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BSI Standards Publication

Code of practice for installation of flooring of wood and wood-based panels

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Contents

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 72, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 October 2011. It was prepared by Technical Committee B/543, *Round and sawn timber*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 8201:1987, which is withdrawn.

Information about this document

This British Standard includes recommendations relating to the work involved in laying flooring and illustrates some typical constructions on which it may be laid.

This is a full revision of the standard, and introduces the following principal changes:

- information and recommendations have been rationalized in consideration of current best practice;
- new materials and product availability;
- materials are included in a new Section **2**; and
- details provided are now in relation only to wood and wood-based panels installed as, or as a component part of, finished wood flooring

General recommendations applicable to all types of wood flooring are contained within Section **1**, Section **2**, Section **3** and Section **9**, with recommendations specific to individual types of flooring given in Sections **4** to **8** . Because some recommendations are applicable to more than one individual type of floor, this involves some repetition. It was considered that a limited degree of repetition to ensure reasonable completeness of each section would be preferable to excessive cross-referencing.

Annex A describes the test method for use in conjunction with the recommendations given in **12.4.6**.

Increasingly, in addition to material selection based on performance capabilities, suitability and appearance, consideration is being given to the specification of wood and wood products with regard to legality and sustainability of source.

Whilst this aspect of material specification is not within the remit of British Standards (this might be set to change with the desire of the European Commission to see environmental criteria included in EN product standards) the committee believe it to be of sufficient importance that reference to provisions being made in the UK to address this issue is included in the new Annex B.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Section 1: General

Introduction

This British Standard gives recommendations and guidance on the material, environment and installation variables that in combination have a fundamental effect on the achievement of satisfactory performance and serviceability of finished wood flooring.

The content of the document has been modified to reflect more appropriately wood and wood-based panels installed as finished flooring and, of necessity, as underlayment for finished wood flooring but not for subsequent installation of carpet or resilient flooring.

The installation and use of wood-based panels as primarily a load-bearing surface has been cross referenced to BS 8103-3.

The words "timber" and "wood" in this British Standard cover softwoods, hardwoods and wood-based panels, as appropriate in the context.

1 Scope

This British Standard gives recommendations for laying the following types of flooring:

a) board;

b) pre-assembled board;

c) strip;

d) mosaic;

e) overlay;

f) parquet;

g) block;

h) end grain flooring;

i) multi-layer; and

j) wood-based panels.

This British Standard does not cover the protection afforded to a floor by floor coverings or surface finishes.

This British Standard does not cover floors for temporary structures or floors intended for limited use. Different considerations might apply to these floors.

NOTE For laminate flooring, see BS 8425.

Bamboo flooring is also not covered by this British Standard.

The hygrometer test for dampness of concrete bases is given in Annex A. Guidance on the selection of wood species is given in Annex B.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 1187, *Specification for wood blocks for floors*

BS 1202-1, *Specification for nails – Part 1: Steel nails*

BS 1210, *Specification for wood screws*

BS 1297, *Specification for tongued and grooved softwood flooring*

BS 4050-2, *Specification for mosaic parquet panels – Part 2: Classification and quality requirements*

BS 6100-8, *Building and civil engineering – Vocabulary – Part 8: Work with timber and wood-based panels*

BS 8103-3, *Structural design of low-rise buildings – Part 3: Code of practice for timber floors and roofs for housing*

BS 8204-1 *Screeds, bases and in situ floorings – Part 1: Concrete bases and cementitious levelling screeds to receive floorings – Code of practice*

BS 8204-4:2004 *Screeds, bases and in situ floorings – Part 4: Cementitious terrazo wearing surfaces – Code of practice*

BS 8417:2011, *Preservation of timber*

BS EN 204, *Classification of thermoplastic wood adhesives for non-structural applications*

BS EN 300:2006, *Oriented strand boards (OSB) – Definitions, classification and specifications*

BS EN 301, *Adhesives, phenolic and aminoplastic, for loading bearing timber structures – Classification and performance requirements*

BS EN 312:2003, *Particleboards – Specifications*

BS EN 636:2003, *Plywood – Specifications*

BS EN 1313-2, *Round and sawn timber – Permitted deviations and preferred sizes – Part 2: Hardwood sawn timber*

BS EN 1991-1-1, *Eurocode 1 – Actions on structures. Part 1-1: General actions – Densities, self-weight, imposed loads for buildings*

NA to BS EN 1991-1-1, *UK National Annex to Eurocode 1 – Actions on structures. General actions – Part 1-1: Densities, self-weight, imposed loads for buildings*

BS EN 1995-1-1, *Eurocode 5 – Design of timber structures – Part 1-1: General – Common rules and rules for buildings*

BS EN 13226, *Wood flooring – Solid parquet elements with grooves and/or tongues*

BS EN 13228, *Wood flooring – Solid wood overlay flooring elements including blocks with an interlocking system*

BS EN 13629, *Wood flooring – Solid pre-assembled hardwood board*

BS EN 13986, *Wood-based panels for use in construction – Characteristics, evaluation of conformity and marking*

BS EN 14342:2005, *Wood flooring – Characteristics, evaluation of conformity and marking*

BS EN 14904, *Surfaces for sports areas – Indoor surfaces for multi-sports use – Specification*

DD CEN/TS 15676, *Wood flooring – Slip resistance – Pendulum test*

Other publications

[N1] Property Care Association. *Remedial Timber Treatment Code of Practice*. Huntingdon: PCA, 2008.

