

Chapter 6.4



Timber and concrete upper floors

This chapter gives guidance on meeting the Technical Requirements for timber and concrete upper floors.

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6.4.1 Compliance

Also see: Chapter 2.1

Timber and concrete upper floors shall comply with the Technical Requirements.

Timber and concrete upper floors that comply with the guidance in this chapter will generally be acceptable.

6.4.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to appropriate personnel.

Design and specification information should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- direction of floor span, and size and spacing of joists or concrete components
- size of trimmers and trimming joists
- position of strutting
- detailing of openings in the floor
- supporting walls below
- walls and partitions above
- positions of restraint straps
- positions of large service penetrations, eg chimneys and SVPs
- position of insulation
- details of all junctions
- manufacturers' recommendations for assembly and fixing of proprietary components
- detailing for acoustic and fire separation where floor forms a compartmentation between dwellings.

6.4.3 Upper floor design

Also see: Chapter 6.5

Upper floors shall support and transmit loads safely to the supporting structure without undue deflection or deformation. Issues to be taken into account include:

- 1) loads and support to partitions
- 2) steelwork
- 3) support of external envelope and projections.

6.4.3.1 Loads and support to partitions

Structural design of timber and concrete upper floors should be in accordance with BS EN 1991-1-1.

The design of upper floors should account for dead loads, including:

- floor structure, decking and finishes
- ceilings and applied finishes
- walls and partitions supported by the floor
- permanent fixtures such as boilers, watertanks, etc.

Imposed loads should be calculated in accordance with the relevant British Standards, including BS EN 1991-1-1 which recommends:

- 1.5kN/m² for self-contained homes
- values for communal areas serving flats or maisonettes.

Bearers or additional joists should be used to support heavy loads.

Joists built into separating walls may provide lateral support, and should be detailed to ensure that sound insulation and fire resistance requirements are met.

Masonry partitions

Where first floor masonry partitions cannot be built directly in line with ground floor masonry walls, steel or reinforced concrete support should be specified. Masonry should not be supported on timber or engineered joists.

Lightweight partitions

Where multiple solid timber joists support lightweight non load-bearing partitions which are parallel to the joists, they should be suitably fixed together. Where I-joists and metal web joists are used, they should:

- be positioned centrally below a non load-bearing partition and, where necessary, additional joists should be doubled or tripled in accordance with the designer's and manufacturer's recommendations
- support the weight of the non load-bearing partition by noggings or bearers fixed to the joists on either side. Unless designed otherwise, noggings should be a minimum 38mm x 90mm minimum at 600mm centres and fixed with metal clips. The sole plate of the non load-bearing partition should be fixed to the noggings (see Figures 1 and 2), or
- be in accordance with the manufacturer's recommendations.

Figure 1: Support of non-loadbearing partition on I-joisted floors

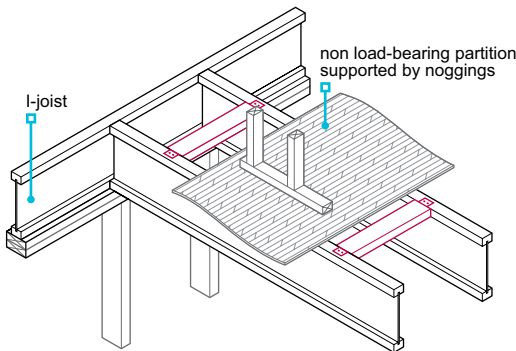
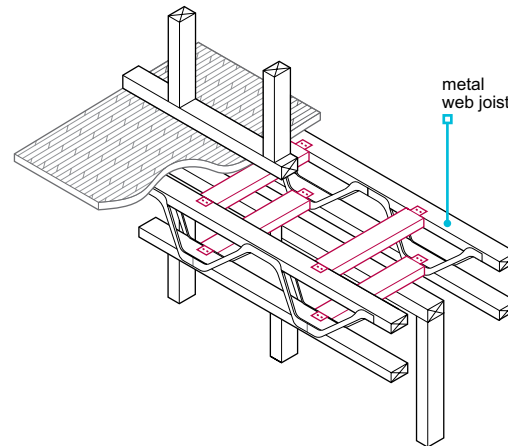


Figure 2: Support of non-loadbearing partition on metal web joisted floors



6.4.3.2 Steelwork

Steelwork supporting upper floor should be:

- designed by an engineer in accordance with Technical Requirement R5 and comply with Chapter 6.5 Steelwork
- sized to allow an adequate bearing of the floor system.

Structural continuity of the floor should be provided by the use of continuous decking fixed to joists on both sides of a transverse steel joist.

Steel beams should be protected by a suitably durable paint coating as detailed in Chapter 6.5 Steelwork.

6.4.3.3 Support of external envelope and projections

Deflection of concrete upper floors should be adequately designed, monitored and controlled to ensure it does not adversely affect its proper functioning or appearance.

Particular attention should be paid to edges of upper floors in flat slab constructions or floors without edge beams spanning over 5m.

Where upper floors are required to support balconies and/or masonry support systems, and horizontal joints are to be provided as part of the external envelope of a framed building, they should be suitably designed and detailed to cater for both thermal and moisture movements of the envelope, in addition to any residual floor deflection that may be expected from the supporting structure. The concrete floor, together with any associated horizontal (eg masonry) movement joint it supports, should be appropriately designed, taking into consideration the following:

- floor deflection behind the cladding/envelope/balcony
- building elevation and load paths
- cladding (eg masonry) support system deflections
- elastic shorting of structural columns and walls
- cladding (eg masonry) joint details
- building sway.

Further guidance on horizontal movement joints in masonry can be found in Chapter 6.1 External masonry walls.

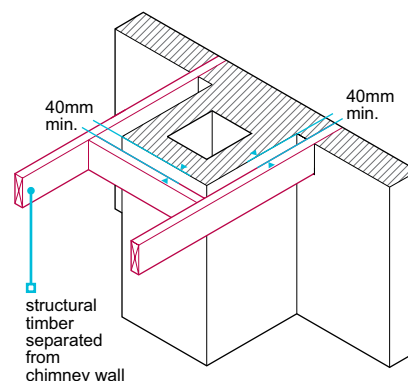
6.4.4 Fire spread

Adequate fire resistance and fire-stopping shall be provided by floors between homes and at penetrations. Upper floors shall be constructed to ensure structural timber is located away from heat sources.

Floors and ceilings should:

- comply with the relevant Building Regulations and Technical Requirement R3
- be in accordance with the design
- have adequate fire-stopping
- be able to resist the passage of smoke when the fire-stopping has been installed.

Figure 3: Minimum distances between timber floor and heat sources like chimneys



Timber

To counteract fire spread:

- combustible material should be kept away from heat sources
- structural timber should be separated from sources of heat in accordance with Chapter 6.8 Fireplaces, chimneys and flues.

Ancillary product

Where ceilings of intermediate floors in houses, or compartment floors in flats/apartments, are perforated or penetrated by services such as recessed light fittings (downlighters), ceiling-mounted air valves, vents, and extractor fans and pipes, the floor construction should still achieve the required period of fire resistance.

When installing such ancillary products and/or services, including their fire-stopping elements and intumescent seals used to maintain the fire resistance of the floor, one of the following should be met:

- a satisfactory fire test evidence and/or extended field of application reports that support the use of such products/systems in the particular type of floor being considered, or
- products and systems with a satisfactory assessment by an appropriate independent technical approvals authority accepted by NHBC covering the particular type of floor being considered, or
- a proprietary floor system with satisfactory assessment by an appropriate independent technical approvals authority accepted by NHBC which includes the use of a specific floor type and ancillary products which have been demonstrated to be satisfactory through testing and assessment, and are to be used within the limitations of the certification.

6.4.5 Sound insulation

Upper floors shall be constructed to ensure that sound transmission is adequately limited.

Timber upper floors should comply with Building Regulations and Chapter 9.3 Floor finishes.

6.4.6 In-situ concrete floors and concreting

In-situ concrete upper floors shall be adequately reinforced and of a mix which is suitable for the location and intended use, and appropriately constructed.

Concrete floors should:

- comply with BS EN 1992-1-1 and Chapter 3.1 Concrete and its reinforcement
- comply with the design
- be reasonably level and smooth, especially at doorways and junctions
- be in accordance with Technical Requirement R3 where proprietary elements are used.

