Chapter

6.5

Steelwork

This chapter gives guidance on meeting the Technical Requirements for:

- **steelwork which supports masonry partitions and timber floors, including trimmed openings**
- **the protection of steelwork.**

Figure reference table

Figure Reference Table 6.5			
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6.5.1 Compliance

Also see: Chapter 2.1

Steelwork shall comply with the Technical Requirements.

Steelwork (including trimming to floor voids) for supporting masonry partitions or timber floors which comply with the guidance in this chapter will generally be acceptable.

The information provided in this chapter is in accordance with BS EN 1993-1-1 using grade S275 steel; however, more economical or smaller beams may be designed by an engineer.

Steelwork, including its support and any connections, should be:

- designed by an engineer in accordance with Technical Requirement R5, or
- detailed in accordance with this chapter.

6.5.2 Design guidance

Also see: Chapters 6.1, 6.3 and 6.4

Steelwork shall be designed to support and transmit loads to the supporting structure without undue movement or deflection. Issues to be taken into account include:

1) support of masonry partitions

2) support of timber floors, including trimmed openings.

6.5.2.1 Support of masonry partitions

Masonry partitions may be supported by steelwork selected in accordance with this chapter. Care should be taken to avoid masonry supported by steelwork being partially supported or out of true.

Conditions for Tables 1 and 2

Steel beams in accordance with Tables 1 and 2 of this chapter will generally be acceptable for the support of masonry partitions where the following conditions are met:

- the partition is of one of the types detailed in Table 1
- the partition is built centrally on the steelwork beam and is less than 2.7m in height
- the span of the steel beam is less than 4m
- steel beams only support the weight of the partition and self-weight
- brickwork or blockwork (workface size 440mm x 215mm) supporting the steel beam has a minimum strength of 2.8N/mm^2 and the beam supports do not occur over a door or window opening
- padstones are provided where required, in accordance with Table 6.

Where any of the conditions are not met, steelwork should be designed in accordance with Technical Requirement R5.

Method of applying tables:

- ensure that all conditions apply
- identify the masonry partition construction and thickness
- use Table 1 to establish the load per metre run
- check the span of the beam(s)
- use Table 2 to determine a suitable steel section size
- use Table 6 to determine if padstones are required.

An example is provided at the end of this chapter.

Table 1: Load of partition to be supported

Type of masonry for supported partition (not more than 2.7m high and plastered both sides)	Maximum masonry density (kg/m^3)	Structural thickness (mm)		
		100	90	75
		Load (kN/m run)		
Dense masonry	2,000	6.8	6.2	5.4
Medium masonry	1,400	5.1	4.8	4.2
Lightweight masonry	800	3.5	3.3	2.9

Table 2: Size of steel beam supporting partition

Partition load (from Table 1) (kN/m run)	Clear span of beam (m)	Smallest suitable universal beam size (mm x mm x kg/m)
Less than 3	Up to 4 Over 4	127 x 76 x 13 (2)
3 to 5	Up to 3 3 to 3.5 3.5 to 4 Over 4	127 x 76 x 13 152 x 89 x 16 178 x 102 x 19 (2)
5 to 7	Up to 2.5 2.5 to 3 3 to 4 Over 4	127 x 76 x 13 152 x 89 x 16 178 x 102 x 19 (2)

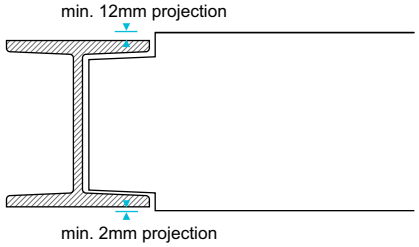
Notes

1. For spans up to 4m, universal column 152mm x 152mm x 23kg/m (smallest size available) may be used.
2. For spans over 4m, beams should be designed by an engineer in accordance with Technical Requirement R5.

6.5.2.2 Support of timber floors, including trimmed openings

Timber floors may be supported by steelwork selected in accordance with this chapter and should include full allowance for the shrinkage of timber joists.