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 6100-8 and the following apply.

3.1 base/subfloor
element that supports the flooring

3.2 battens
solid wood or laminated wood to enable timber flooring to be mechanically fixed and raised off a solid subfloor or base

NOTE Battens are usually floating. They may be used with cradles or other levelling systems.

3.3 block flooring
softwood or hardwood blocks either square edged or with a system of interlocking into each other

3.4 concrete subfloor
mass concrete base (floor slab) onto which wood flooring, or a finishing screed prior to installation of wood flooring, is to be applied

3.5 damp-proof membrane
continuous layer of impervious material installed under a concrete slab between the slab and the ground

3.6 end grain block flooring
flooring of softwood or hardwood blocks with the wearing surface at right angles to the grain

3.7 end matched
joint at the end of the strip or board, square-ended and tightly abutted, usually interlocking in the form of a tongued and grooved joint

NOTE This term does not in any way refer to the colour or grain pattern of the timber.

3.8 face
better or preferred surface of the element

3.9 fixed floor
method of construction where the flooring is fixed directly to the base

NOTE E.g. fixed to joists or glued down to the base. [See Figure 1 and Figure 3a).]

3.10 floating floor
method of construction where the flooring is fixed to a floating batten or laid upon a base, with a resilient underlay between, without being positively fixed to the base

NOTE See Figure 2.

3.11 flooring
upper layer of a floor providing a finished surface; including wood board and strip, block, mosaic, overlay and parquet, and wood-based panel products

3.12 flooring thickness
finished thickness of the flooring prior to installation

3.13 laminate flooring
plastic laminate bonded to a wood-based material

3.14 mosaic flooring
panels comprising squares assembled from softwood or hardwood fingers held together by a removable surface membrane or fixed flexible backing

3.15 multi-layer flooring (engineered hardwood flooring)
interlocking laminated elements consisting of a top layer of solid wood, greater then 2.5 mm in thickness and additional lower layer or layers of wood or wood-based materials bonded together

3.16 overlay
panels or interlocking wood strips or boards for direct application to a fully supporting base

3.17 panel flooring
plywood, blockboard, flooring type particleboard, OSB and hardboard panels having square, rebated or tongued and grooved edges

3.18 parquet
hardwood strip or strip of proprietary manufacture, in long or short lengths according to pattern requirement, for direct application to a fully supporting base

NOTE Although not a true term for wooden flooring, this is also a modern generic term for decorative types of hardwood flooring.

3.19 pre-assembled board
solid or multi-layered timber product of proprietary manufacture available in a multitude of widths, thicknesses and lengths and finishes

NOTE Pre-assembled board is made by factory joining smaller pieces together and supplied in long lengths. Boards are normally tongued and grooved/interlocking and end matched.

3.20 prefinished
method of supplying hardwood flooring, where it has a uniform moisture content and a protective and decorative finish applied during manufacture

3.21 screed
layer of material of substantial thickness laid in-situ to provide a suitable flat surface upon which the flooring can be applied without requiring further adjustments of level to bring the surface of the flooring to the designated level

3.22 service class
class defined by the moisture levels of products used in dry (service class 1), humid (service class 2) or exterior (service class 3) conditions

NOTE See BS EN 1995-1-1 for further details on service classes.

3.23 solid
product that is manufactured or joined together from one piece throughout its entire thickness

3.24 surface damp-proof membrane
material applied to the surface of the subfloor to inhibit the passage of water vapour

NOTE The membrane is designed to inhibit water vapour of above 75% relative humidity (RH) to the manufacturer's maximum level.

3.25 suspended floor
floor that spans between (local) supports

3.26 underlay
product or component, usually in the form of a thin sheet, installed beneath flooring

3.27 underlayment
smoothing compound/levelling compound or wood-based panel, applied in-situ to a sound base, screed or substrate to provide a suitable finish to receive adhesive, the underlay or floor covering

3.28 unfinished
method of supplying hardwood flooring, where it will need to be sanded and sealed on site after fitting and might need to be acclimatized to ensure the moisture content is uniform

3.29 vapour check membrane
a membrane laid over the base, subfloor or screed to prevent low levels of residual moisture affecting the timber flooring

NOTE A low level is considered to be below 75% RH.

