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# Packaging code

## Section 8. Wooden containers

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Code d'emballage  
Section 8. Récipients en bois

Verpackungscode  
Abschnitt 8. Holzbehälter

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## Foreword

This Section of this British Standard, prepared under the direction of the Packaging and Freight Container Standards Committee, was first published in December 1943 and revised in December 1950. This revision supersedes BS 1133 : Section 8 : 1950, which is therefore withdrawn.

BS 1133 was originally issued primarily to give guidance on the packaging of service and other Government supplies, but was later also used by civilian packers.

Subsections one, two and three, which deal with framed wooden cases and nailed wooden cases, are the result of a major research project conducted by the Timber Research and Development Association involving many thousands of samples and tests. In addition, work done by other organizations in recent years is used. Designs of case are described and tables of performance are included to assist the buyer and manufacturer in deciding the best case for a particular function.

Consideration is given to the correct choice of species and grade of timber. In most instances, materials for packaging can be met from less expensive lower grades, particularly for small containers of less than about 2 m in length or less than about 500 kg capacity. However, where cases are larger than this, higher stresses in case timbers are more likely to occur, and regard should be given to the strength of the main structural members (skids, rails and headers); this will include some degree of visual assessment in order to avoid specifying overlarge and therefore more costly timbers. Internationally, the purchasing and supply of timber has moved to strength graded timber and the grades offered are clearly defined and used in this standard. Strength graded timber is only recommended for main structural members.

Lower grades of timber are acceptable for all items, including main structural members, but a compensatory increase in dimensions may be required. The same applies to the weaker types of fastening where compensatory numbers per joint or increased gauge or length may also be required.

Special attention is drawn to BS 1133 : Sections 1-3, which give guidance on the choice and storage of packaging materials.

BS 1133 now consists of the following Sections, all of which are published separately with the exception of Sections 1-3, which are published in one volume.

### Sections 1-3. Introduction to packaging

Section 1 gives general guidance on the choice of containers, precautions to be taken in packaging and choice

of packaging methods, and notes relating to physical and statutory limitations, and packing bay conditions.

Section 2 gives recommendations regarding the storage of packaging materials and deals with covered and open storage, weight limitations, fire hazards, dangerous goods and inspection.

Section 3 gives guidance on the addressing, marking and labelling of containers.

**Section 4. Mechanical aids in package handling.** Describes briefly the many types of mechanical handling equipment suitable for the moving of packaging materials and filled packages in factories and warehouses. Also gives notes to assist users in selecting equipment and using it to the best advantage.

**Section 5. Protection against spoilage of packages and their contents by micro-organisms, insects, mites and rodents.** Gives guidance on the avoidance of damage to packages and their contents by moulds, bacteria, insects, mites and rodents.

**Section 6. Temporary protection of metal surfaces against corrosion (during transportation and storage).** Gives guidance on the cleaning and drying of metal surfaces prior to the applications of temporary (i.e. easily removable) protectives against corrosion and on the selection and application of the protectives. Performance specifications are included for eight types of protectives together with methods of test.

**Section 7. Paper and board wrappers, bags and containers.** Gives general guidance in the use of paper and board in the following forms:

wrapping papers, waxed paper, greaseproof paper, glassine, vegetable parchment, waterproof paper, wet strength paper, bags, envelopes, multiwall sacks, liners and linings, paperboard cartons and boxes, moulded pulp and fibreboard drums.

Methods of test are also given.

**Section 8. Wooden containers.** Gives general information regarding the styles, design and construction of large and small framed wooden cases, battened wooden cases, plywood cases of metal-edged construction, and wooden crates.

**Section 9. Textile bags, sacks and wrappings.** Describes and defines materials and methods of stitching and closing jute bags. Cotton bags are also dealt with. Methods of baling and the jute materials to be used are described and typical specifications are given.

**Section 10. Metal containers.** Gives descriptions of the materials and construction for tins and cans, drums, crates, hampers and trays, collapsible tubes and composites. Includes many illustrations of types of containers and their closures. For tins and cans it also describes decoration, testing, filling and closing. For collapsible tubes it covers styles, decoration, filling and packaging for transport.

**Section 11. Packaging felt.** Covers pressed felts and needle-loom felts for cushioning against shock. It describes five types of felt, and methods of proofing.

**Section 12. Cushioning materials (excluding packaging felt).** Deals with protection against shock and is concerned with the physical properties of the materials used. Basic cushioning theory and suggested cushion design procedures are included. Methods of test for materials are given.

**Section 13. Twines and cords for packaging.** Gives guidance on the types of twine and cord available for packaging and the purposes for which they may be used.

**Section 14. Adhesive closing and sealing tapes.** Gives general guidance, with illustrations, on the uses and various properties of gummed tape and self-adhesive tape available for packaging purposes.

**Section 15. Tensional strapping.** Gives guidance on the use of metallic and non-metallic tensional strapping for packaging purposes.

**Section 16. Adhesives for packaging.** Describes the characteristics and use of the principal types of adhesive used in packaging.

**Section 17. Wicker and veneer baskets.** Gives general descriptions and definitions relating to wicker baskets, hampers and veneer baskets (chips) and punnets.

**Section 18. Glass containers and closures.** Gives general guidance on the types of glass container available for packaging and describes the factors to be considered when ordering or using them. Details of various forms of closure are also given.

**Section 19. Use of desiccants in packaging.** Gives guidance on the use of desiccated packages, the factors governing the choice of desiccant, determination of quantity of desiccant and general considerations affecting this method of packaging.