6.4.7 Precast concrete

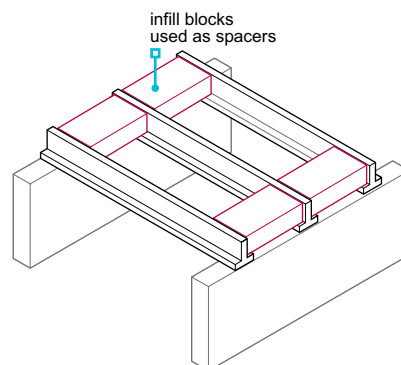
Precast concrete upper floors shall be erected in accordance with the design.

Precast concrete flooring systems should be in accordance with Technical Requirement R3, applicable product standards and BS EN 1992-1-1.

For precast concrete beam and block systems:

- details of the manufacturer's assembly instructions and any independent certification should be available on site and followed
- beams, planks or infill blocks that are damaged should not be used
- adequate support should be provided until design strength is reached
- joints should be grouted in accordance with the manufacturer's recommendations.

Figure 4: Use of infill blocks as spacers



Bearings should be:

- solid and level
- 90mm minimum on masonry (open frogs in brickwork should be filled)

The setting out of beam and block floors should:

- ensure correct spacing between beams, using infill blocks as spacers (see Figure 4)
- be in accordance with the design

Infill blocks should:

- be omitted or cut where necessary to allow for services

Where floors rely on structural topping or in-situ make-up sections, propping may be needed until the in-situ concrete has reached design strength.

Trimmed openings

Where voids in precast concrete floors are to be trimmed:

- specifications and drawings should be followed
- steel trimmer shoes may be used.

Double beams, common around trimmed openings, should be adequately supported until all voids have been solidly concreted and the concrete has reached its design strength.

Restraint straps and ties

Straps:

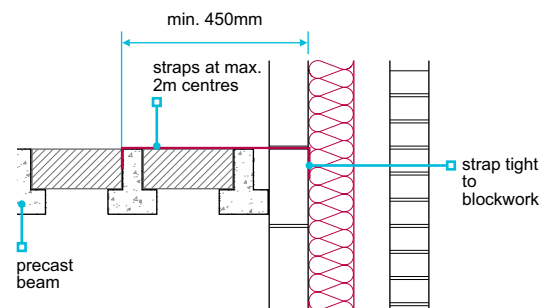
- should be shown in the design
- are generally required where beams run parallel with the wall (see Figure 5).

- 75mm minimum on steelwork.

- allow for additional beams where required to support concentrated loads such as partitions.

- be cut carefully and neatly without damage (not using a hammer and bolster).

Figure 5: Strapping of floor spanning parallel to wall



6.4.8 Timber joist spans

Timber floor joists shall be adequate for the spans and loads, and be correctly installed.

Solid timber joist sizes are provided in the BS 8103-3 span tables. Where the tables do not apply, or where there are concentrated loads, floor joists should be designed by an engineer in accordance with Technical Requirement R5.

Span tables for solid timber joists

Tables 1 and 2 in this chapter are derived from the BM TRADA Technology Ltd. Eurocode 5 span tables for solid timber members in floors, ceilings and roofs for dwellings (4th edition). Tables 1 and 2 give permissible clear spans of simply supported domestic floor joists of solid timber for specified loadings, sizes and spacings calculated in accordance with EC5. The tables make no allowance for concentrated or line loads applied by partitions, trimmers or other similar loads. The minimum bearing length assumed for the tables is 40mm unless noted otherwise, and longer bearing lengths may be required for other practical reasons. The section sizes are based on regularised ALS or CLS timber.

For timber floors between homes (compartment floors):

- to meet acoustic performance, the dead load of the construction of up to 1.25kN/m² may be assumed
- use the three right-hand columns from Tables 1 and 2.

For upper floors with 22mm thick chipboard decking and a 12.5mm plasterboard ceiling:

- a dead load of up to 0.5kN/m² may be assumed
- use the centre three columns from Tables 1 and 2.

Where lightweight non load-bearing partitions weigh up to 1.0kN (101.9kg) per metre run and are parallel to the joists, the following applies:

- partitions may be directly supported by one or two additional joists
- partitions should be fixed through the floor decking into the joist(s) beneath
- where similar lightweight partitions run at right-angles to the joists, the maximum spans in Tables 1 and 2 should be reduced by 10%
- for all other additional loads, joist sizes should be designed by an engineer in accordance with Technical Requirement R5.

Table 1: Permissible clear spans for domestic floor joists. Strength class C16

Imposed load not exceeding $q_k = 1.5 \text{ kN/m}^2$ or $Q_k = 2.0 \text{ kN}$. Service class 1 or 2.

Dead load g_k (kN/m ²) excluding self-weight of joist											
Size of joist		gk not more than 0.25			gk not more than 0.50			gk not more than 1.25			
		Joist spacing (mm)									
		400	450	600	400	450	600	400	450	600	
Breadth (mm)	Depth (mm)	Maximum clear span (m)									
38	95	1.71*	1.62	1.40	1.61	1.52	1.32	1.40	1.33	1.16	
38	120	2.37*	2.24*	1.95	2.19*	2.08*	1.82	1.87	1.78	1.56	
38	145	2.86*	2.75*	2.49	2.69*	2.59*	2.33	2.35	2.23	1.97	
38	170	3.34*	3.21*	2.91	3.15*	3.03*	2.74	2.75	2.64	2.39	
38	195	3.83*	3.68*	3.34	3.61*	3.47*	3.14	3.15	3.03	2.73	
38	220	4.31*	4.14*	3.76	4.06*	3.90*	3.54	3.55	3.41	3.08	
44	95	1.84*	1.74	1.51	1.72	1.63	1.42	1.50	1.42	1.24	
44	120	2.49*	2.39*	2.09	2.33*	2.22*	1.95	1.99	1.89	1.67	
44	145	3.00*	2.89*	2.62	2.83*	2.72*	2.46	2.47	2.37	2.10	
44	170	3.51*	3.38*	3.06	3.31*	3.18*	2.88	2.89	2.78	2.51	
44	195	4.02*	3.86*	3.51	3.79*	3.64*	3.30	3.32	3.18	2.88	
44	220	4.52*	4.35*	3.95	4.26*	4.10*	3.72	3.73	3.59	3.25	
47	95	1.90*	1.79	1.56	1.77	1.68	1.47	1.54	1.46	1.28	
47	120	2.55*	2.45*	2.16	2.40*	2.28*	2.01	2.05	1.95	1.72	
47	145	3.07*	2.95*	2.68	2.89*	2.78*	2.52	2.53	2.43	2.16	
47	170	3.59*	3.45*	3.13	3.38*	3.25*	2.95	2.96	2.84	2.57	
47	195	4.10*	3.95*	3.59	3.87*	3.72*	3.38	3.39	3.26	2.95	
47	220	4.62*	4.44*	4.04	4.36*	4.19*	3.81	3.82	3.67	3.32	
63	95	2.17*	2.06*	1.80	2.02*	1.92	1.68	1.74	1.66	1.47	
63	120	2.80*	2.70*	2.45	2.64*	2.54*	2.29	2.30	2.20	1.95	
63	145	3.38*	3.25*	2.96	3.19*	3.07*	2.79	2.79	2.68	2.43	
63	170	3.94*	3.80*	3.46	3.72*	3.58*	3.26	3.27	3.14	2.85	
63	195	4.51*	4.34*	3.95	4.26*	4.10*	3.73	3.74	3.60	3.26	
63	220	5.07*	4.88*	4.45	4.79*	4.61*	4.20	4.21	4.05	3.68	
72	120	2.93*	2.82*	2.56	2.76*	2.66*	2.42	2.42	2.32	2.06	
72	145	3.52*	3.39*	3.09	3.33*	3.20*	2.91	2.92	2.81	2.55	
72	170	4.11*	3.96*	3.61	3.89*	3.74*	3.41	3.42	3.29	2.98	
72	195	4.70*	4.53*	4.13	4.44*	4.28*	3.90	3.91	3.76	3.41	
72	220	5.28*	5.09*	4.65	5.00*	4.82*	4.39	4.40	4.23	3.85	
ALS/CLS											
38	89	1.56	1.47	1.27	1.47	1.39	1.21	1.29	1.22	1.07	
38	114	2.21*	2.09*	1.82	2.05*	1.94	1.70	1.76	1.67	1.47	
38	140	2.76*	2.65*	2.40	2.60*	2.50*	2.23	2.25	2.14	1.89	
38	184	3.61*	3.47*	3.15	3.41*	3.27*	2.97	2.98	2.86	2.58	
38	235	4.60*	4.42*	4.01	4.33*	4.17*	3.78	3.79	3.64	3.29	
89	184	4.74*	4.57*	4.18	4.49*	4.33*	3.95	3.96	3.81	3.46	
89	235	6.00*	5.79*	5.30	5.69*	5.49*	5.01	5.03	4.84	4.41	

* Two additional joists required
Bold text = normal bearing increased to 50mm

Table 2: Permissible clear spans for domestic floor joists. Strength class C24

Imposed load not exceeding $q_k = 1.5 \text{ kN/m}^2$ or $Q_k = 2.0 \text{ kN}$. Service class 1 or 2.