3.30 veneered
laminated elements with a thin decorative top layer of solid wood less than 2.5 mm thick

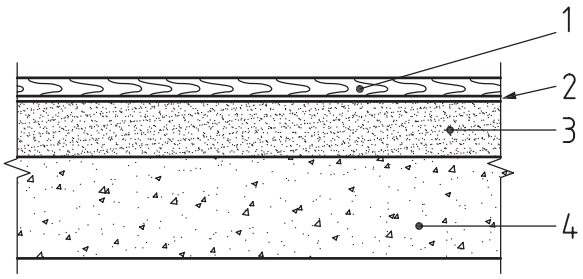
3.31 wood board flooring
solid timber of random length, and varying width exceeding 100 mm installed in parallel rows or multi-layered timber product of proprietary manufacture available in a multitude of widths, thickness and finishes

NOTE Boards are normally tongued, grooved and end matched.

3.32 wood strip flooring
solid timber of random length and varying width not exceeding 100 mm to be installed in parallel rows

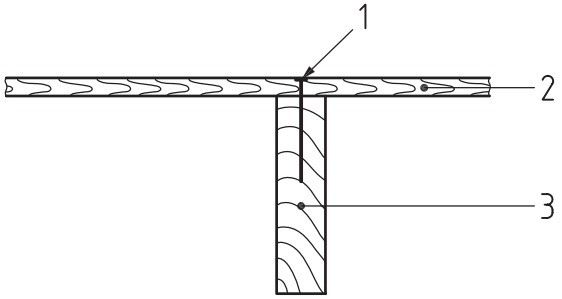
NOTE The strips are normally tongued, grooved and end matched.

Figure 1 **Typical forms of fixed floor construction for use with timber or wood-based panel flooring**



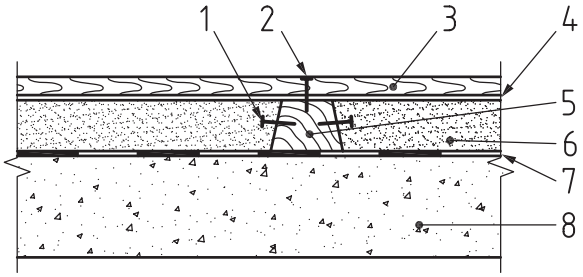
a) Floor glued down to a subfloor of screed or wood

Key
1 Flooring
2 Adhesive
3 Screed
4 Concrete base



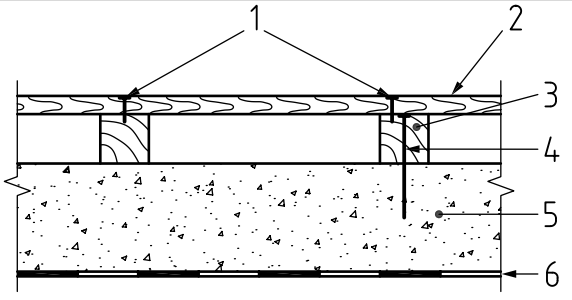
b) Suspended timber floor

Key
1 Fixing nail or screw
2 Flooring
3 Joist



c) Batten held in position by in-filling and located over sandwich damp-proofing

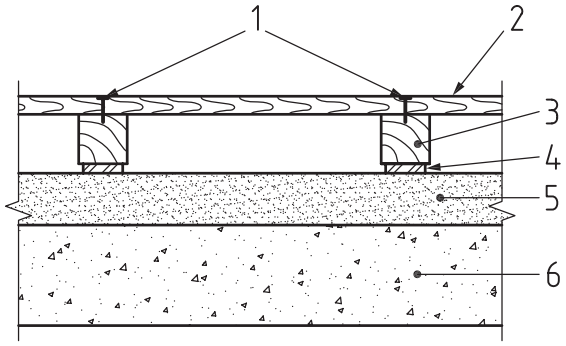
Key
1 Clout nails
2 Fixing nail or screw
3 Flooring
4 Vapour check
5 Batten
6 Insulating screed
7 Damp-proof membrane
8 Concrete base



d) Batten held in position by plug and screw fixing and located over surface damp-proofing

Key
1 Fixing nails or screws
2 Flooring
3 Batten
4 Plug and screw fix
5 Concrete base
6 Damp-proof membrane

Figure 2 **Typical forms of floating floor construction to provide impact and airborne sound resistance (e.g. between flats)**