**Section 20. Packaging for air freight (excluding livestock).** Gives guidance on the special problems of packaging for air freight in relation to different types of container; it also includes clauses on the general precautions to be taken in the carriage of machinery, fragile items, restricted articles, obnoxious cargo and cargo susceptible to variations in temperature. Labelling, marking and prohibited packaging materials are also discussed.

**Section 21. Regenerated cellulose film, plastics film, aluminium foil and flexible laminates.** Gives general information and guidance on the manufacture, properties and uses of various forms of these four types of material.

**Section 22. Packaging in plastics containers.** Describes the properties and characteristics of the various materials from which containers, ranging in size from squeeze tubes and bottles to drums, are made. The principal manufacturing processes employed and the uses of the containers are given.

British Standard

# Packaging code

## Section 8. Wooden containers

### Subsection one. General

#### 1. Scope

This Section of this British Standard gives guidance on the design of:

- (a) wooden cases and crates;
- (b) plywood cases of metal-edged construction.

NOTE. A knowledge of engineering principles is necessary to produce a design specification from the information given.

#### 2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

#### 3. Definitions

For the purposes of this British Standard, the following definitions apply.

**3.1 braces.** Single, double, treble or multiple diagonal members taking the form of an X or XX shape, fitted mainly to prevent racking (diagonal deformation) and, to a lesser extent, to prevent puncture and compressive damage in that the total thickness is increased.

**3.2 battens.** Strips of wood added to a wooden case or crate to hold the boards together and to strengthen and protect it. (See figure 1.)

**3.3 corner posts.** Formed by, and at, the interface between sheathing members. They are rarely separate components but are formed by the vertical rail, or pair of vertical rails, when constructing the case by jointing sheathing elements. (See figure 2.)

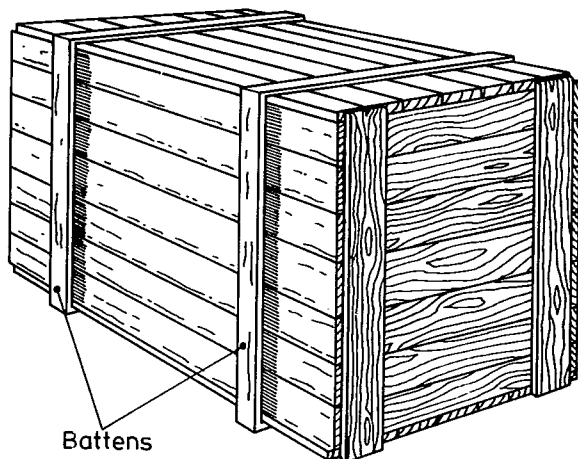


Figure 1. Battens

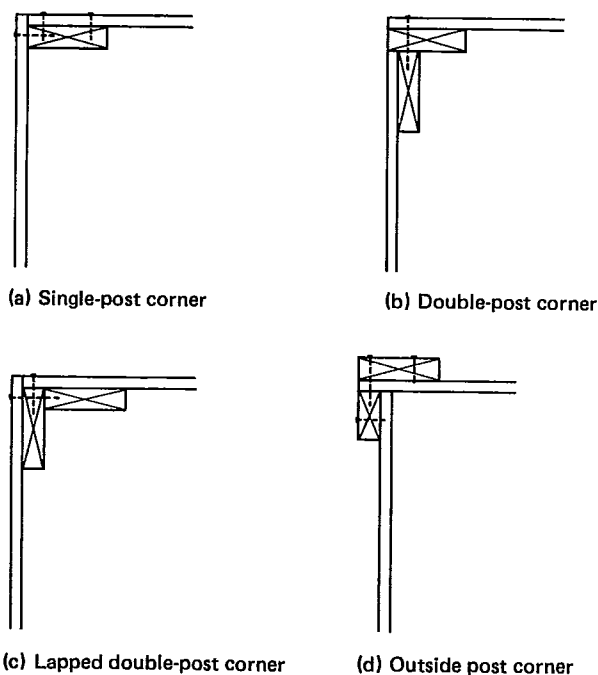


Figure 2. Corner posts (1)

**3.4 crush battens.** Members placed below or above the case top to prevent side crushing caused by lifting-grabs and also to give additional support to the lid. (See figure 3.)

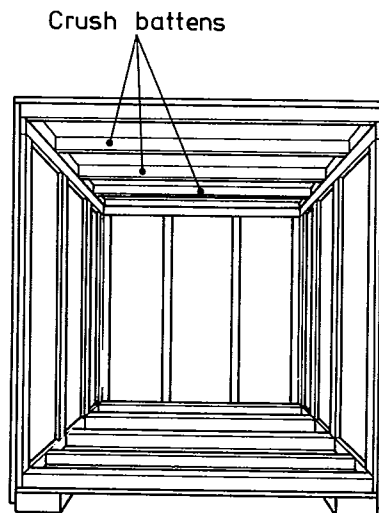


Figure 3. Crush battens

**3.5 dunnage.** All items used in holding secure the goods inside a case, and external loose lengths of timber inserted between adjacent cases to reduce stress.

**3.6 headers.** Skid-like members attached at right angles to the skids in order to distribute the load between the main skids and to complete the solid basework. (See figure 4.)

**3.7 racking resistance.** The ability of a case to maintain its squareness when subjected to load in various forms. This feature assists protection of the contents.

**3.8 rails.** Members, usually at right angles to the sheathing, that both support and act as assembly jigs during construction of sheathing panels. (See figure 10.)

**3.9 rubbing strips.** Thin strips of wood nailed to the underside of skids or sills to facilitate the entry of slings or fork tines, and having no structural strength other than compressive and rubbing strength. (See figure 5.)

