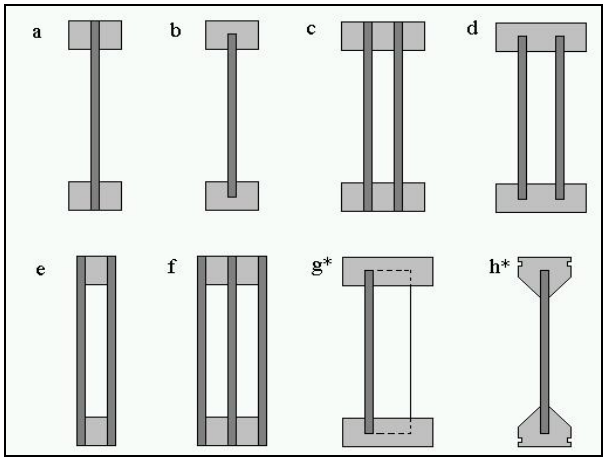
2.8 Application of panels in the production of Box and I-beams

2.8.1 Selection of panels for Box and I-beams

Timber I-joists comprise a timber flange (typically solid timber or LVL – laminated veneer lumber) and a panel product web (usually OSB - oriented strand board). Box beams are a similar form but with a web on each side of the flanges. Some typical forms of timber box and I-beams are shown in Figure 2.18.



a	*I beam - 2 part flange*	*e*	*Box beam*
b	*I beam -1 part flange*	*f*	*Double box beam*
c	*Double I beam -3 part flange*	*g*	*Corply beam *(web zigzags across the flange)*
d	*Double I beam -1 part flange*	*h*	*Tecton beam **

Figure 2.18 Typical forms of timber Box and I-beams (*patented designs)

Structurally the I-joist works on the principle that the greatest forces in a beam under bending are at the outer faces. Hence, if the stronger tensile and compressive material is positioned at the outside edges, the central zone can be reduced in size as it carries very little of the bending forces. However, the central zone (web) carries the reaction and shear forces.

Most commercially manufactured timber I-joists are of the form "b" in Figure 2.18 and use high grade timber or structural timber composites for the flanges, routed to accept a timber-based board web (oriented strand board, hardboard or plywood). The web is secured to the flange by an approved weatherproof, structural adhesive within the rout. Some of the other forms of beam can be made with adhesive or mechanical fasteners. Commercially available products are available in a range of sizes, alternatively "one-off" products can be designed and manufactured for a specific situation.

The selection of suitable wood-based panels for box and I-beams depends upon a number of factors including:

- the load the beam has to carry
- the ambient environmental conditions

The selection of panels meeting these requirements is set out in Table 2.11. Some typical details for the use of I-joists, for both timber frame and masonry construction, in single dwellings, are shown in Figures 2.19 and 2.20. Note that the drawings are for illustration only and do not show all the constructional details which may be required for a particular floor, such as stiffeners, strutting etc.