a) Flooring fixed to battens on resilient pads or strips

Key

1 Nail or screw fixing (should not project through batten)

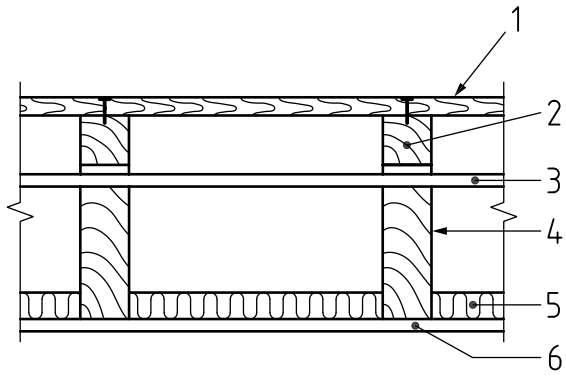
2 Flooring

3 Batten

4 Resilient pad or strip

5 Screed

6 Concrete base



b) Flooring fixed to battens on subfloor over joists

Key

1 Flooring

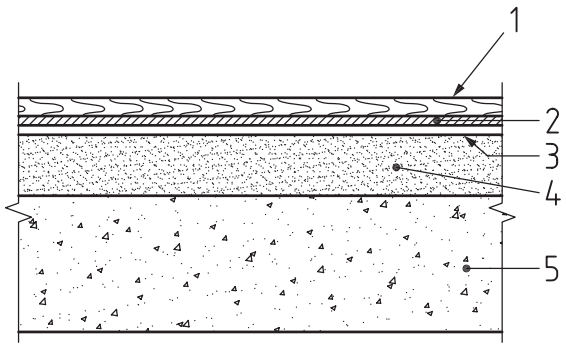
2 Batten

3 Subflooring

4 Joist

5 Insulation

6 Ceiling



c) Flooring loose-laid on concrete base

Key

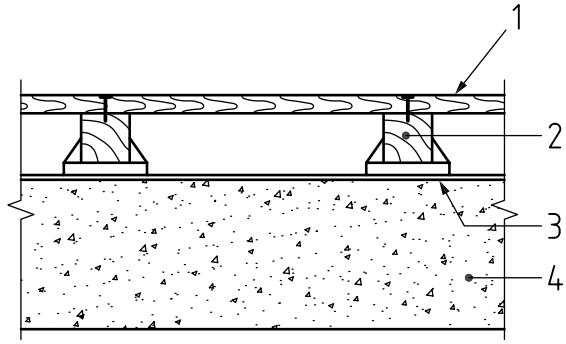
1 Flooring

2 Underlay

3 Vapour check

4 Screed

5 Concrete base



d) Flooring fixed to battens in cradle support

Key

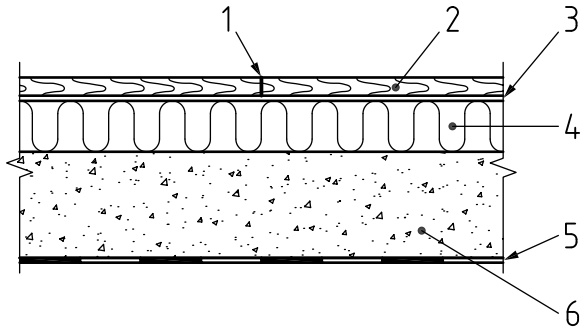
1 Flooring

2 Cradle and batten

3 Vapour check

4 Concrete base

Figure 3 **Typical forms of ground floor construction for use with wood-based panel products**



a) Panel flooring carried on continuous layer of insulating material

Key

1 Glued tongued and grooved joint

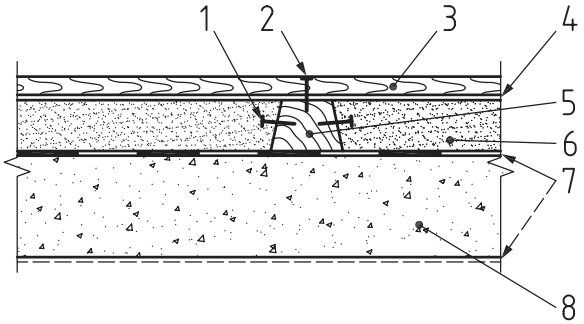
2 Flooring

3 Vapour check

4 Thermal insulation layer

5 Damp-proof membrane

6 Concrete base



b) Panel flooring fixed to battens on concrete

Key

1 Clout nails

2 Fixing nail or screw

3 Flooring

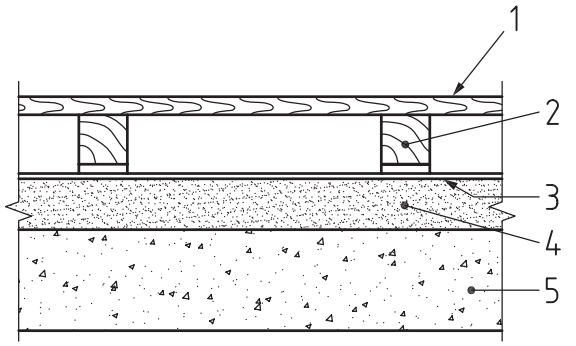
4 Vapour check

5 Batten

6 Insulating screed

7 Damp-proof membrane (or below concrete base)

8 Concrete base



c) Panel flooring fixed to floating battens

Key

1 Flooring

2 Foam backed batten

3 Vapour check

4 Screed

5 Concrete base

4 Performance factors

4.1 General

Wood flooring should conform to BS EN 14342; wood-based panels should conform to BS EN 13986.

NOTE The suitability of wood for flooring use depends on resistance to wear, resistance to dimensional change (movement), appearance and other factors.

Quarter-sawn material usually gives better stability than plain sawn stock. Plywood has some advantages in economy of material and in fixing but, due to comparative thinness of face veneers, has less tolerance to wear than solid boarding.