Figure 1: Allowing for shrinkage of timber joists



Conditions for Tables 3 and 7

Steel beams in accordance with Tables 3 and 7 will be acceptable to NHBC for the support of floors, where the following conditions are met:

- the floor construction is of decking (softwood boarding, chipboard, oriented strand board or plywood) on timber joists and the ceiling is plasterboard with a plaster skim coat or a plastic finish (Artex or similar)
- allowance has been made of 0.5kN/m^2 for self-weight (floor and ceiling load)
- the floor does not support masonry partitions
- any lightweight partition, such as plasterboard on timber studwork or proprietary product, is non load-bearing
- padstones are provided where required in accordance with Table 6
- clear span of beam does not exceed 4.4m
- connections between steelwork beams are in accordance with Clause 6.5.6, or are designed by an engineer
- the floor support is one of the methods shown in Figure 1.

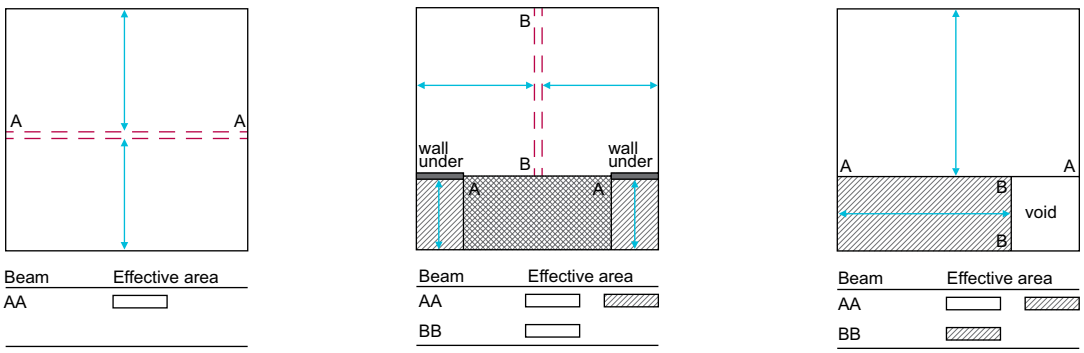
Where any of the conditions are not met, steelwork should be designed by an engineer in accordance with Technical Requirement R5.

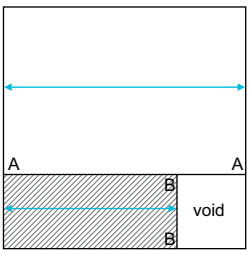
Method of applying tables:

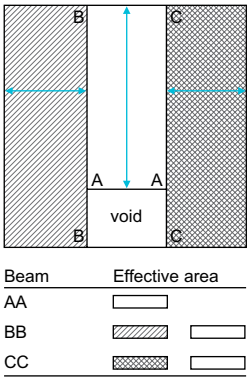
- use Figure 1 to determine the area supported by the beam(s)
- check the span of the beam(s)
- use Table 3 to determine a suitable steel section size
- use Table 7 to determine if padstones are required
- where steel beam-to-steel connections are required, refer to the connections in Clause 6.5.6.

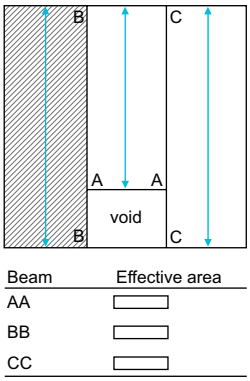
Ensure that all conditions apply.

Figure 2: Effective areas supported by steel beams









Where any area shown as 'void' contains a staircase, add 2m² to the effective area supported by any beam which fully or partially supports that staircase.

Table 3: Size of steel beam supporting timber floor

Effective area supported (m²)	Effective trimmer span = clear span + 100mm (m)	Smallest suitable steel section size (mm x mm x kg/m)	
		Universal beam	Universal column
0 to 20	0 to 2.0	127 x 76 x 13	152 x 152 x 23
0 to 20 20 to 30	2 to 2.5	127 x 76 x 13 152 x 89 x 16	152 x 152 x 23 152 x 152 x 23
0 to 10 10 to 20 20 to 30	2.5 to 3	127 x 76 x 13 152 x 89 x 16 178 x 102 x 19	152 x 152 x 23 152 x 152 x 23 152 x 152 x 23
0 to 10 10 to 30 30 to 40	3 to 3.5	127 x 76 x 13 178 x 102 x 19 203 x 133 x 25	152 x 152 x 23 152 x 152 x 23 152 x 152 x 30
0 to 10 10 to 20 20 to 30 30 to 40 40 to 50	3.5 to 4	152 x 89 x 16 178 x 102 x 19 203 x 102 x 23 203 x 102 x 30 *	152 x 152 x 23 152 x 152 x 23 152 x 152 x 23 152 x 152 x 30 152 x 152 x 37
0 to 10 10 to 20 20 to 30 30 to 40 40 to 50	4 to 4.5	203 x 102 x 23 203 x 133 x 25 203 x 133 x 30 * *	152 x 152 x 23 152 x 152 x 23 152 x 152 x 30 152 x 152 x 37 203 x 203 x 46

*Beams should be designed by an engineer in accordance with Technical Requirement R5.