**3.10 sheathing.** A covering intended to both protect the goods and add strength or stability to a case. (See figure 10.)

**3.11 sills.** Internally placed longitudinal timber beams. The alternative to skids where, for example, a machine's mounting points are not its lowest part, i.e. it has projections below its base. (See figure 5.)

**3.12 skids.** External longitudinal timber beams that, together with cross boarding, support the load and form the base of a case. They may be vertically laminated if length or cross section demand. (See figure 10.)

**3.13 fork-lift battens.** Battens of sufficient depth to allow the use of tines of a fork-lift truck.

**3.14 sling location battens.** Short battens nailed to the underside of skids and/or sills to provide location for crane slings.

#### 4. Choice of type of case

**4.1 General.** Information on the general factors to be considered when determining the broad choice of type of packaging for any given requirement are discussed in BS 1133 : Sections 1-3. When using a wooden container, the particular factors in 4.2 to 4.5 should be considered.

**4.2 Product to be packed.** The following points should be considered.

- (a) Is the product an 'easy' or 'difficult' one to pack?
- (b) Does the product give the case added strength?
- (c) Should the product be broken down to reduce the cubage?
- (d) Should a number of products be packed into one box to improve handling, or should each one be packed separately?

Products considered 'easy' to pack would comprise articles of moderate density, evenly distributed, being in full contact with sides and base of the case and not exerting undue pressure at any one point.

A 'difficult' product would be one of high density where a large proportion of the weight is placed on a small proportion of the case sides or base. The term 'difficult' may also apply to light loads that are fragile, of awkward shape or difficult to protect.

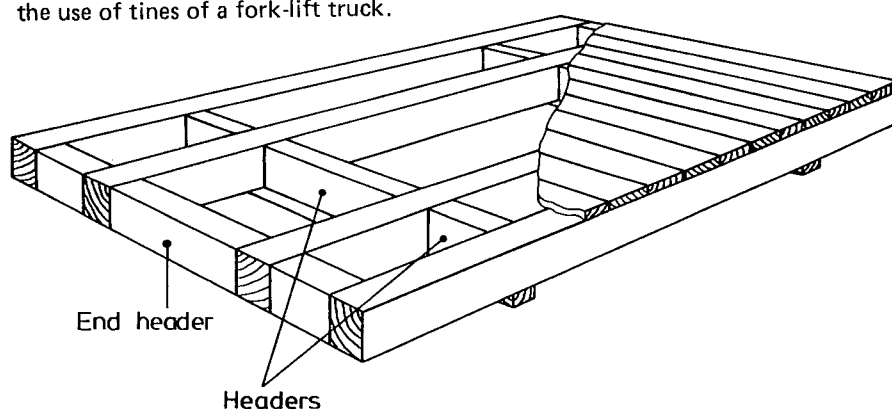


Figure 4. Headers

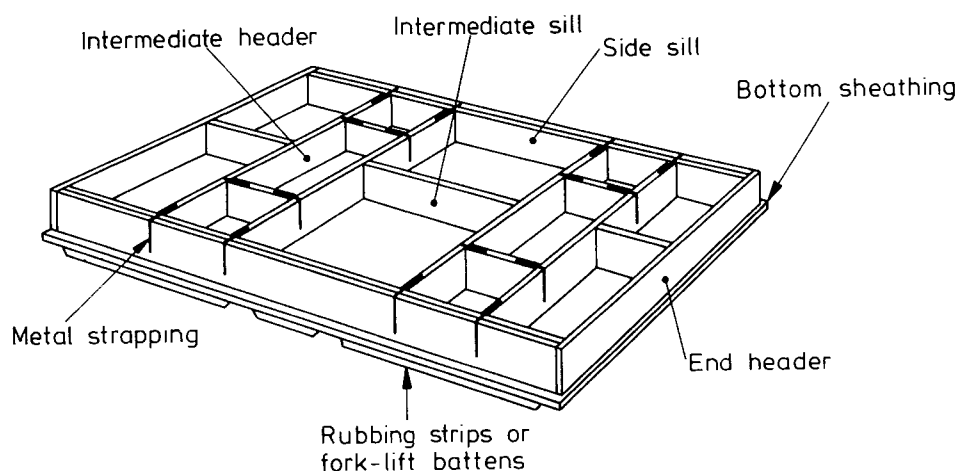


Figure 5. Sills and rubbing strips

**4.3 Weight and size limits.** All forms of transport, whether road, sea or air, have limitations and, possibly, penalties for exceeding the maximum weight and size limits.

Excessively wide cases do not allow for the use of lifting-grabs, and 500 kg is often set as the upper weight limit for the use of lifting-grabs. Very small or light cases are often manhandled, which may be more hazardous than mechanical handling.

**4.4 Standardization and economy.** It is difficult to standardize case sizes except when long production runs of similar size products are envisaged. Nevertheless, the use of one type and size of case for products that vary slightly in size may well prove to be more economic than manufacturing a case for each size of product.

**4.5 Journey hazards.** All articles, whether packaged or not, will encounter certain hazards during distribution to customers. Before any steps are taken to design a case for a given article, consideration should be given to these hazards. Methods of test for complete filled transport packages are given in BS 4826.

## 5. Selection of timber and panel products

**5.1 Sawn timber.** Timber is a natural material and it is, therefore, not possible to control its quality by methods appropriate for processed products such as plywood, hardboard or metals. It is versatile and the species and grade should be selected to suit the particular end use.