4.2 Temperature and moisture

Where the range of atmospheric humidity is likely to be wide or where seasonal moisture changes are likely to be large, e.g. with underfloor heating, the width of the floorboards should be as narrow as practicable.

NOTE 1 With underfloor heating the appearance of gaps is less noticeable if the widths of the flooring elements are kept as narrow as practicable.

If a wood floor is desired in a situation where it might be subject to frequent wetting, species with good natural resistance to liquid and low movement should be chosen. Additional coats of protection should be applied in these cases. The manufacturer's recommendations should be followed when using all these materials.

NOTE 2 Timber flooring is affected by exposure to dampness and wetting and is therefore designed for dry areas or for areas subject to minimal liquid exposure. Where the floor is to be subject to pooling water that is not cleaned up in a timely manner, the use of a wood floor is not advisable.

NOTE 3 Seals provide excellent wearing properties but might produce "fissure cracking" or "rafting" in newly installed floors which have contracted. For further details on floor surface treatment, see TRADA's guides to seals [1, 2, 3].

4.3 Impact resistance

End grain wood blocks (see **3.5**) should be used in industrial premises where the use of wood is required for its sound reducing qualities and for its ability to absorb impact from heavy objects, e.g. castings, without damage to the object and without unacceptable damage to the floor.

NOTE These blocks are usually impregnated to improve durability and to reduce movement problems.

End grain wood blocks are normally supplied as proprietary items and the manufacturer's recommendations for installation should be followed.

4.4 Resistance to abrasion

Resistance to abrasion is an inherent variable characteristic of wood species, with a higher resistance to abrasion generally commensurate with a higher density. Resistance to abrasion of a floor finish is dependent on the nature of the coating materials. Choice of either wood species or floor finish should be based on the anticipated wear to which the floor is to be subjected. For unfinished or waxed wood Tables B.1 to B.11 provide useful guidance. For proprietary coatings, seek manufacturer's guidance.

NOTE It is emphasized that none of the normal finishes for floors can "upgrade" the classification in the tables of a species by improving its natural ability to resist abrasive action. This resistance is mainly governed by the particular nature of its anatomical structure. In general, the influence of a floor finish is superficial and not effective in depth.

4.5 Acoustic and impact sound insulation

The sound attenuation properties of a floor are dependent on the entire floor construction; when the finished floor forms an integral part of the acoustic system for sound attenuation between dwellings, installers should work precisely to the flooring designer's details ensuring that mechanical fixings do not breach any separation layer.

NOTE Acoustic and impact sound insulation is as much a matter of construction as of materials. Figure 2 gives typical examples of floating floor construction intended for this purpose. Attention is drawn to the Building Regulations [4, 5, 6]. It is advisable to consult Robust Details (www.robustdetails.com) for advice on acoustic and impact sound insulation.

4.6 Slipperiness

Where a slip resistance is specified, testing should be in accordance with DD CEN/TS 15676. Sports floors should conform to BS EN 14904.

NOTE 1 An increase in slipperiness is almost certainly linked to surface contamination owing to improper or insufficient maintenance. Generally, finishes on wood or wood-based panel floors have a low potential for slip in dry conditions. However, if they are allowed to get wet, for example with spillages, the potential for slip increases.'

Specialist slip resistant site applied coatings should be applied if the spillages cannot be managed.

NOTE 2 In dry conditions, most wood-based flooring falls within the Low Potential for Slip category when tested in accordance with BS 7976-2, and remains so if it is finished and maintained in accordance with the manufacturer's recommendations.

4.7 Thermal insulation

NOTE 1 The thermal resistance of wood varies with the species but is in the order of 0.13 m^2 K/W. In recent years, underfloor heating has been used more commonly with wooden flooring.

Wood materially reduces heat transfer through the whole floor construction, and thus wood flooring should only be considered over an underfloor heating installation with full prior consultation with the heating engineer and the floor supplier. The heating engineer should be informed of the thickness of the wood flooring to be used along with the thermal conductivity and thermal resistance so that this can be taken into account in the heating calculations.

NOTE 2 The low thermal capacity of wood provides a surface which is readily warmed and upon which moisture vapour is unlikely to condense.

*NOTE 3 See **12.6** for further information on underfloor heating. Figure 3 shows typical ground floor constructions having improved thermal insulation.*

4.8 Fire performance

*COMMENTARY ON **4.8***

For all floors above the lowest floor, it is the fire resistance of the complete floor construction that is of primary importance in a fire, and the reaction to fire (ignitability and surface spread of flame) characteristics of wood flooring itself are not normally significant for the purpose of evacuating a building.

4.8.1 Fire resistance

The fire resistance of a floor is dependent upon the entire floor construction and should be determined taking into account only those elements considered as permanent unless there is specific advice to the contrary.

NOTE For a wood floor this would include the permanent structural floor deck but not the decorative finished floor which could be removed or replaced at any time.

4.8.2 Reaction to fire

*COMMENTARY ON **4.8.2***

Wood is a combustible material and, in the densities normally used for flooring (greater than 400 kg/m^3), has surfaces of class 3 flame spread as determined by the tests described in BS 476-7. Wood flooring is classified as "P" by the ignitability test described in BS 476-12.