6.5.3 Steel grade and coatings

Steelwork shall be specified to provide sufficient strength, durability and fire resistance.

The design should detail the method of fixing or connecting structural steelwork. The guidance given in this chapter applies to steelwork which is to be bolted (using black bolts) or not connected.

Steelwork should be in accordance with the guidance in this chapter and:

- BS EN 10365 Hot rolled steel channels, I and H sections. Dimensions and masses, or
- BS EN 10056 Structural steel equal and unequal leg angles - Dimensions.

To ensure adequate durability in the environment it will be exposed to, steelwork should:

- have a protective coating system applied before being delivered to site
- comply with the level of fire resistance required by Building Regulations.

Where welding is to be carried out, the protective coating system specified by the designer should be used.

Further guidance on the protection of structural steel is given in BS EN ISO 12944 Paints and varnishes. Corrosion protection of steel structures by protective paint systems and BS EN ISO 14713 Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures.

Decorative finishes should be compatible with the protective coat specification. The designer should determine compatibility in accordance with the manufacturer's recommendations. Chapter 9.5 Painting and decorating contains further guidance for decorative paint finishes to steelwork.

Table 4: Environment categories for component groups in different locations and exposure conditions

Component group	Location	Description of exposure condition	Environment categories
External	Outside a home	Above splash zone	C4 or C5(1)
		At ground level within splash zone (up to 150mm above ground)	C5(2)
	Outside or basement	Below ground level	C5(2)
Internal	Sub-floor void(3)	Unventilated	C3
		Ventilated	C2
Internal	Kitchen/bathroom, etc	Moist humid conditions — protected against condensation	C2
	Kitchen/bathroom, etc	Moist humid conditions — exposed to condensation	C2
	Rooms other than kitchen/bathroom, etc	Warm dry	C2
	In roof void	Unheated dry	C2
Internal/external	Façade	Embedded or partially embedded in building envelope	C5(4)

Notes
1. For construction located within 500m of coastal shoreline.
2. Alternatively, steelwork may be encased in concrete.
3. For steelwork not in contact with the ground.
4. For steelwork in contact with, or embedded in, an external masonry wall, for at the contact / embedment length.

Alternatively, guidance on suitable atmospheric corrosivity categories (C1–C5) and appropriate protective coatings for domestic construction may be based on the recommendations given on the website **www.steelconstruction.info**. A site-specific assessment is required in order to determine an appropriate classification level for the steelwork. A suitable protective coating specification is to be determined by the designer in accordance with the coating manufacturer's recommendations.

Table 5: Protective coatings for hot rolled structural steelwork for atmospheric corrosivity category (recommended for housing applications only)

Atmospheric corrosivity and risk	Surface preparation (4)	Protective coating (1, 2, 3)			Site or factory applied	Making good of damaged areas of protective coating
		Material	Minimum coating thickness (d.f.t.)(5) / weight(6)	Number of coats		
C1 Very low	N/A	None required	N/A	N/A	N/A	N/A
C2 Low	Thoroughly clean surface prior to abrasive blast cleaning to Sa 2½	High build zinc phosphate epoxy primer(7)	80 µm(8)	1 or 2	Factory	Thoroughly wire brush damaged areas and build up coats using the same materials and to the same d.f.t.
C3 Medium	Thoroughly clean surface prior to abrasive blast cleaning to Sa 2½	High build zinc phosphate epoxy (7) primer, followed by high build recoatable epoxy micaceous iron oxide (MIO)	80 µm(8) 120 µm (200 µm in total)	1 or 2 1	Factory	Thoroughly wire brush damaged areas and build up coats using the same materials and to the same d.f.t.
C4 High		Hot dip galvanize to BS EN ISO 1461(9)	460 gms/m²	1	Factory	To be determined by the designer in accordance with the manufacturer's recommendations
C5 Very high		Hot dip galvanize to BS EN ISO 1461(9)	710 gms/m²	1	Factory	To be determined by the designer in accordance with the manufacturer's recommendations