Timber is classified into softwood (from coniferous trees such as pine) and hardwood (from deciduous trees such as elm) irrespective of whether it is actually hard or soft.

Most timber for packaging applications is softwood but hardwoods may be used. The heavier species of timber are usually stronger, although they may be more difficult to work and to fasten. Where the properties of a timber species are not known it is advisable to check before use the strength and nailability. Nailability may be particularly relevant when improved nails, such as the annular ringed shank nail, are used. Some timbers are also particularly liable to cause corrosion of metallic objects and this hazard should be considered.

Sapwood (the outer living portion of the tree-trunk) is often lighter in colour than the inner heartwood but may not be distinguishable. Sapwood contains starches and is more susceptible to insect and fungal attack than heartwood. It is not practical to specify heartwood for wooden container construction, nor is it necessary for the short life of the average container.

The moisture content (m.c.) of wood is important and can be simply and quickly measured by the use of an electric moisture meter.

Table 1 lists common timbers for packaging applications and gives their approximate densities at moisture contents of 12 %, 20 % and 50 % (green).

After sawing, timber is normally stacked with spacers (stickers) to season (dry out). Kiln-drying in a controlled atmosphere is relatively costly and is rarely applicable for packaging timber, which is mainly air-dried. In the British climate it is not usually possible to air-dry timber under open-sided cover to below 20 % m.c. Much packaging timber is stored in the open where the moisture content cannot be controlled since it will depend on the time of

**Table 1. Densities and appearance grades of timber for packaging applications**

| Standard name of species | Country/region of origin | Appearance grade suitable for packaging application | Density at 12 % moisture content | Density at 20 % moisture content | Density at 50 % moisture content |
|--------------------------|--------------------------|-----------------------------------------------------|----------------------------------|----------------------------------|----------------------------------|
|                          |                          |                                                     | kg/m <sup>3</sup>                | kg/m <sup>3</sup>                | kg/m <sup>3</sup>                |
| Corsican pine            | UK                       | Ungraded                                            | 480                              | 510                              | 610                              |
| Douglas fir              | Canada                   | No. 3 common                                        | 550                              | 580                              | 670                              |
| Douglas fir              | UK                       | Ungraded                                            | 500                              | 530                              | 630                              |
| Elm (hw)                 | UK                       | Ungraded                                            | 510                              | 550                              | 640                              |
| Hem-fir                  | Canada                   | No. 3 common                                        | 470                              | 500                              | 590                              |
| Keruing (hw)             | Malaysia                 | Standard and higher                                 | 850                              | 860                              | 930                              |
| Larch                    | UK                       | Ungraded                                            | 550/480                          | 590/530                          | 670/600                          |
| Maritime pine            | Portugal                 | Ungraded                                            | 480                              | 530                              | 610                              |
| Redwood                  | Poland                   | VI, (V)                                             | 480                              | 510                              | 630                              |
| Redwood                  | USSR                     | V, (IV)                                             | 480                              | 510                              | 630                              |
| Redwood                  | Scandinavia              | VI, (V)                                             | 480                              | 510                              | 630                              |
| Scots pine               | UK                       | Ungraded                                            | 510                              | 540                              | 630                              |
| Spruce, sitka            | UK                       | Ungraded                                            | 380                              | 450                              | 480                              |
| Spruce                   | Canada                   | No. 3 common                                        | 430                              | 460                              | 530                              |
| Spruce, Norway           | UK                       | Ungraded                                            | 400                              | 420                              | 500                              |
| Whitewood                | Poland                   | VI, (V)                                             | 420                              | 450                              | 530                              |
| Whitewood                | USSR                     | V, (IV)                                             | 420                              | 450                              | 530                              |
| Whitewood                | Scandinavia              | VI, (V)                                             | 420                              | 450                              | 530                              |

NOTE 1. (hw) = hardwood.

NOTE 2. Within each species of timber given in table 1, the higher the grade number the lower the appearance grade and corresponding strength, since knots, as well as reducing appearance, also reduce strength. Higher grades than those given in table 1 may be used.

NOTE 3. For other than UK timber, the grades given are the lowest imported.

NOTE 4. For redwoods and whitewoods, the numeral given first is the preferred grade.

year and incidence of rain, as well as on factors such as thickness and length of time in stack.

The following factors related to moisture content should be taken into account when selecting timber.

(a) Decay and rot are caused by fungi and their activity is dependent on moisture content. Below about 22 % m.c., water is held in the cell walls of the timber which will not then be attacked by most fungi; above about 22 % m.c. there is free water in the cell cavities and the wood is susceptible to fungal attack. (See also BS 1133 : Section 5, BS 1282 and BS 4978.)

(b) If cases made of wet timber are stored in closed conditions such as in freight containers, the wood will dry out. When the temperature drops, condensation will occur and cause damage to contents or other packages.

(c) Wet wood is relatively heavy; if used in this condition for case manufacture, it will shrink and may warp and split as it dries out.

(d) A higher moisture content eases nail penetration and may reduce splitting at the time of nailing.

NOTE. The Australian quarantine regulations regarding the import and treatment of packaging timber are severe. Full details should be obtained if exporting to that country.

**5.2 Grading.** After sawing into marketable sizes, softwood used in the UK is traditionally graded into 'visual appearance grades', which, although not intended to correlate with strength or 'stress grades' (which primarily indicate bending strength), nevertheless do so to a certain extent.

Stress grading, which by visual or mechanical means enables actual pieces to be marked with their grade, is dealt with fully in BS 4978.