Reaction to fire should be assessed using either the European standard based system or the British Standard system. When using the British Standard system, flame retardance and smoke production of wood-based flooring should be assessed in accordance with BS EN 13501.

NOTE 1 There are seven fire classes for both floor surfaces and other building surfaces: A1, A2, B, C, D, E and F. Most wood floors are in categories C or D and therefore have an average fire safety rating. In addition to the origin and spread of fire, information is also required for the classification of smoke production. There are three smoke classification groups: S1: Minimal smoke production; S2: Average smoke production; and S3: Large smoke production. Most wood floors belong in category S1.

When using the European standard based system, wood-based flooring should be assessed in accordance with BS EN 13051-1.

NOTE 2 A typical classification for wood and wood-based panels used in flooring would be D_{fl}-s1 with specific installation requirements (e.g. without an air gap) or E_{fl} for any end use condition. See BS EN 14342.

4.9 Formaldehyde release

Where formaldehyde-containing materials, particularly aminoplastic resins or coatings, have been added to the wood or wood-based panel flooring as part of the production process, the product should be tested for the release of formaldehyde and classified into one of two classes, E1 or E2, in accordance with BS EN 14342:2005+A1 (for solid wood flooring) or BS EN 13986 (for wood-based panels). All timber flooring products should conform to BS EN 14342 or BS EN 13986, which set out the level of formaldehyde permitted in timber products.

4.10 Colour sensitivity

Wood is sensitive to light; it affects the colour of the wood over a period of time, varying from species to species and this should be considered at the design stage.

5 Care on site

On site, all materials intended for flooring should be stacked carefully to retain flatness. They should be stored in a weathertight and dry environment with conditions that maintain the moisture content at the level recommended for laying (see **12.5.3**) and as close as possible to the conditions of the finished building.

Unless there is a particular need to acclimatize the flooring, delivery should be programmed to ensure the shortest possible storage period. The moisture content of timber and wood products should be checked immediately upon receipt on site or, if well protected by moisture resistant wrapping, when unwrapped. Packages should not be undone until fixing is to take place.

Before flooring is laid, all other building operations should, as far as possible, have been completed. All wet trades should be completed and fully dry. However, the fixing of skirtings, architraves and other similar finishings should be deferred until after the floor has been installed.

The laid flooring should be kept clean and free from cement, plaster droppings and other debris likely to cause damage. As the flooring is laid, it should be protected progressively with suitable material. If plant such as trestles, ladders or steps has to be used, parts resting on the flooring should be provided with protective padding. No plant should be slid over the finished flooring.

A suitable permanent division strip, allowing for the movement of the timber flooring, should be inserted at any change in the flooring to protect the exposed edge.

NOTE This might also be appropriate at doors/openings between separate rooms, refer to manufacturer's advice.

Where flooring has to be sanded and sealed on site, for example in accordance with the recommendations of **15.6**, such sanded finish should encompass all of the upper surface. Sanding papers of appropriate grits should be used in sequence to achieve an all-over smooth surface free from score marks.

NOTE Squash courts are finished with a 60 grit paper and unless specified otherwise are left unsealed.

Wood shavings and other debris should be prevented from accumulating under a floor as this can lead to a fire hazard or to infestation by vermin.

6 Exchange of information

In order for the wood flooring to be correctly installed under appropriate conditions, all parties should have a clear understanding of the requirements of the project [see list a) to ii)], and of the implications for all concerned. To ensure that this is achieved, there should be wide consultation between all parties involved in the project, including sub-contractors and materials suppliers. This consultation should start early in the design stage but is necessary throughout the contract, especially if requirements or the time scale change and as new-contract work is initiated.

The information to be exchanged should include whichever of the following are applicable:

a) location, access, unloading and storage facilities;

b) construction of base;

c) type, thickness, species, grade and use of flooring;

d) method of heating the building;

e) type and location of damp-proofing;

f) type, thickness and finish of screed;

g) level of finished floor;

h) preservative treatment;

i) work consequent upon services passing through the flooring;

j) type of underlay;

k) method of fixing;

l) treatment of skirtings and abutments;

m) provision for expansion and position and treatment of expansion gaps;

n) treatment of junctions with adjacent flooring;

o) any dressing or polishing required;

p) method of and responsibility for protection of the completed work;

q) lighting and power supply;

r) any special site or contract conditions applicable;

s) time schedule for progress of the work and its relationship to the work of other trades, particularly wet trades;

t) type of use;

u) type and density of foot and/or wheeled traffic;

v) loadings;

w) specific requirements;

x) acoustic requirements;

y) whether upper floor, ground floor or below ground level;

z) whether ground-supported or suspended construction;

aa) particulars of any under floor heating installation or security installation;

bb) curing and drying times of screeds and bases likely to be required before the installation of floor coverings;

cc) screed or base with finished floor level, permissible departure from datum and class of surface regularity required;

dd) in refurbishment work, the type and condition of existing base or floor finish and any type of treatment required;

ee) type of damp-proof membrane and position within the floor construction, in particular, the need for specialist surface applied membranes where likely drying times for the base exceed time available in the programme;

ff) choice of substrate, underlayment, adhesives, intermediate products and floor coverings;

gg) requirements for direction of material and the position and type of expansion joint profiles;

hh) size, position and design of barrier matting; and

ii) advice on regular routine maintenance requirements (see Section **9**).