Dead load g_k (kN/m ²) excluding self-weight of joist											
Size of joist		gk not more than 0.25			gk not more than 0.50			gk not more than 1.25			
		Joist spacing (mm)									
		400	450	600	400	450	600	400	450	600	
Breadth (mm)	Depth (mm)	Maximum clear span (m)									
38	95	1.99*	1.89*	1.64	1.86*	1.76	1.54	1.61	1.53	1.34	
38	120	2.64*	2.54*	2.27	2.49*	2.39*	2.11	2.14	2.03	1.80	
38	145	3.18*	3.06*	2.78	3.00*	2.88*	2.61	2.62	2.52	2.26	
38	170	3.72*	3.58*	3.25	3.51*	3.37*	3.06	3.07	2.95	2.67	
38	195	4.26*	4.10*	3.72	4.02*	3.86*	3.51	3.52	3.38	3.06	
38	220	4.79*	4.61*	4.19	4.52*	4.35*	3.95	3.96	3.81	3.45	
44	95	2.14*	2.02*	1.76	1.99*	1.89	1.65	1.71	1.63	1.44	
44	120	2.77*	2.67*	2.42	2.61*	2.51*	2.25	2.27	2.16	1.92	
44	145	3.34*	3.21*	2.92	3.15*	3.03*	2.75	2.76	2.65	2.40	
44	170	3.90*	3.76*	3.42	3.69*	3.54*	3.22	3.23	3.10	2.81	
44	195	4.47*	4.30*	3.91	4.22*	4.06*	3.68	3.70	3.55	3.22	
44	220	5.02*	4.84*	4.40	4.75*	4.57*	4.15	4.16	4.00	3.63	
47	95	2.20*	2.08*	1.82	2.05*	1.94	1.70	1.76	1.68	1.48	
47	120	2.83*	2.73*	2.48	2.67*	2.57*	2.32	2.33	2.22	1.97	
47	145	3.41*	3.28*	2.98	3.22*	3.10*	2.81	2.82	2.71	2.45	
47	170	3.99*	3.84*	3.49	3.77*	3.62*	3.29	3.30	3.17	2.87	
47	195	4.56*	4.39*	4.00	4.31*	4.15*	3.77	3.78	3.63	3.29	
47	220	5.13*	4.94*	4.50	4.85*	4.67*	4.24	4.26	4.09	3.71	
63	95	2.52*	2.43*	2.14	2.38*	2.26*	1.99	2.03	1.94	1.72	
63	120	3.11*	2.99*	2.72	2.94*	2.83*	2.57	2.57	2.47	2.22	
63	145	3.74*	3.60*	3.28	3.54*	3.40*	3.09	3.10	2.98	2.70	
63	170	4.37*	4.21*	3.84	4.13*	3.98*	3.62	3.63	3.49	3.17	
63	195	5.00*	4.81*	4.39	4.72*	4.55*	4.14	4.15	4.00	3.62	
63	220	5.61*	5.41*	4.94	5.31*	5.12*	4.66	4.68	4.50	4.08	
72	120	3.25*	3.13*	2.85	3.07*	2.96*	2.69	2.70	2.59	2.35	
72	145	3.91*	3.77*	3.44	3.70*	3.56*	3.24	3.25	3.13	2.84	
72	170	4.57*	4.40*	4.02	4.32*	4.16*	3.79	3.80	3.66	3.32	
72	195	5.22*	5.03*	4.59	4.94*	4.76*	4.34	4.35	4.19	3.81	
72	220	5.86*	5.65*	5.17	5.55*	5.35*	4.88	4.90	4.71	4.29	
ALS/CLS											
38	89	1.82*	1.72	1.50	1.71	1.62	1.41	1.49	1.41	1.24	
38	114	2.51*	2.41*	2.12	2.36*	2.24*	1.97	2.01	1.91	1.69	
38	140	3.07*	2.96*	2.68	2.90*	2.79*	2.53	2.53	2.43	2.17	
38	184	4.02*	3.87*	3.52	3.79*	3.65*	3.31	3.32	3.19	2.89	
38	235	5.11*	4.92*	4.47	4.83*	4.64*	4.22	4.23	4.06	3.68	
89	184	5.26*	5.08*	4.64	4.98*	4.81*	4.39	4.40	4.24	3.86	
89	235	6.65*	6.42*	5.88	6.31*	6.09*	5.57	5.58	5.38	4.90	

* Two additional joists required
Bold text = normal bearing increased to 50mm

6.4.9 Timber joist performance

Also see: Chapter 3.3

Floor joists shall be of an appropriate size and quality, and be suitably durable.

I-joists and metal web joists should not be used in situations where any part of the joist is exposed to external conditions, and be:

- in accordance with Technical Requirement R3
- used in accordance with the manufacturer's recommendations
- protected from adverse weather conditions during transport and storage
- stored clear of the ground and stacked vertically
- not used where damaged
- designed in accordance with BS EN 1995-1-1 and its UK National Annex.

Instantaneous deflection of floor joists should be:

- no more than $0.003 \times$ the span for the combined bending and shear based on the total dead and imposed loads, with a maximum deflection of 14mm where strutting is provided, or 12mm where strutting is not provided.

Floors formed by the bottom chords of attic trusses are required to meet the above guidance.

Structural solid timber joists should be specified according to the strength classes in BS EN 338, eg C16 or C24, and marked with:

- the strength class, or evidence of species and grade made available so as to determine the strength class
- the identification of the company responsible for the grading (when graded to BS 4978 or BS EN 14081).

When graded to BS 4978:

- the species should be included in accordance with BS EN 1912 or the class strength specified
- BS EN 338 can be used to determine strength class.

Regularised timber should be used for solid timber joists, and be:

- dry graded to BS 4978 or BS EN 14081
- marked 'DRY' or 'KD'.

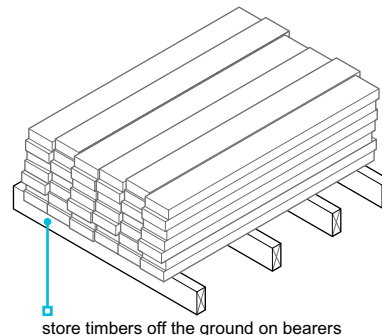
Materials should be checked on delivery for conformity with the design.

Joists should be stored on bearers or in racks and be protected (see Figure 6).

Timber should not be used where:

- it is excessively bowed, twisted or cambered
- it has large edge knots or shakes
- it has a wane edge more than half the thickness
- it is damaged or has any sign of rot.

Figure 6: Timber stored on bearers clear off the ground



6.4.10 Construction of timber floors

Also see: Chapter 3.3

Upper floors shall be constructed in a workmanlike manner and provide satisfactory performance.

Issues to be taken into account include:

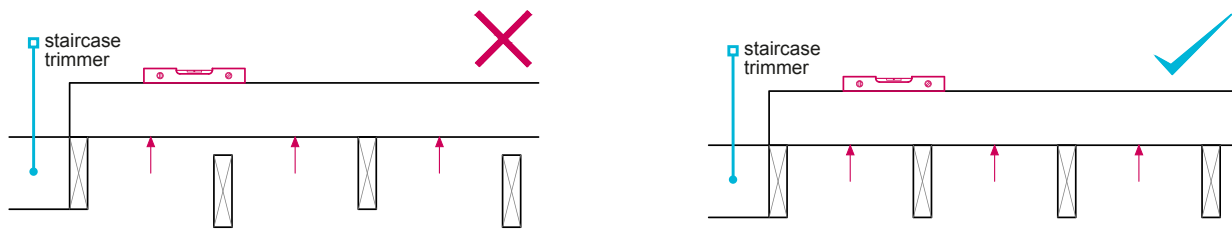
- 1) levelling
- 2) joist spacing and clearance
- 3) support.