Most packaging timber is based on appearance grades (e.g. Scandinavian V grade), but for highly stressed components of larger cases, such as skids, stress graded timber may be used. It is uneconomic to use the highest grade, i.e. special structural (SS) timber for packaging applications.

The two methods of stress grading covered by BS 4978 are:

(a) KAR (knot area ratio) visual method, whose grades are special structural (SS), general structural (GS) and 'reject';

(b) machine grading, which is carried out by actually stressing, by a small amount, each piece by passing it through a high speed machine. The grades allotted are equivalent to the visual grades in strength, but have a prefix M, thus MSS and MGS.

The lower qualities, with corresponding lower strength standards, are adequate for case production.

Table 1 includes the common packaging species and approximate visual appearance grades, and table 7 includes those species available in stress grades.

### 5.3 Timber defects

NOTE. Timber defects referred to in this subclause do not refer to panel products.

Although the KAR (knot area ratio) method is specified in BS 4978, the following are the common defects found in softwood and their effects.

(a) *Non-rectifiable defects* (other than by positioning in a low stress area)

(1) *Knots*: live knots (attached to surrounding timber) and dead knots (not attached to surrounding timber) can have large strength-reducing effects.

(2) *Slope of grain*: when excessive, can cause early failure since timber is weak in bending across the grain.

(3) *Fissures*: caused by drying out, but are less important from a strength point of view than knots and slope of grain.

(4) *Major insect damage*: causes weakness according to extent of attack. Some countries reject attacked timber unless adequately treated under quarantine regulations.

(5) *Wane*: important to avoid in highly stressed areas such as central portions of skids.

(6) *Wormholes*: although active infestation is not acceptable, pinholes and wormholes are permitted to a limited extent in structural timbers since they do not cause significant loss of strength.

(7) *High growth rates*: sometimes associated with lower strength but the timber may still have excellent properties. High growth rates should not necessarily be rejected.

(8) *Density*: correlates with strength; i.e. high density indicates high strength and low density indicates low strength.

(9) *Fungal damage*: major damage by wood-destroying fungi causes serious loss in strength and care should be taken to exclude any timber infected with incipient decay.

Fungi causing blue sap stain do not significantly affect the structural strength of timber, and there is no reason why timber showing slight discoloration from blue stain, etc. should be rejected.

NOTE. The Australian quarantine regulations regarding the import and treatment of packaging timber are severe. Full details should be sought if exporting.

(b) *Rectifiable defects*

(1) *High moisture content caused by inadequate seasoning*: this may be reduced by allowing surface moisture to dry for a few weeks while the timber is under cover and adequately 'sticked' to allow passage of air. Softwood will dry quickly when in this condition and in doing so will both shrink a small amount and gain strength (see clause 18). Difficulties may arise with bowing and warping in some batches. Table 1 gives densities at 20 % moisture content.

(2) *All defects*: not all components in a case are stressed. A case made from 50 % defective timber could perform adequately provided that the defective timber is carefully sited (see clause 18).

### 5.4 Panel products

**5.4.1 General.** Table 2 gives details of panel products used in packaging.

**5.4.2 Hardboards and medium boards (fibre building boards).** The cohesion and strength of hardboards are derived mainly from the felting together of wood fibres and their inherent adhesive properties under a heat and pressure cycle that impresses the typical screen pattern on one face of the board leaving the other smooth.

Table 2. Panel products used in packaging applications

| Panel construction type | Variation in panel type or standard name of species | Grade suitable for packaging applications | Country/continent/region of origin         | Glueline        | Average density range                                         | Short-term container life in wet conditions (see 5.5) | Comments                                                                                                |
|-------------------------|-----------------------------------------------------|-------------------------------------------|--------------------------------------------|-----------------|---------------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Fibre building board    | Hardboard                                           | Tempered (TE, TN)                         | Europe, America, Australasia, South Africa | not applicable  | kg/m <sup>3</sup><br>960 to 1180<br>800 to 1000<br>600 to 900 | High<br>Low<br>Low                                    | Grades should comply with the requirements of BS 1142                                                   |
|                         | Hardboard Medium board                              | Standard                                  |                                            |                 |                                                               |                                                       |                                                                                                         |
| Particle board          | Chipboard                                           | Type I                                    | Europe, UK<br>Europe, UK<br>Canada         | not applicable  | 500 to 850<br>500 to 850<br>600 to 700                        | Low<br>Medium<br>Low                                  | Grades should comply with the requirements of BS 5669                                                   |
|                         | Waferboard                                          | Type III                                  |                                            |                 |                                                               |                                                       |                                                                                                         |
| Plywood                 | Beech faced (hw)<br>Birch (hw)                      | BB<br>WG, ISO IV                          | Czechoslovakia<br>Finland                  | WBP<br>WBP      | 670<br>670                                                    | High<br>High                                          | Glueline should comply with the requirements of BS 1203                                                 |
|                         | Birch (hw)<br>Douglas fir                           | C<br>Sheathing                            | USSR<br>Canada                             | WBP<br>Exterior | 670<br>550                                                    | High<br>High                                          | Glueline verification should be sought*<br>Glueline should be equivalent to the requirements of BS 1203 |
|                         | Douglas fir                                         | CDX, C-C, Ext.                            | USA                                        | Exterior        | 550                                                           | High                                                  | Glueline should be equivalent to the requirements of BS 1203                                            |
|                         | Far Eastern redwood and whitewood (hw)              | B/BB, BB/C                                | Malaysia, Korea, Singapore, Philippines    | WBP or type 1   | 400 to 770<br>400 to 770                                      | High<br>Medium                                        | Glueline should comply with the requirements of BS 1203                                                 |
|                         | Gaboon (hw)<br>Mahogany (hw)<br>Spruce              | B/BB<br>B/BB, Blue Label<br>CPC, CPD, CC  | France, Israel<br>West Africa<br>Sweden    | WBP<br>WBP      | 430<br>550<br>420                                             | High<br>High<br>High                                  | Glueline verification should be sought*<br>Glueline should comply with the requirements of BS 1203      |
|                         | Spruce                                              | III, IV, ISO III                          | Finland                                    | WBP             | 420                                                           | High                                                  | Glueline should comply with the requirements of BS 1203                                                 |
|                         | Softwood                                            | CSP sheathing                             | Canada                                     | Exterior        | 450 to 530                                                    | High                                                  | Glueline should be equivalent to the requirements of BS 1203                                            |
|                         | Whitewood<br>Southern pine                          | C<br>CDX, C-C, Ext.                       | USSR<br>USA                                | WBP<br>Exterior | 420<br>550                                                    | High<br>High                                          | Glueline verification should be sought*<br>Glueline should be equivalent to the requirements of BS 1203 |
|                         |                                                     |                                           |                                            |                 |                                                               |                                                       |                                                                                                         |
|                         |                                                     |                                           |                                            |                 |                                                               |                                                       |                                                                                                         |
|                         |                                                     |                                           |                                            |                 |                                                               |                                                       |                                                                                                         |
|                         |                                                     |                                           |                                            |                 |                                                               |                                                       |                                                                                                         |