Where a Building Owner's Manual is required, all the necessary information should be provided for inclusion, e.g. species of timber, where used and maintenance procedures.

7 Time schedule

The time schedule should include dates for the following:

a) delivery of materials;

b) start and completion of the various sections of the flooring.

When a time schedule is prepared, arrangements should be made, amongst other things, for:

1) all services to be installed and tested before the flooring is laid (see **12.6.5**);

2) any concrete and screed in the base or any adjacent bases and any wet plaster to have time to dry before the flooring is laid (see **12.4.6**).

Section 2: Materials

NOTE The names used for the wood species referred to in this British Standard are in accordance with the nomenclature given in BS EN 13556.

The classification of softwoods and hardwoods is botanical. Softwoods, belonging to the order Coniferae (conifers), include European redwood, European whitewood, Douglas fir, hemlock and yew. Hardwoods, belonging to the order Dicotyledoneae (broad leaf trees), include, for example, oak, beech, teak, maple and balsa.

8 Selection of flooring type

Careful consideration should be given to the selection of the form of the flooring, whether board, strip, blocks, mosaic or panel products, taking into account all the performance factors (see Clause **4**) applicable to the intended use, wood species capabilities, charateristics and availability.

9 Selection of wood species

The suitability of hardwoods and softwoods for various flooring applications should be based on the known performance of the wood species. The listings for different flooring end use applications given in Table B.1 to Table B.11 should be used as an initial reference (this information was derived from the annex to Forest Products Research Laboratory Bulletin 40 [7]) together with all pertinent performance factors given in Clause **4**.

*COMMENTARY ON Clause **9***

The suitability of wood species listed in Table B.1 to Table B.11 is based on comprehensive research, together with a long history of satisfactory use over many years, providing a valuable information resource when determining which wood species are most appropriate for particular flooring applications. The lists have been included, in their entirety, from the previous edition of this British Standard.

The listed species are recommended as having performance suited to use as flooring, mainly in wood strip, board or wood block form but not as end grain blocks. The list is not exhaustive and the omission of any particular wood species does not imply that it is necessarily unsuitable for flooring. At the same time the inclusion of a wood species in the list does not imply that it is always readily available on the market.

Those species mentioned as especially suited to particular conditions of service can be used under other conditions when they possess the necessary properties. Some species have been included therefore in more than one group. It ought to be appreciated, however, that the various species indicated as suitable for any particular service conditions might not all be equally suitable in every respect.

The species listed are a selection only. Property requirements for each category of use are given in "Timber selection by properties, the species for the job, Part 1: Windows, doors, cladding and flooring" [8] where additional timbers are listed.

For further information on the selection of wood species, see Annex B.

10 Selection of panel products

NOTE For guidance on the selection of timber species, see Annex B.

10.1 General

*COMMENTARY ON **10.1***

Solid timber has been extensively used and tested and can be expected to last the life of the building. However, it is not possible to be as definite about the wear of panel products. The recommendations given in this subclause apply to an exposed wearing surface and not to the basic flooring structure, and it is assumed that the wearing surface will have applied to it (and suitably maintained) a surface finish comparable to that which would be given to a hardwood or softwood floor in the same performance classification.

Where floors have a structural function, the thicknesses, related spans and fixings of wood-based panels should conform to BS 8103-3 or be in accordance with the manufacturer's recommendations.

Wood-based panels are generally available in sizes based on a 300 mm modular dimension, with the customary sizes being:

a) square edged: 2 400 mm × 1 200 mm;

b) tongued and grooved: 2 400 mm × 600 mm.

The availability of smaller panels should be established before being specified.

Wood-based panels intended for use as finished flooring should not be exposed to the weather before or during construction. The floor should only be laid once the building is weather proof and all wet trades completed.

10.2 Plywood and blockboard

NOTE Plywood and blockboard are considered suitable only for 'light' and 'normal' pedestrian traffic.

Where the face veneer is to become the wearing surface, the wood should be of a suitable species (see Annex B for guidance) and of sufficient thickness to accommodate the anticipated wear. Panels sanded on at least one surface should be used to reduce variety of thicknesses between panels.

For face veneers that have a coating applied, consideration should be given to the density of the species used (e.g. a high density gives better wear characteristics than a plywood with lower densities).

Blockboard should not be used without continuous support (see **29.3**); in consequence, the panel thickness of blockboard is determined by the service conditions applicable to the situation where the blockboard is used.