6.4.10.1 Levelling

Bearings for joists should be level. The floor should be levelled:

- from the staircase trimmer and trimming joist
- using hard packing; loose or soft packing should not be used.
- in accordance with the manufacturer's recommendations

Figure 7: Level bearing of floor joists



6.4.10.2 Joist spacing and clearance

Joist spacing should:

- be in accordance with the design and not increased
- account for the decking material to be used
- be a maximum of 600mm
- have a clearance of 25mm–75mm between the first joist and the wall face to aid the installation of services and the fixing of floor decking.

6.4.10.3 Support

The floor should have an adequate bearing on the supporting structure.

Timber joists should normally have a minimum bearing as shown in Table 3.

Table 3: Support of joists

Type of timber joist	Minimum bearing (mm)	
	End support	Intermediate support
Solid joist on masonry walls	90 (75)	90 (75)
Solid joist on timber wall plate	75	75
I-joist	90 (45)	90
Metal web joist	90 (45)	90

The figures in brackets should only be used when the joist is not providing restraint to the wall.

Joists may be:

- supported on joist hangers or on internal load-bearing walls
- built into the inner leaf of an external cavity wall, with care taken to ensure airtightness.

Where joists are built into separating walls, fire- and sound-resisting performance, in accordance with Building Regulations, should be taken into account.

I-joists and metal web joists

Where engineered joists are built into the inner leaf of a cavity wall, only proprietary products should be used to seal the gap between the sides of the joists and the masonry. Expanding foam fill should not be used or relied upon for this purpose.

I-joists and metal web joists should not be built into solid external walls.

The support reaction, due to dead and imposed loads on the floor, should not exceed the recommended value specified by the manufacturer.

Where there are concentrated loads:

- web stiffeners should be used for I-joists (see Figure 9)
- uprights between the flanges, held in place by punched metal plate fasteners or bottom chord (flange) support, should be used for metal web joists (see Figure 10)
- the manufacturer's recommendations should be followed.

Figure 8: Typical engineered floor joists

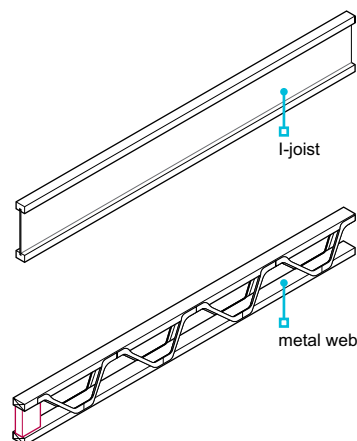


Figure 9: Typical web stiffeners on I-joists

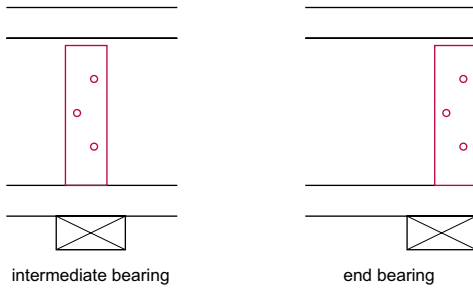
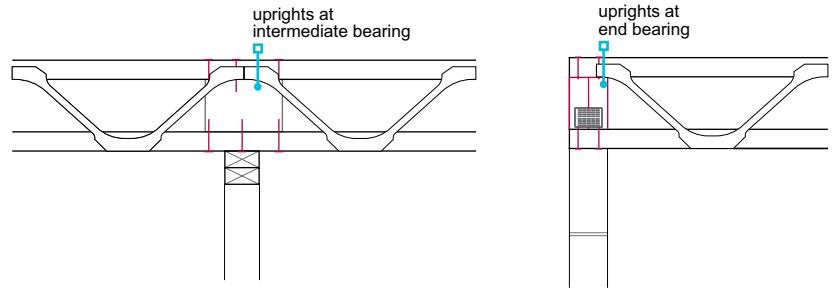


Figure 10: Typical bearing stiffeners on metal web joists



Where joists are supported on walls, noggings may be required at the top flange along the wall to support the floor decking, and at the bottom flange to support the plasterboard ceiling. Where joists are not built into brickwork or blockwork, blocking should be provided at the joist bearing (see Figures 11 and 12). The blocking may be used for fixing plasterboard and floor decking.

Figure 11: Blocking to restrain top flange of metal web joists

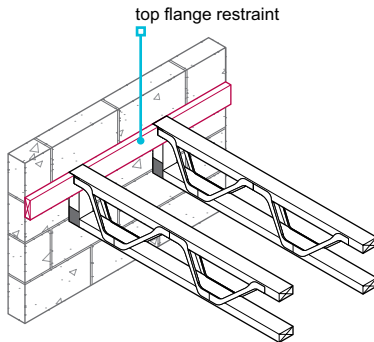
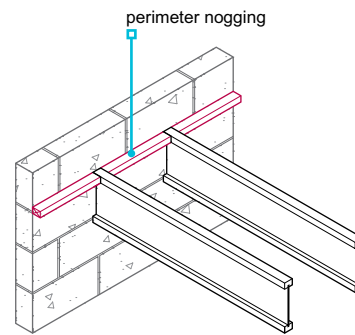


Figure 12: Blocking to restrain top flange of I-joists



6.4.11 Joists supported by intermediate walls

Joists shall be properly fixed at intermediate load-bearing walls.

Solid timber joists

Solid timber joists bearing onto intermediate load-bearing walls (see Figure 13) should:

- be nailed together where they overlap
- not project more than 100mm.

I-joists

I-joists bearing onto intermediate load-bearing walls (see Figure 14) should have:

- blocking used to brace the butt joint
- short sections of joist used to provide lateral support.

Metal web joists

Metal web joists bearing onto intermediate load-bearing walls (see Figure 15) should:

- have a minimum 90mm bearing
- be overlapped.

Figure 13: Solid joists supported on internal load-bearing wall

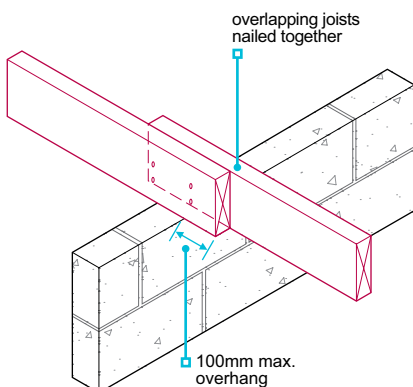


Figure 14: I-joists supported on internal load-bearing wall

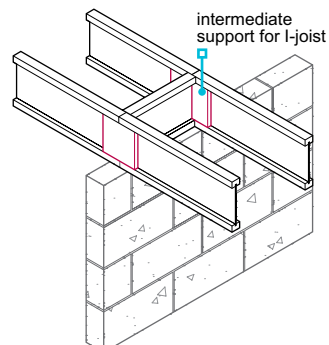
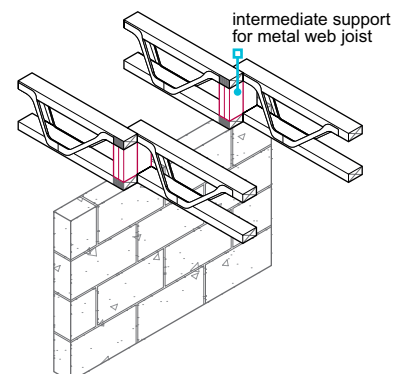


Figure 15: Metal web joists supported on internal load-bearing wall



6.4.12 Joists connected to steel

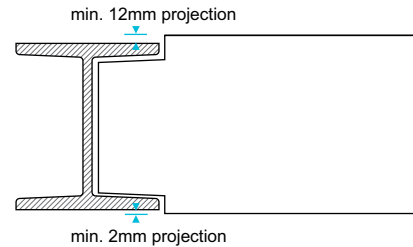
Joists shall be suitably connected to steelwork.

Solid timber joists

Where connected to steel beams, solid timber joists should:

- be deep enough to be notched
- have 12mm top and 2mm bottom projections to allow for timber shrinkage (see Figure 16)
- be provided with strutting to prevent rotation (see Figure 17).