Notes
1. Where steelwork is to be given a decorative finish, the protective coat is to be compatible with the decorative finish. Manufacturers' recommendations should be followed.
2. Where steelwork is to be protected by intumescent paint for fire purposes, manufacturers' recommendations should be followed.
3. All fixings and fittings to the structural steel elements are to be protected against corrosion in a manner that is both commensurate and compatible with the protective coatings.
4. Surface preparation to BS EN ISO 12944-4.
5. Coating thicknesses given represent nominal dry film thickness (d.f.t.).
6. Thicknesses and weights shown represent the coating to be applied to each face of a steel section.
7. Epoxy primers have a limited time for over-coating. Manufacturers' recommendations should be followed.
8. 80 µm can be in one coat or as 20 µm pre-fabrication primer plus 60 µm post-fabrication primer.
9. Alternatively, use products manufactured from austenitic stainless steel in accordance with the recommendations of BS EN 1993-1-4:2006.

Where shop-applied protective coatings have been damaged, the coatings should be made good on site prior to being built into the works, as indicated in Table 5 Making good of damaged areas of protective coating.

Where steelwork is to be welded, the protective coating system specified by the designer should be used.

Where steelwork is to be protected by intumescent paint for fire purposes, this should be in accordance with the manufacturer's recommendations.

6.5.4 Installation and support

Steelwork shall be installed to achieve the required structural performance. Issues to be taken into account include:

1) section size and grade detailed in the design

2) steelwork support.

6.5.4.1 Section size and grade detailed in the design

When materials are delivered to site, they should be checked to ensure conformity with:

- engineer's design, or
- steelwork sizes in this chapter.

6.5.4.2 Steelwork support

Beam supports should not occur above window or door openings. Bearings for steelwork supported on masonry should be:

- 100mm minimum
- clean, dry and level.

6.5.5 Padstones

Steelwork shall be supported by padstones where required to distribute point loads safely to the supporting structure without undue movement or deflection.

Where a steel beam is supported by masonry, a padstone may be required to spread the load over a larger area to prevent overstressing. Padstones should be in accordance with:

- the engineer's design, or
- the guidance given in this chapter.

Where the inner leaf of the cavity wall contributes to the overall thermal performance of the wall, padstones should:

- have similar thermal properties to the masonry used for the rest of the inner leaf, or
- not create a cold bridge.

Table 6: Size of padstones (for steel supporting partition walls)

Type of masonry for supported partition (not more than 2.7m high and plastered both sides)	Thickness of wall supporting beam (mm)						Minimum depth of padstone (mm)
	100	125	140	150	190	215	
	Minimum length of padstone (mm)						
Dense masonry	215	190	185	180	165	155	150
Medium masonry	155	140	135	130	120	110	150
Lightweight masonry	95	85	80	75	70	70	150

Notes

1. Padstones are not necessary where the flange dimension of the beam exceeds the length of the padstone given in this table.
2. When steelwork is in line with the wall supporting it ie, when acting as a lintel over an opening:
   - the flange dimension of the beam should not be more than 50mm greater than the thickness of the supporting wall
   - the minimum length of padstone should be 200mm
   - the padstone depth should match the coursing of adjacent masonry
   - the web of the beam should be over the centre of the wall.
3. The minimum length of steel bearing onto padstone should be 100mm.

Table 7: Size of padstones (for steel supporting floors)

Effective area supported (as used in Table 3) (m^2)	Minimum padstone size (mm)					
	Thickness of wall supporting steel beam (mm)					
	Up to 105		105 to 155		156 to 216	
	Length	Depth	Length	Depth	Length	Depth
Up to 10	95	150	80	150	70	150
10 to 20	185	150	160	150	140	150
20 to 30	275	150	240	150	210	150
30 to 40	365	215	320	150	280	150
40 to 50	455	300	400	215	345	215

Notes

1. Padstones are not necessary where the flange dimension of the beam exceeds the length of the padstone given in this table.
2. When steelwork is in line with the wall supporting it, ie, when acting as a lintel over an opening:
   - the flange dimension of the beam should not be more than 50mm greater than the thickness of the supporting wall
   - the minimum length of padstone should be 200mm
   - the padstone depth should match the coursing of adjacent masonry, and
   - the web of the beam should be over the centre of the wall.

