation. As such, we require these floor boards for timber joists (both engineered and traditional) to have a third party approval certificate from an independent approval body which is accepted by us which covers weather resistance for the period of time the boards are to be left exposed on site.

Any boards that are left exposed beyond the period stated in the third party product conformity certificate should be replaced.

Typical floor board arrangement



Minimum thickness for structural floor boards

Structural floor boards should be specified in accordance with the following table[1].

Structural floor board type	400mm joist centres	450mm joist centres	600mm joist centres
Softwood floor boarding	16mm	16mm	19mm
Particle board (chipboard)	18mm	18mm	22mm
Oriented strand board (OSB)	15mm	15mm	18mm/19mm
Plywood boarding	15mm	15mm	18mm/19mm
[1] This table applies to normal domestic loads (imposed loads of 1.5 kN/m^2)			

Softwood floor boarding

- Softwood floor boarding should be specified in accordance with BS EN 13353 and BS 1297.
- Maximum moisture content at the time of fixing should be between 15%-19% (this may be reduced when installing in heated spaces, see BS 8103-3 for further details).
- All boards must be double nailed or secret nailed to each joist using nails that are at least three times the board depth.

Particle board (chipboard) and oriented strand board (OSB)

- Particle board should be type P5 to BS EN 312 or OSB boards should be type 3 or 4 to BS EN 300.
- Maximum moisture content at the time of fixing should be 12%.
- Flat headed annular-ringed shank nails or screws should be used.
- All fixings should be a minimum of 50 mm or 2 times the thickness of the board, whichever is greater.
- The diameter of the fixing should be a minimum of 0.16 times the thickness of the board.
- Fastenings should be spaced at centres not more than 150 mm along both continuously supported edges and 300 mm along the intermediate supports.
- Fastenings should be at least 8 mm from the edge of the board.
- Nail heads should be punched 2-3mm below the surface of the board and screws should pre-drilled and countersunk.
- Fixings in service class 2 fixings should be corrosion resistant.
- A 3 mm gap should be left between each square edge boards.

Plywood boarding

- Plywood boarding should be specified in accordance with BS EN 636.
- Maximum moisture content at the time of fixing should be 12%.
- Plywood boarding should be laid so that the grain within the face is at right angles to the supporting elements.
- Fixings should be spaced at a maximum of 150mm around the outer perimeter of the boards, with fixings a maximum of 300mm apart at intermediate supports.
- An expansion gap of a minimum of 2mm should be allowed between each panel.

Plywood boarding: Minimum fixing nails

	Plain wire nails	Annular ring shank nails
Minimum diameter	3.35mm	3mm
Minimum length	65mm	50mm
Minimum penetration	40mm	32mm

10.1.11 Plasterboard requirements

Plasterboards shall:

- Be adequately supported and fixed in accordance with the manufacturer's instructions.
- Provide an adequate surface to receive the intended finish required by the design.
- Supporting test evidence will be required where the plasterboard is intended to perform additional functions (e.g. fire or acoustic resistance).

Support of plasterboard

Supports for plasterboard should be designed so that the following span limits are not exceeded:

Board thickness	Timber support centres	Intermediate supports required	Perimeter supports required [1]
9.5mm	400mm	No	Yes
	450mm	Yes	Yes
12.5mm	400mm	No	Yes
	450mm	No	Yes
15mm	600mm	Yes	Yes
	600mm	No	Yes
[1] Fire resisting plasterboard should be fully supported at edges by noggins if the floor joist are not against the wall.			