Figure 16: Notching of solid timber joist into steel beam



I-joists

Where connected to steel beams, I-joists should not be notched at the flange, and should:

- bear directly into the steel beam where the bearing is more than 45mm. Strutting, (noggings 38mm x thickness of flange) should be provided at the top and bottom flanges, or
- have blocking fixed to the steel beam to enable the I-joists to be face fixed using joist hangers. Strutting is not required when hangers the full depth of the joist are used to face fix joists to the blocking (see Figure 18).

Metal web joists

Where connected to steel beams, metal web joists should not be notched at the flange, and should:

- bear directly into the bottom flange of the steel beam where the bearing is more than 75mm. There should be timber uprights between the flanges and 38mm x 97mm noggings between the uprights
- where the bearing is less than 75mm, the joist can be supported on the top flange with the bottom flange fixed to timber blocking supported inside the steel beam (see Figure 19).

Figure 17: Strutting of solid joists notched into steel beam

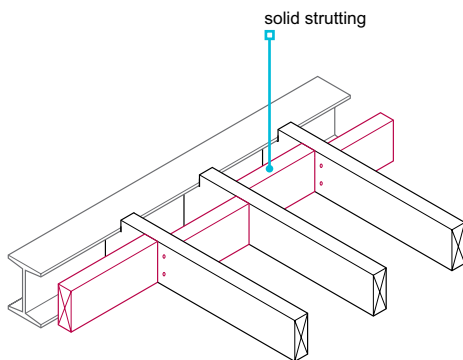


Figure 18: I-joist supported on timber blocking fixed to web of steel beam

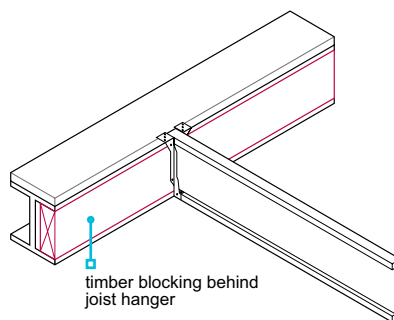
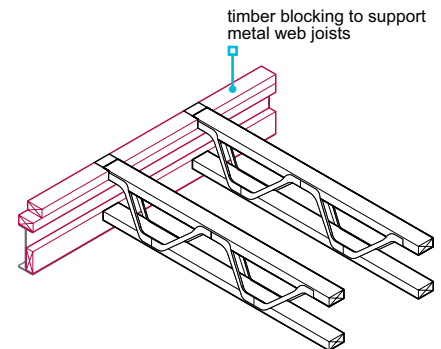


Figure 19: Metal web supported on top flange of steel beam



6.4.13 Joists into hangers

Joist hangers shall provide a suitable bearing on the supporting structure and be of an adequate size, strength and durability.

Masonry supporting joist hangers should be checked for level and height. The top flange loading on the joist hanger should not be greater than the strength of the supporting masonry. Where joist hangers are supported on lightweight blockwork, the suitability of the hanger should be checked. Joist hangers which meet BS EN 845-1 have a stamp indicating the minimum compressive strength of block for which they are suitable.

Hangers should:

- be detailed in the design, including the type of support to be used for joists, trimmers and trimming joists (see Figure 20)
- have a 75mm minimum bearing on masonry
- comply with BS EN 845-1 or another acceptable clause described in Technical Requirement R3
- have performance equivalent to restraint straps at 2m centres where required to provide restraint
- be the correct size for the joist or trimmer
- be nailed through each circular hole in the vertical sides
- bear on level beds and be tight to the wall
- not be cut into the walling.

Joists should be accurately cut to length. Where joists are not built into brickwork or blockwork, blocking should be provided at the joist bearing (see Figure 22). The blocking may be used for fixing plasterboard and floor decking.

Solid joists

Where connected to hangers, solid timber joists should:

- have a minimum bearing of 75mm onto the hanger
- be notched into the hanger to keep the ceiling line level (see Figure 21)
- be the full depth of the hanger.

I-joists

Where connected to hangers, I-joists should not be notched at the flange, and should have:

- a minimum bearing of 45mm onto the hanger
- the tabs of the hanger bent and nailed to the bottom flange (see Figure 23).
- at least 0.6 x the depth of the joist and have stiffeners (full depth) fixed to both sides of the web.

Metal web joists

Where connected to hangers, metal web joists should not be notched at the flange, and should have:

- a minimum bearing of 75mm onto the hanger
- timber uprights fixed between the flanges.

Hangers should be to the full depth of the joist and restrain the top flange, or another suitable means of restraining the top flange should be provided (see Figure 24).

Figure 20: Types of joist hangers

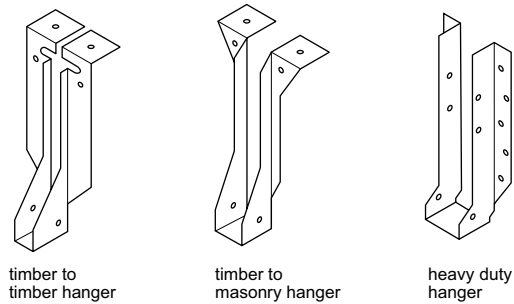


Figure 21: Solid timber joist supported on hanger

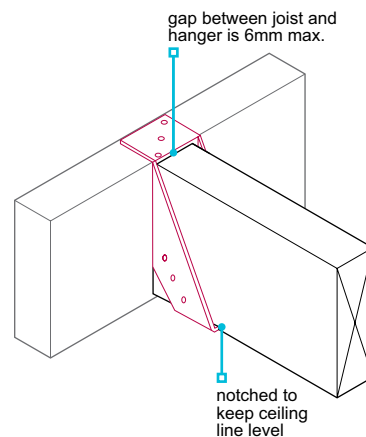


Figure 22: Blocking of solid joists supported on hanger

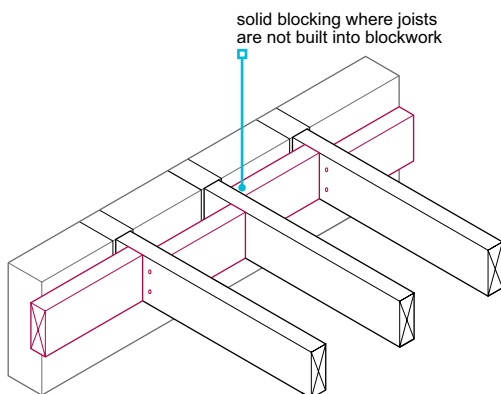


Figure 23: I-joist supported on hanger

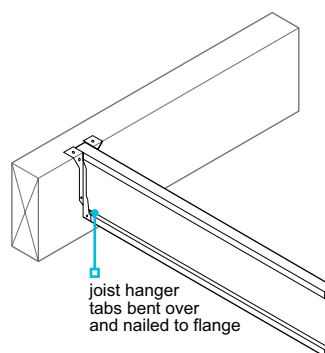
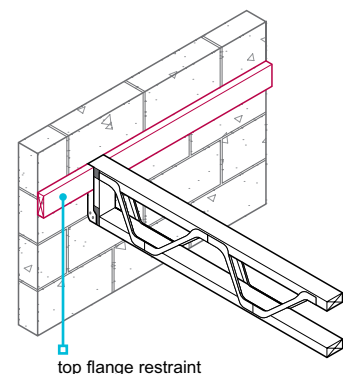


Figure 24: Blocking of metal web joists supported on hanger



6.4.14 Timber joist and restraint straps

Also see: Chapter 6.1 and BS 8103-1

Upper floors shall provide adequate lateral restraint.

Restraint straps and joist hangers suitable for taking tensile forces may be required to tie walls and upper floors together, or when the external wall is stabilised by a connection to the floor. Straps (see Figures 25 and 26) should:

- be detailed in the design, including the size, position and fixings
- be galvanised steel with a 30mm x 5mm cross-section or be in accordance with Technical Requirement R3
- have adequate packing between the wall and the first joist
- bear on the centre of bricks or blocks and not on mortar joints
- be fixed on the side, top or bottom, as appropriate to the joist type.