\* At the time of publication of this standard, this source was in a state of change as regards gluing, and up-to-date information should be sought from the importer.

NOTE 1. (hw) = hardwood.

NOTE 2. The strength of the above panel materials varies considerably from material to material and also varies with thickness. Further details of strength can be obtained by reference to subsection three of this standard.

The manufacturing process provides a consistent, defect-free board and includes a final humidity treatment to establish a controlled moisture content. Hardboards are normally stored under cover before use.

Three types of hardboard are used in packaging.

(a) Standard hardboard has a density in the range  $800 \text{ kg/m}^3$  to  $960 \text{ kg/m}^3$  and is available in thicknesses of 2 mm to 6.4 mm. Its weather resistance is adequate for many packaging applications but edge sealing or close fastening may be required to prevent warping if exposed to moisture.

(b) Medium boards have densities in the range  $350 \text{ kg/m}^3$  to  $800 \text{ kg/m}^3$  and are used in thicknesses ranging from 6 mm to 12 mm. They have a weather resistance similar to standard hardboard.

(c) Oil tempered boards have densities in the range  $960 \text{ kg/m}^3$  to  $1180 \text{ kg/m}^3$ . They have a high degree of moisture resistance and are suitable for outdoor use.

Variations in the length and nature of the fibres used, the press cycle and final treatment significantly affect the physical properties of the finished boards. Hardboards are produced for applications calling for medium strength characteristics, ease of die-stamping or moulding, or ease of painting. It is recommended that hardboards for cases are selected with particular reference to the jointing techniques to be used.

**5.4.3 Particle boards.** These are split into two main categories.

(a) *Chipboard*, which is made from particles of wood bonded with synthetic resin or other organic binder. It is manufactured under pressure by extrusion or static press methods and then sanded on each face. Thinner chipboards may be suitable for internal use.

Although chipboard is of a lower density than hardboard it is only available in greater thicknesses, which results in the density per unit area being greater than that for fibre building boards.

Two grades of chipboard suitable for packaging applications where weight limits are not of prime importance are:

- (1) chipboard complying with the requirements of BS 5669 type I, which is not weather resistant;
- (2) chipboard complying with the requirements of BS 5669 type II, which is of improved weather resistance.

(b) *Waferboard*, which is a wood chipboard made exclusively from wood chips at least 28 mm in length. The strength is similar to chipboard but the appearance is more coarse.

**5.4.4 Plywood.** Plywood for packaging is generally made from rotary-peeled wood veneers bonded together with adhesives. The species of timber, the number of veneer plies, the type of adhesive used and the degree of surface finish are the main variables to be taken into account in selection. The species and type of adhesive will affect the weatherproofness and the resistance to attack by micro-organisms.

The bonding process takes place in a heated press, resulting in a controlled moisture content. Plywood is normally stored under cover and moisture is therefore not such a significant factor as with sawn timber.

The grades used for plywood refer only to the quality of the face and back veneers assessed after the board has been made and not while in the form of veneer; the grades do not define the quality of the internal veneers or the adhesives used. Grading is usually carried out in the country of origin and while the numbers or names of the grades of several producing countries are similar they do not necessarily represent the same permissible defects. Table 2 gives an indication of equivalent grades from various producing countries.

There is no international standard for the glueing of plywood although the British and North American Standards are often applied by other countries. Table 2 contains a column giving the appropriate British glueing standard and applies this to other countries where this is common practice.

Although lower veneer qualities are acceptable for general packaging applications since aesthetics are not relevant to design, this does not apply to glueing standards. If plywood delaminates owing to inadequate veneer glueing then the strength largely disappears. Of the four British Standard grades, only the highest glueing standard has been found to be acceptable for general export packaging. This grade is 'WBP' (British Standard terminology) or 'Exterior' (North American terminology). The next lower grades of MR, BR and INT (complying with the requirements of BS 1203) may be suitable for indoor use or short-term exposure and advice should be sought from the supplier.

Far Eastern suppliers of plywood use a glue standard commonly called type 1, which has been shown not to be equal to WBP grades although it may be suitable for less severe use. Many of these suppliers also supply plywood to the British Standard grade of WBP and this would be a suitable choice for general export packaging.