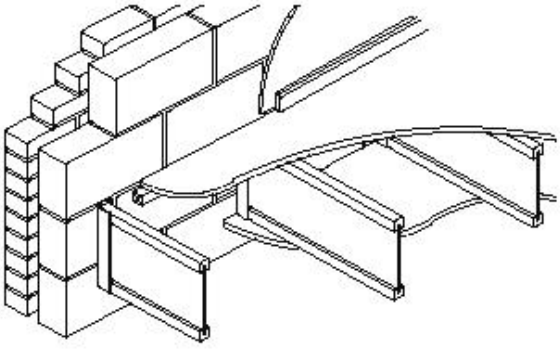


Figure 2.19 I-joists in block wall construction

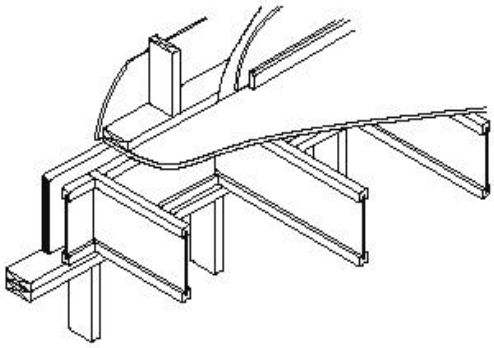


Figure 2.20 I-joists in timber frame construction

2.8.2 The design of box and I-beams

There are some aspects of designing with I-joists which require different treatment from solid rectangular timber due to their geometry and the fact that they are a composite assembly of different materials. These affect the actual behaviour of the I-joist in terms of strength and stiffness and the detailing plus handling and storage. Each I-joist brand has specific strength characteristics which are presented in third-party certification literature (often repeated in the manufacturers literature). This contrasts with solid timber which is strength-graded to common grade values presented in British Standards and Eurocodes. Most I-joist manufacturers have comprehensive design and drawing software to produce specifications and cutting schedules.

Strength capacity

In common with solid timber beams in some applications (eg floors, rafters), the strength values provided by the third party certification and included in manufacturers' literature should allow for load-sharing and should be used without application of the normal K factors in BS 5268-2. The strength values will have been determined through a combination of calculation and testing and can be provided for use in Service Classes 1 and 2. In Service Class 1 most timber is defined as attaining a maximum moisture content of 12% and in Service Class 2, 20%. I-joists can thus be targeted for both intermediate and ground floors respectively.

TABLE 2.11 PANEL GRADES* FOR BOX- AND I-BEAMS

Selection

BEAM WEB	SERVICE CLASS	PLYWOOD EN 636	PARTICLEBOARD EN 312	OSB EN 300	MDF EN 622-5	FIBREBOARD EN 622-3,4	CBPB EN 634
Box and I	1,2	636-2	P5	OSB/3	-	HB.HLA2	-

* The table provides the minimum grade of panel that satisfies the particular set of requirements: panels of higher quality may be substituted, and their selection may result in a reduction in required thickness.

Although all the panels meeting the grade specifications will satisfy a particular set of requirements, the level of performance of different brands of these panels may vary considerably, some may even be endowed with high levels of properties not directly covered by the table.

Control of deflection

Deflection of an I-joist is a combination of strain due to both bending and shear. Unlike solid rectangular sections, shear deflections in I-joists can be more than 10% of the total deflection and must be included in the calculation. For an I-joist under a uniformly distributed load this is given by

total mid-span deflection, u = (bending deflection, u_{EI} + shear deflection, u_G) x creep factor, K_c

Appropriate material properties are normally presented in the manufacturer's literature.

For commercially certificated beams (BBA or BM TRADA Q-Mark), the K_c co-efficient is normally incorporated in the design values presented. Due to the lighter weight and longer spans of a typical I-joist floor, vibrations may be higher than for floors of solid joists and designers should consider reducing the deflection limit. This is particularly important in main activity rooms such as kitchens and living rooms or in office areas. In the UK the normal deflection limit for solid timber domestic floors is 0.003 times span (L/333) or 14 mm, whichever is the lesser. This limit should not always be assumed to be acceptable for lightweight I-joists, particularly in long spans. Subject to proprietary data on I-joist performance, it is recommended that the deflection limit is reduced for I-joists and, in common with North American guidance, the following is more applicable:

Limit on live load (variable actions) = L/480

Total load (permanent and variable actions) = L/360

Further guidance on deflection limits and floor vibration, particularly in relation to Eurocode design, is given in the TRADA Wood Information Sheet 4 –24 *Serviceability limit states for timber in buildings* and in the TRADA Timber Engineering Guidance Document GD 6 *Vibration in timber floors*.

2.8.3 Storage and installation of box and I beams

For commercial systems, it is important that the manufacturer's guidance on storage and installation is followed but some general advice can also be given.

As with all wood-based products, box and I-beams are affected by changes in moisture content and are generally only suited for use in Service Class 1 or 2 conditions. They should be stored in dry conditions, clear of the ground and protected from direct wetting. Beams should generally be handled and stacked in the vertical position, rather than flat.

Beams can be cut with normal wood-working tools and can be fixed in position with nails or screws. Alternatively, specific joist hangers are also available for some commercial products.

If holes need to be cut in the web, for services etc, it is important that these are accounted for in the engineering design or are within limits set by the manufacturer.