Figure 25: Side fixing of restraint straps to floor joists

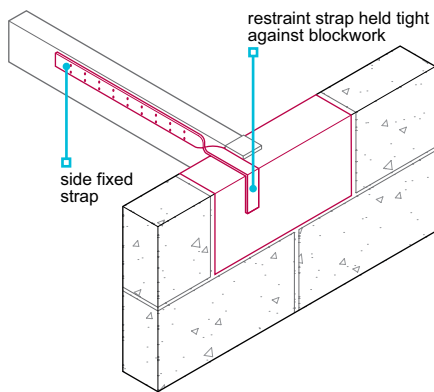
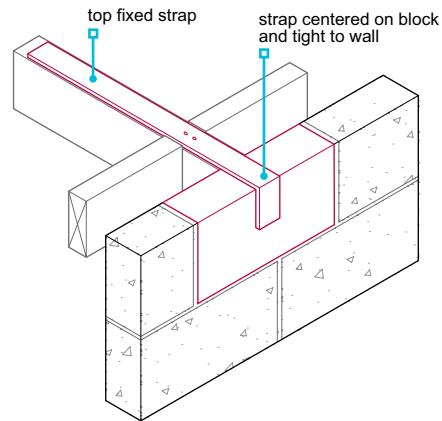


Figure 26: Top fixing of restraint straps to floor joists



Restraint straps should be provided along the direction of the joists and spaced at a maximum of 2m centres (see Figure 27). They are not generally required at the ends of joists in buildings up to, and including, two storeys where:

- restraint type joist hangers in accordance with Technical Requirement R3 are used, or
- joists are built into a wall and bear at least 90mm on the wall.

Where joists run parallel to the wall, straps should be fitted along the joists with a maximum spacing of 2m (see Figure 28) and:

- be supported on noggings and extend over at least three joists
- be fixed with two screws or nails into each joist
- have noggings provided to receive two additional nails (for solid joists, two 4.76mm diameter x 50mm long wood screws (No.10) or 4mm diameter x 75mm round nails (8 SWG) can be used in each joist).

Figure 27: Restraint strap required with use of non-restraint joist hangers

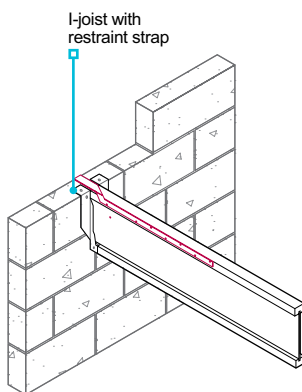
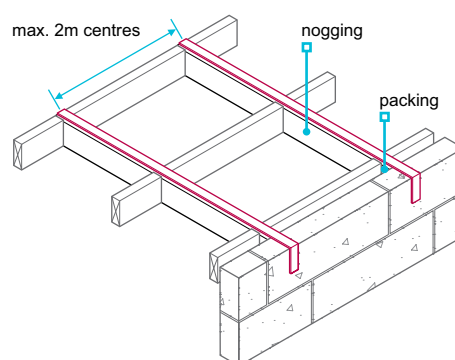


Figure 28: Restraint strap fixed to solid timber joists parallel to external wall



Solid timber joists

Solid timber joists should have noggings provided at:

- a minimum of 0.5 x the depth of the member when straps are located on top of the joist, or

I-joists

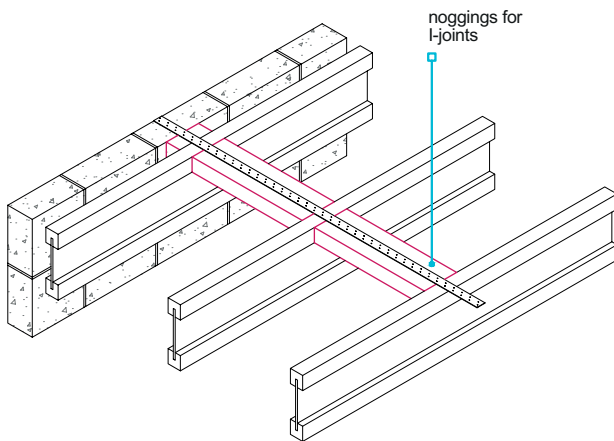
I-joists should not be notched and have:

- solid timber noggings no less than 0.5 x the depth of the member and a maximum of 150mm fixed between the webs and located beneath the top flange, with the straps installed through small slots neatly cut through the top of the web of the joists (see Figure 30)

When nailing into laminated veneer lumber flanges:

- care should be taken to prevent splitting

Figure 29: Restraint strap fixed to I-joists parallel to external wall — through noggings set flush with top flange

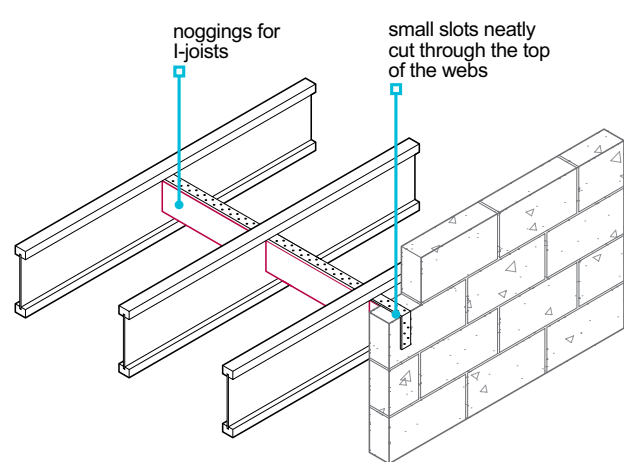


- the full depth of the member where straps are located beneath the joist.

- noggings made from short lengths of I-joist, or solid timber the full depth of the I-joists, or
- noggings half the depth of the member x depth of the flange laid on their side between the flanges (see Figure 29).

- nails should be driven in at an angle (not horizontally) and should not protrude from the flanges.

Figure 30: Restraint strap fixed to I-joists parallel to external wall — through slots cut in top of web



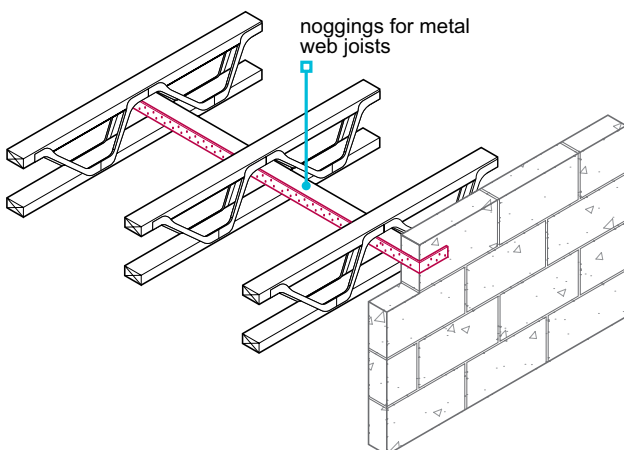
Metal web joists

Metal web joists should not be notched and should have:

- 35mm x 97mm solid timber noggings beneath the top flange of the metal web joists

- noggings nailed twice to each joist
- noggings should be butted tight to the wall.

Figure 31: Restraint strap fixed to metal web joists parallel to external wall



6.4.15 Strutting

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

Strutting should:

- not project beyond the top and bottom edges of joists
- be firmly blocked to the wall at the end of each run
- be provided before the deck is laid.

Proprietary metal strutting should comply with Technical Requirement R3.

Strutting should be provided along the length of joists at intervals recommended in Table 4 or 5. These should be provided in addition to those required at support, depending on the type of support. The following are minimum provisions.

Solid timber and I-joists

Strutting to solid timber and I-joists should be:

- provided in accordance Table 4
- herringbone (38mm x 38mm timber) or solid blocking (minimum 38mm thick and 0.75 x the depth of the joist).

Figure 32: Typical strutting arrangement

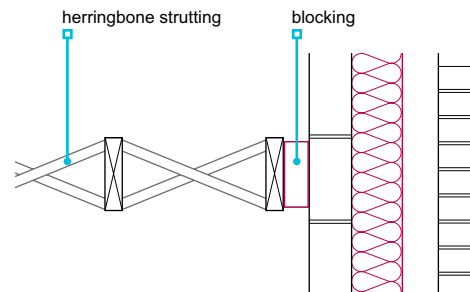


Table 4: Strutting for solid timber and I-joists

Joist span (m)	Rows of strutting
Under 2.5	None needed
2.5-4.5	1 (at centre of span)
Over 4.5	2 (at equal spacing)

I-joists

Strutting to I-joists should be:

- provided in accordance with the Table 4, where required.