**5.5 Effects of environment.** Apart from the strength linked fluctuations in moisture content occurring due to exposure, solid timber, WBP plywood and tempered hardboard do not suffer any loss of strength over a number of years. However, the ability to retain fastenings does change considerably and this ability for the most important timbers given in table 1 is quantified in clause 19.

The staining that occurs with exposure does not affect the structural strength, but joints are affected by moisture (see clause 19).

Panel materials may be affected by exposure over a period of time and an indication of structural integrity over this period is given in table 2 under the column headed 'Short-term container life in wet conditions'. Low life is of the order of a few weeks whilst high indicates a year or more depending upon the severity of exposure and the particular type of panel construction.

**5.6 Standardization.** Standard sizes and sections should be used for economic reasons. Table 3 gives standard sizes based on BS 4471 : Part 1. However, slightly undersize sizes of timber need not be rejected since this is unavoidable with the natural drying that inevitably takes place after case construction.

**Table 3. Basic dimensions of sawn softwood**  
(from BS 4471 : Part 1)

NOTE. Producers in Canada supply sizes, appearance grades and stress grades of timber for their domestic constructional markets in accordance with their own national standards. These standard sizes and stress grades do not necessarily accord with the provisions of tables 3A and 3B.

**Table 3A. Basic cross-sectional sizes of sawn softwood**

(All dimensions are in millimetres.)

| Thickness | Width |     |     |     |     |     |     |     |     |
|-----------|-------|-----|-----|-----|-----|-----|-----|-----|-----|
|           | 75    | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 300 |
| 16        | x     | x   | x   | x   |     |     |     |     |     |
| 19        | x     | x   | x   | x   |     |     |     |     |     |
| 22        | x     | x   | x   | x   |     |     |     |     |     |
| 25        | x     | x   | x   | x   | x   | x   | x   | x   | x   |
| 32        | x     | x   | x   | x   | x   | x   | x   | x   | x   |
| 36        | x     | x   | x   | x   |     |     |     |     |     |
| 38        | x     | x   | x   | x   | x   | x   | x   |     |     |
| 44        | x     | x   | x   | x   | x   | x   | x   | x   | x   |
| 47*       | x     | x   | x   | x   | x   | x   | x   | x   | x   |
| 50        | x     | x   | x   | x   | x   | x   | x   | x   | x   |
| 63        |       | x   | x   | x   | x   | x   | x   |     |     |
| 75        |       | x   | x   | x   | x   | x   | x   | x   | x   |
| 100       |       | x   |     | x   |     | x   |     | x   | x   |
| 150       |       |     |     | x   |     | x   |     |     | x   |
| 200       |       |     |     |     |     | x   |     |     |     |
| 250       |       |     |     |     |     |     |     | x   |     |
| 300       |       |     |     |     |     |     |     |     | x   |

\*The range of widths for 47 mm thickness are usually available in constructional quality only.

NOTE. The smaller sizes contained within the broken lines are normally, but not exclusively, of European origin. The larger sizes outside the dotted lines are normally, but not exclusively, of North and South American origin.

**Table 3B. Basic lengths of sawn softwood**

(All dimensions are in metres.)

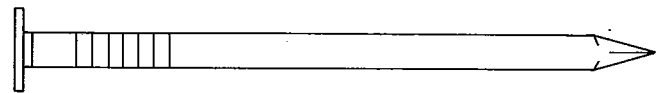
|      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|
| 1.80 | 2.10 | 3.00 | 4.20 | 5.10 | 6.00 | 7.20 |
|      | 2.40 | 3.30 | 4.50 | 5.40 | 6.30 |      |
|      | 2.70 | 3.60 | 4.80 | 5.70 | 6.60 |      |
|      |      | 3.90 |      |      | 6.90 |      |

## 6. Fastenings

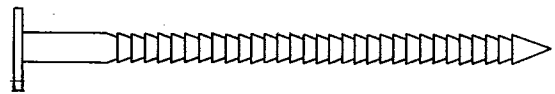
**6.1 General.** As important as the timber are the fastenings. Any of those illustrated in figure 6 are suitable for packaging applications.

Nails are specified by their diameter and length in millimetres. Screws are at present specified by length in millimetres and imperial gauge.

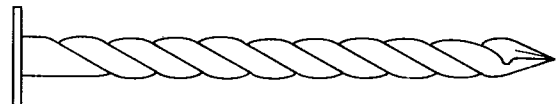
Adhesives are rarely used for reasons of time, difficulties of quality control and inspection, and low impact strength; exceptions to this are those used in the jointing and manufacture of plywood and particle board.



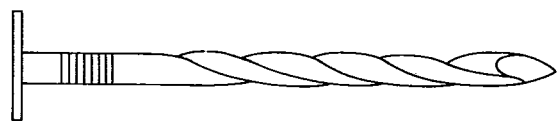
Round plain shank flat head



Annular ringed shank flat head



Square twisted shank flat head



Helical thread shank flat head

**Figure 6. Major categories of packaging nails**

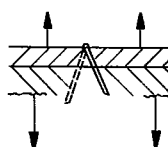
**6.2 Joint strength.** Joint strength depends upon correct design, good fastenings and the soundness of the timber. Recent studies have shown that the species of timber can affect the strength of the joint; this information is given in table 8.

Loaded cases impose shear and tensile stresses in joints, and when overload occurs, cleavage (where timber splits, allowing free movement of the nail) and 'nail pull-out' may occur. Particular attention should be paid to cleavage. The edge nailing distance and the nail gauge should suit the type and moisture content of the timber used.