Padstones should be formed in one unit with a minimum compressive strength of 10 N/mm^2 from:

- in-situ concrete
- precast concrete
- concrete blocks
- clay bricks, or
- engineering bricks (when less than 215mm x 100mm).

6.5.6 Connections

Connections shall be chosen and installed to achieve the required structural performance.

Steelwork connections should:

- be in accordance with the guidance in this chapter, or
- where other forms of connection (eg high-strength friction grip bolts) are required, be designed by an engineer in accordance with Technical Requirement R5.

Only weld, cut or drill steelwork where it is required by the design.

Bolts for connections should comply with the design information and relevant British Standards, including:

BS 4190	Specification for ISO metric black hexagon bolts, screws and nuts
BS EN 1011	Welding. Recommendations for welding of metallic materials
BS EN 14399	High-strength structural bolting assemblies for preloading
BS EN 1993-1-8	Eurocode 3. Design of steel structures — design of joints

The connection methods detailed in this chapter are suitable for connecting steel beams used to support floor loads only, using black bolts or welding.

Figure 3: Joints between beams of similar size (beams 170mm to 230mm deep)

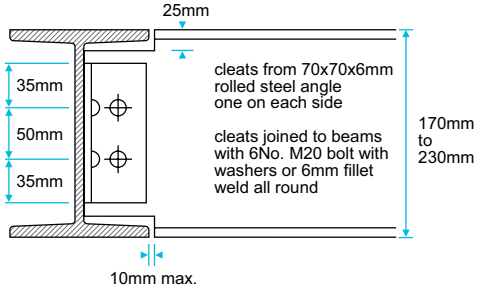
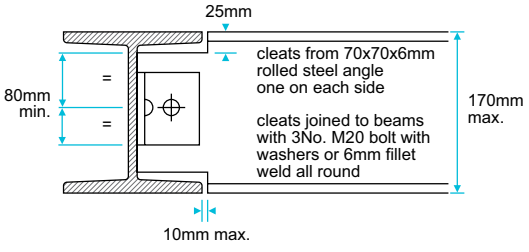


Figure 4: Joints between beams of similar size (neither beam deeper than 170mm)



Conditions for the use of this method are:

- beams should only support timber floors in accordance with this chapter
- both beams have been chosen from Table 3
- beams do not differ in depth by more than 40mm.

Connections between steel sections should be designed by an engineer in accordance with Technical Requirement R5, where the above conditions are not met.

6.5.7 Examples

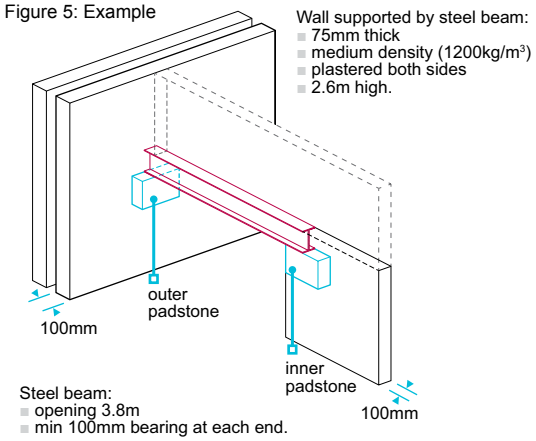
1 Using information about the supported wall and Table 1:
- load per metre run = 4.2kN/m.

2 Using the load per metre run, the span of the beam and Table 2:
- suitable section size = 178 x 102 x 19 UB.

152 x 152 x 23 UC is not suitable as it is too wide for the inner padstone/wall.

3 Using information about the wall supporting the beam (100mm thick), the walls supported by the beam (medium density block) and Table 6:

Figure 5: Example



Results from example calculation:

Minimum padstone size	155mm long 150mm deep
Outer padstone (beam at right angles to wall)	
Minimum length **Minimum depth** **Thickness**	155mm long(1) 150mm 100mm, to match blockwork(2)
Inner padstone (beam in line with the wall)	
Minimum length **Minimum depth** **Thickness**	200mm (see note 2 to Table 6) 150mm 100mm, to match blockwork

Notes
1. This is greater than the flange dimension of the steel section obtained in 2 above — 102mm — therefore a padstone is required to distribute the load.
2. The actual length and depth of a padstone could be greater to suit masonry coursing.

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