Metal web joists

Strutting to metal web joists should be:

- provided in accordance with Table 5
- solid timber 'strongback' bracing (see Figure 33).

Figure 33: Strongback bracing

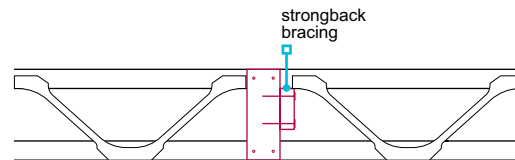


Table 5: Strutting for metal web joists

Joist span (m)	Rows of strutting
4-8	1 (at centre of span)
Over 8	2 (at equal spacing)

6.4.16 Joists and openings

Also see: Chapter 6.6

Upper floors shall have adequately sized and properly supported trimmer joists around openings.

Trimmer, trimmed and trimming joists should be:

- detailed in the design
- designed in accordance with Technical Requirement R5.

Connections between joists should be made with suitable 'timber-to-timber' hangers and:

- where face fixing I-joists to another I-joist, be provided with backer blocks on both sides of the web of the trimmer (see Figure 35)
- where metal web joists are used as a trimming joist to support another metal web joist, have timber uprights between the flanges of the trimmer (see Figure 36).

Figure 34: Trimming around openings in floors

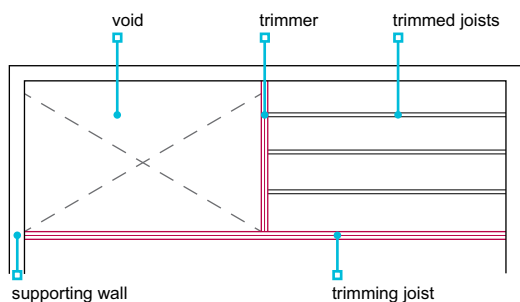


Figure 35: I-joist connection of trimmer and trimming joists

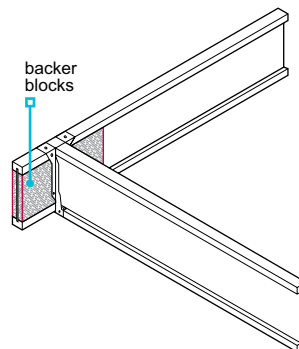
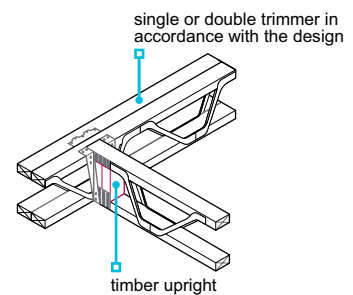


Figure 36: Metal web joist connection of trimmer and trimming joists



Deflection

The following should be considered in the design and detailing around openings in floors:

- deflection of trimming joists should be similar and no worse than the adjacent floor joists
- compound deflection of the floor, including trimming and trimmed joists, should be limited to the overall floor deflection, to ensure there is no differential movement or noticeable step in the floor level adjacent to the trimming joists
- where partition walls are built off trimmers and trimming joists, particularly fire compartment walls, additional care should be taken to ensure that the overall deflection of such joists would not result in residual gaps at the heads of the walls, or in distorted walls or openings within the walls.

There should be no notching or drilling of trimmers or trimming joists unless proven by design calculations.

6.4.17 Multiple joists

Multiple joists shall be securely fixed together.

Joists can be doubled or tripled up to provide additional support, eg for lightweight partitions or to form trimmers. The design should specify how the joists are fixed together and be in accordance with manufacturers' recommendations.

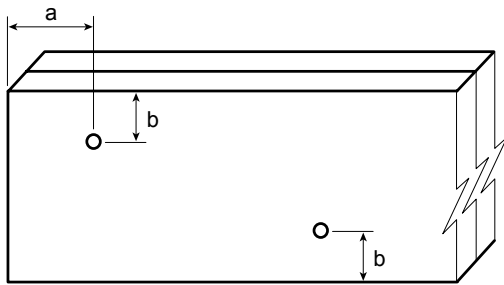
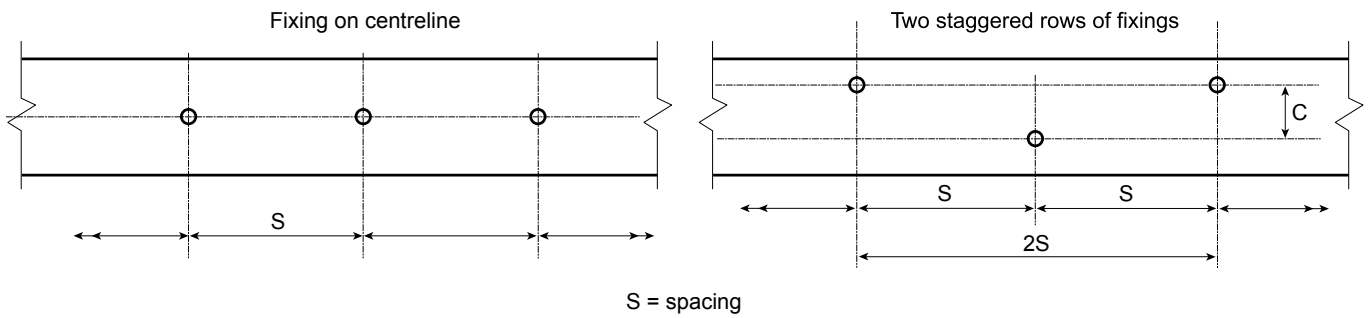
As a minimum, the fixing centres for double member trimmer and trimming joists should be at centres of no more than twice the adjacent joist spacing.

When securing solid joists:

- fixings should be in accordance with the engineer's specification and should be checked before the ceiling is fixed, including the tightness of bolts
- washers or single-faced connectors should be used with bolts
- toothed plate, split ring and shear plate connectors should be provided where required
- ensure that timber is not damaged by over-tightening.

Coach bolts can be used to fix multiple solid joists together. They could be located at centreline or staggered, depending on the loading and design. Where located on centreline, spacing of between S (joist centres) and 1.0m can be used. Where more than two joists are secured together, or a heavy concentrated load is to be supported, the fixing arrangement with staggered spacing shown in the table below may be used (see Figure 37).

Figure 37: Fixing of multiple solid joists

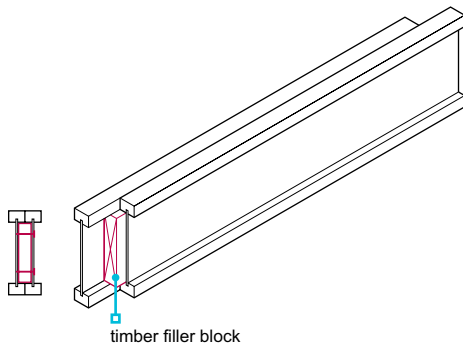


Fixing type	Minimum dimension (mm)		
	a	b	c
Bolt	Maximum of 7d or 80mm	4d	4d

d – diameter of bolt

Engineered joists should be secured together in accordance with the manufacturer’s recommendation.

Figure 38: Fixing of double I-joists



6.4.18 Notching and drilling

Notching and drilling shall be carried out within recognised limits.

Solid timber joists

Notching and drilling should be designed by an engineer where:

- the joist is deeper than 250mm
- it does not meet the guidelines in this chapter, or
- it is close to heavy loads, such as those from partitions, cisterns, cylinders and stair trimming.

Notching and drilling (see Figure 39) should:

- have a minimum horizontal separation of 100mm
- be in accordance with Table 6.