Cases and joints should be arranged to apply shear loads (see clause 19) because the load required to fail a fastened joint is greater with a shearing load. There are certain exceptions in the case of annular ringed shank nails; these may warrant a larger proportion of tensile loaded joints since they perform well in this mode.

### 6.3 Methods of fastening

**6.3.1 Slant nailing.** Slant nailing is a method that may increase joint strength; any improvement is mainly in the withdrawal mode. A typical method is shown in figure 7 and is discussed in clause 19.

**Figure 7. Slant nailing**

**6.3.2 Clinching.** Clinching involves the use of a plain shank nail or staple longer than the thickness of timber being jointed, and the making of the joint over a steel plate that deforms the nail end to form a strong joint. Allowances for clinching are normally:

- (a) approximately 6 mm, for 2.65 mm diameter nails;
- (b) approximately 9 mm, for 3.35 mm diameter nails;
- (c) approximately 6 mm to 12 mm, for all staples.

Excessive clinch allowances, e.g. 15 mm, do no harm but since the overall strength is dependent upon the bend strength then no increase of overall strength results.

**6.3.3 Staples.** Staples (an example of which is shown in figure 8) are used for fixing waterproof linings and

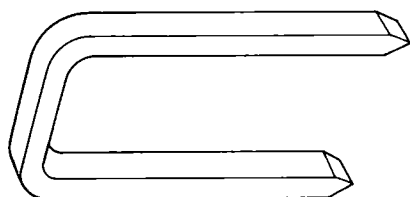
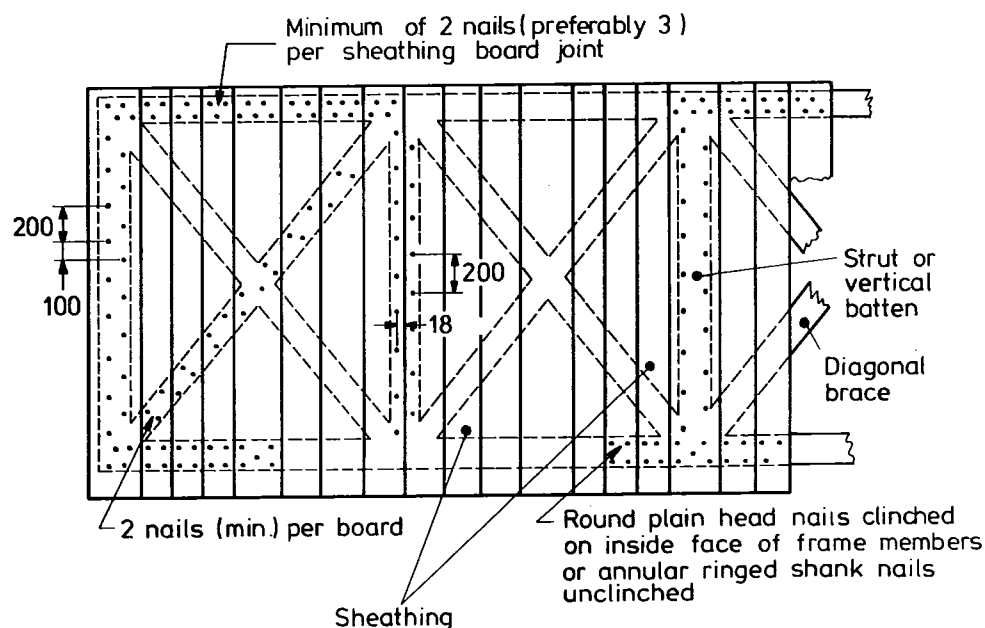
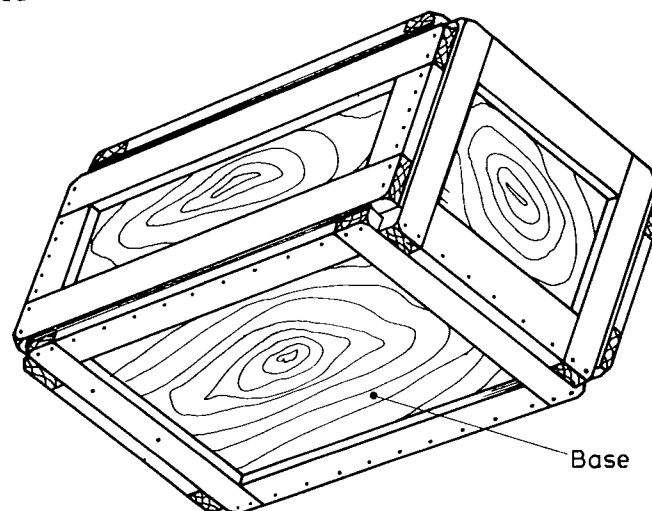


Figure 8. Chisel-point staple



(a) Medium to large braced softwood boarded case



(b) Small plywood case

All dimensions in millimetres.

Figure 9. Typical nailing patterns

cushioning material to the inside of a case. They are not usually used as a structural fastening, although if required and designed in accordance with clause 19, they should not be excluded as such.

**6.4 Nailing patterns.** Nailing patterns and density of nailing are important and vary according to the type and size of nail. Figure 9 shows typical nailing patterns for certain types of construction. It is important for optimum design that these patterns vary with the type of nail (see clause 19).

Nails too close to each other do not allow the joint to distribute the load. Nails too near the edge of the timber may 'break out', with a consequent reduction of strength.

Table 4 gives the approximate count per kilogram of round plain head or annular ringed shank nails for common sizes.