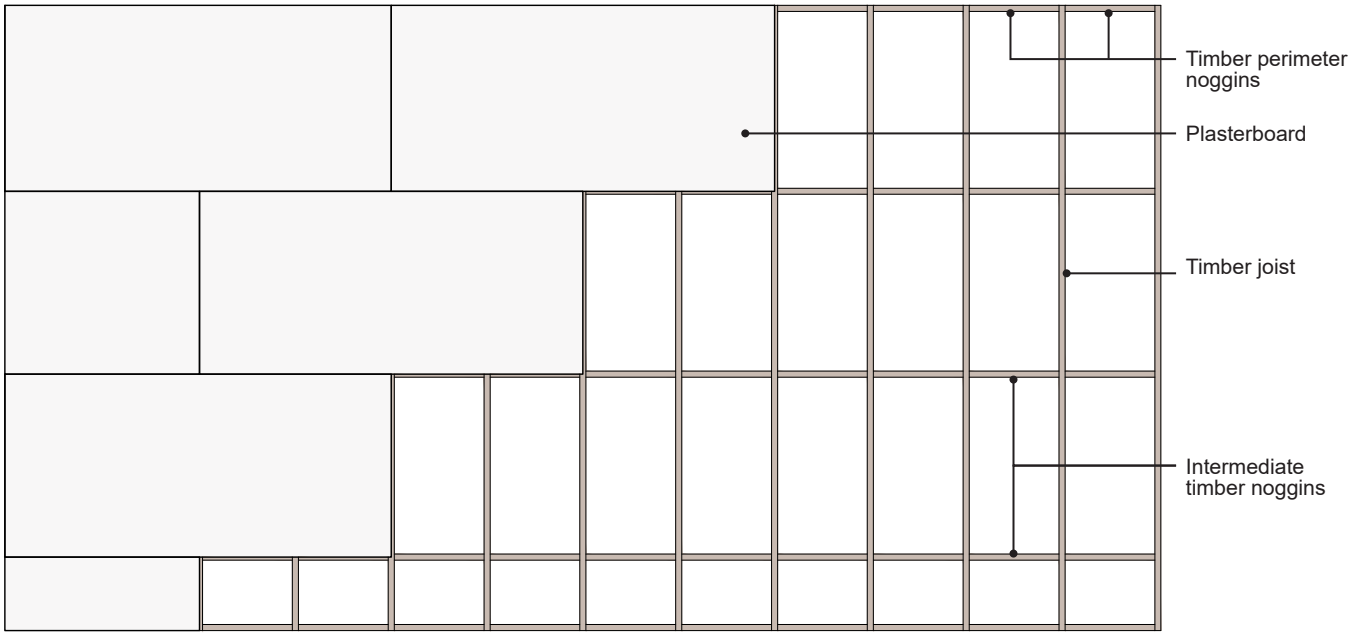
Fixing of plasterboards

When fixing plaster boarding:

- Fix boards with decorative side out to receive joint treatment or a skim plaster finish.
- Lightly butt boards together and never force boards into position.
- Install fixings no closer than 13mm from cut edges and 10mm from bound edges.
- Position cut edges to internal angles whenever possible, removing paper burrs with fine sandpaper.
- Stagger horizontal and vertical board joints between layers by a minimum of 600mm.
- Locate boards to the centre line of framing where this supports board edges or ends.
- Fix to timber joists using dry-wall screws.

Gaps between boards should not exceed 3mm and consideration should be given to sealing all gaps to improve building air tightness.

Ceiling plan - plasterboard fixed to timber joists



10.1.12 Plastering

Plastering shall provide an adequate surface to receive the intended finish as required by the design.

Plastered finishes

Workmanship of plastered finishes to ceilings should be applied to a certain standard to receive a suitable decorative finish. It should be durable enough to prevent surface cracking and, if applicable as part of the whole element, meet the required levels of fire and sound insulation in accordance with current Building Regulations.

Substrate and background

Plasterwork should be applied to suitable substrates. The substrate may also require additional sealing or bonding agents, in accordance with the requirements set out in BS 8481.

Plaster mixes

Plaster mix ratios should be in accordance with manufacturer's recommendations and be appropriate for the intended use.

Minimum plaster thicknesses

The thickness of plaster will vary depending on the evenness of the substrate. The finished element must meet the tolerances identified in this Technical Manual, and be of a suitable quality so that a decorative finish can be applied. Minimum thickness should be in accordance with the table below.

Element	Minimum number of coats	Typical thickness
Ceiling – plasterboard	1	Skim to provide suitable and durable finish