Table 6: Notching and drilling solid timber joists

	Location	Maximum size
Notching joists up to 250mm depth	Top edge 0.1-0.2 x span	0.15 x depth of joist
Drilling joists up to 250mm depth	Centre line 0.25-0.4 x span	0.25 x depth of joist

Figure 39: Notching and drilling requirements of solid joists

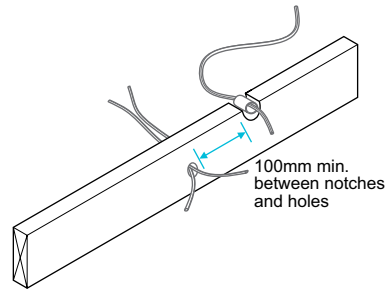
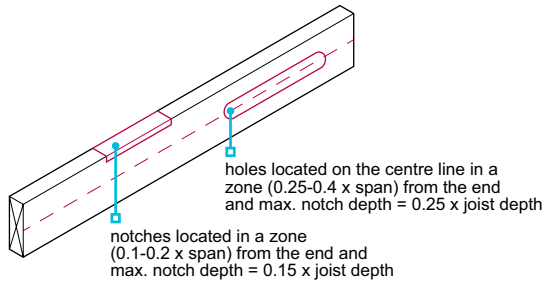
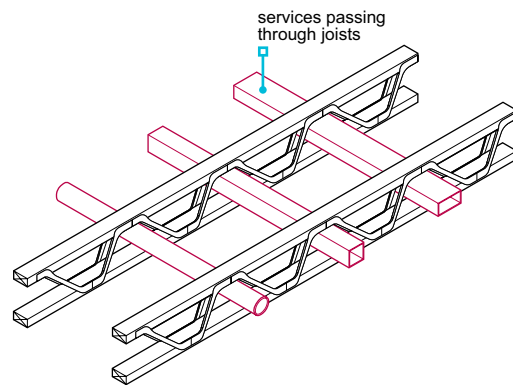


Figure 40: Service conduits in metal web joists



I-joists

Preformed holes should be provided in the web, and:

- holes or notches should not be cut without the approval of the manufacturer
- restraint straps can be slotted into webs immediately below the top flange.

Metal web joists

In metal web joists:

- service conduits should run in the gaps between the metal webs (see Figure 40)
- maximum duct sizes should be in accordance with the manufacturer's recommendations
- large service ducts may have to be inserted before fixing the joists, as it may not be possible after the joists have been fixed.

6.4.19 Floor decking

Floor decking shall be suitable for the intended use and be of adequate strength and moisture resistance. Issues to be taken into account include:

1) type, thickness and fixing

2) protection against damage.

6.4.19.1 Type, thickness and fixing

Where decking contributes to the sound insulation of a floor, the thicknesses listed in this chapter should be checked.

Floor decking should:

- be appropriate to the joist spacing
- be in accordance with Table 7 (which applies to normal domestic loads ie, an imposed load of 1.5kN/m²), or comply with another acceptable clause described in Technical Requirement R3.

Table 7: Floor decking requirements

Floor decking	400mm joist centres	450mm joist centres	600mm joist centres	Standard
Softwood boarding	16	16	19	BS EN 13353
Moisture-resistant chipboard	18	18	22	BS EN 312 — type P5
Plywood	15	15	18/19	BS EN 636
Oriented strand board	15	15	18/19	BS EN 300 — type OSB/3

When installing decking:

- fixings and support should be in accordance with the manufacturer's recommendations
- checks should be made, prior to fixing, to ensure that noggings, blocking and strutting are in the correct position and secure
- butt joints should be staggered and supported on noggings or joists
- adjacent boards should be square
- where nails are used, they should be 2.5 x the thickness of the decking material
- where gluing is required, boards should be glued to the joists and at joints, using a suitable polyvinyl acetate (PVAc) adhesive
- temporary wedges and packing should be removed once the floor decking is complete.

Square edged boards and boards with loose tongues

When fixing boards with square edges or loose tongues, they should be supported on all sides by joists or noggings (see Figure 41).

Tongued and grooved boards

When fixing boards with tongued and grooved edges:

- boards should be laid with long edges at right angles to joists
- short edges should be supported on joists or noggings or cut back to form a butt joint over a joist (see Figure 42)
- boards should be glued to the joists and the sheets glued to each other with PVAc adhesive (not softwood boarding)
- long edges at room perimeters should be fully supported on joists or noggings.

Chipboard flooring

Chipboard flooring should be supported and fixed in accordance with the manufacturers' recommendations, using either:

- flat-headed ring shank nails, 2.5 x the thickness of the board and minimum 3mm diameter, or
- screws to BS 1210, minimum 2 x the thickness of the board and no less than size No. 8.

Figure 41: Longitudinal support to square edged boards

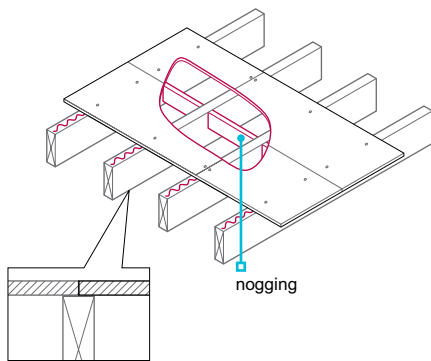


Figure 42: Short edges of floorboards supported on joists

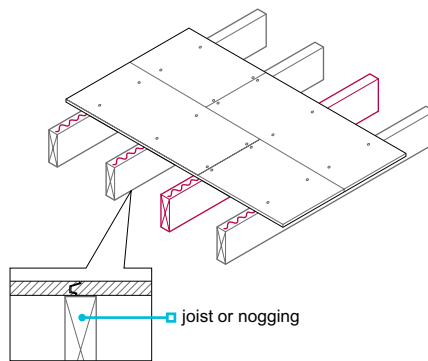
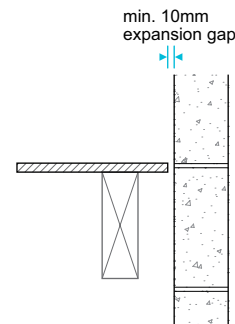


Figure 43: Floorboards abutting rigid upstands



When fixing:

- fixings should have a maximum spacing of 300mm along continuously supported edges and intermediate supports
- where boards abut a rigid upstand, a minimum 10mm expansion gap should be provided; for large areas of boarded floor, a wider expansion gap may be required at upstands, and intermediate expansion gaps of 2mm per linear metre of floor should be provided (see Figure 43).

Oriented strand board (OSB) flooring

When fixing OSB flooring:

- boards should be laid over supports in the direction indicated on the board, with the stronger axis at right angles to the supporting joists
- boards should be long enough to span two joists
- nails should be flat headed and annular grooved nails, 3mm in diameter
- where boards abut a rigid upstand, a minimum 10mm expansion gap should be provided; for large areas of boarded floor, a wider expansion gap may be required at upstands, and intermediate expansion gaps of 2mm per linear metre of floor should be provided.

Plywood flooring

When fixing plywood flooring:

- boards should be laid with the face grain at right angles to the supports
- end joints should occur over joists or noggings
- fixings should have a maximum spacing of 150mm around the perimeter and a maximum spacing of 300mm on intermediate supports
- an expansion gap of at least 1.5mm-2mm should be allowed between each panel.

Nails for fixing plywood should be in accordance with Table 8.

Table 8: Fixings for plywood floors

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

Proprietary flooring

Proprietary flooring should be:

- certified in accordance with Technical Requirement R3
- installed in accordance with certification requirements.

6.4.19.2 Protection against damage

Floor decking should be stored:

- on a hard base
- under cover
- indoors where possible.

Floor decking that is built in as the work proceeds and left exposed to the weather will be subjected to deterioration and adverse effect of the weather, particularly when exposed to prolonged periods of rainfall. Such floor decking, when used in conjunction with engineered and traditional joists, should:

- have a third-party approval certificate from a UKAS accredited body which covers weather resistance for the period of time the boards are to be left exposed on site
- be used strictly in accordance with the manufacturer's instruction and details.

Any floor decking that is left exposed beyond the period stated on the third-party approval certificate should be replaced.

Non-proprietary floor decking without third-party certification should not be used on structural floors exposed to the weather for any period of time, under any circumstances.

Floors should not be overloaded, especially with materials during construction, and be protected against damp, plaster splashes and other damage.

6.4.20 Floating floors or floors between homes

Floating floors shall be separated from the main structure and surrounding walls by a resilient layer.

The structural component of floors between homes may be concrete, steel, timber or a combination of these materials.

The floor finish should be isolated from walls and skirtings.

Where board materials are laid loose, joints in tongued and grooved boards should be glued.

Proprietary floating floor materials and systems should be fixed in accordance with:

- Building Regulations
- manufacturer's recommendations
- relevant certification requirements.

6.4.21 Further information

- BS8103-1 — Structural design of low-rise buildings. Code of practice for stability, site investigation, foundations, precast concrete floors and ground floor slabs for housing*
- BM Trada Tables — Eurocode 5 span tables for solid timber members in floors, ceiling and roofs for dwellings by BM TADA Technology Ltd. 4th Edition*

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