Plywoods and blockboards should conform to BS EN 636 and be of a suitable grade for their end use. BS EN 636:2003, Clause **6**, should only be used in situations where there is no possibility of high humidity. BS EN 636:2003, Clause **7**, and BS EN 636:2003, Clause **8**, should be used where high humidity is likely, such as in bathrooms, washrooms, lavatories, ground floors or kitchens.

10.3 Particleboard

*COMMENTARY ON **10.3***

Particleboard is usually suitable for light and normal pedestrian traffic in domestic situations.

Type P4 or P6 particleboard conforming to BS EN 312:2003 should only be used where the possibility of high humidity does not need to be allowed for (e.g. upper floor bedrooms).

Type P5 and P7 particleboard conforming to BS EN 312:2003 should be used in those situations where the particleboard is likely to be exposed to high humidity (e.g in bathrooms, washrooms, lavatories, ground floors or kitchens).

Wood-based panels intended for use as decorative flooring should not be exposed to the weather before or during construction. The floor should only be laid once the building is weather proof and all wet trades completed.

NOTE Types P4 and P6 are intended only for use in non-humid environments. The National House-Building Council (www.nhbc.co.uk) standards do not recommend type P4 or P6 for use in domestic floors.

10.4 Oriented strand board (OSB)

*COMMENTARY ON **10.4***

OSB is usually suitable for light and normal pedestrian traffic in domestic situations.

An OSB with a sanded finish should be used.

OSB/2 conforming to BS EN 300:2006 should only be used where the possibility of high humidity does not need to be allowed for (e.g. upper floor bedrooms).

OSB/3 conforming to BS EN 300:2006 should be used in situations where the particleboard is likely to be exposed to high humidity (e.g in bathrooms, washrooms, lavatories, ground floors or kitchens).

NOTE 1 The National House-Building Council (www.nhbc.co.uk) standards do not recommend type OSB/2 for use in domestic floors.

NOTE 2 Where there might be subsequent installation of a glued surface covering it should be confirmed that adhesives used are compatible with both the base and the floor covering.

10.5 Hardboard

NOTE Standard hardboard type HB as specified in BS EN 622-2:2004 is suitable for use as a surface subjected to light pedestrian traffic.

Tempered hardboard type HB.E as specified in BS EN 622-2:2004 has a surface suitable for light and normal pedestrian traffic. It provides a slip resistant surface when installed screen-side up.

The overall thickness of hardboard should be related to the intended use as follows:

a) for normal use: 3.2 mm;

b) for floors with open joints (e.g. some square edge boarding): 4.8 mm or 6.4 mm.

11 Basic recommendations

11.1 Freedom from defects

All wood flooring should be free from:

a) rot;

b) active insect attack; and

c) defects that would detract from the suitability of the flooring, e.g. unstable splits, shakes and loose knots.

NOTE 1 For softwoods within the scope of BS 1297, some minor defects are permissible.

NOTE 2 The maximum dimensions of sound and tight knots, and limits on other defects in tongued and grooved or strip flooring of softwood are specified in BS 1297. In certain cases, it might be desirable further to limit the size and number of firm knots in the exposed face of softwood flooring. In other cases, it might be reasonable to allow a relaxation in the normal requirement for hardwood floors. These cases fall outside the scope of this British Standard and, if changes are required, they ought to be the subject of separate agreement between the purchaser and the supplier. If pinholes are so permitted, they ought to be filled with a suitable filler. Pinhole borers (ambrosia beetles) cannot live in wood after it has been cut and dried.

NOTE 3 Many producers of solid wood flooring now offer proprietary named products (e.g. "rustic") which use growth characteristics for different appearance grades. Such products reflect the producer's own quality requirements with regard to grading, appearance, performance and strength.

11.2 Colour variations

Natural colour variations in both softwood and hardwood should be expected but if for a particular contract more uniform colour is required, this should be arranged by prior agreement between the purchaser and the supplier. In such cases, the level of acceptance should be clearly specified preferably after discussion between the parties on the cost and other implications.

11.3 Softwood and hardwood

Tongued and grooved softwood flooring should conform to BS 1297. Sizes of hardwood flooring should conform to BS EN 1313-2.

11.4 Blocks

Blocks should generally conform to BS 1187, although some manufacturers produce blocks of overall dimensions outside BS 1187 limits.

11.5 Mosaic fingers

Mosaic fingers should be in accordance with BS EN 13488. The layout of the individual fingers within a panel should be such as to maintain a regular pattern over the whole of the floor.

11.6 Parquet strips

Parquet strips should be not less than 6 mm thick.

11.7 Adhesives

Adhesives should of an appropriate type and should be applied in accordance with the manufacturer's instructions.

11.8 Nails

Except where masonry nails are recommended, nails and pins should conform to BS 1202-1 and should be selected, as appropriate to the use (see **12.7.2**), from the following list:

a) round plain head nails ("normal" nails);

b) round lost head nails;

c) oval lost head nails;

d) oval brad head nails;

e) annular-ringed shank flat head nails ("improved" nails);

f) clout nails; and

g) panel pins.

In addition, the use of lost head screw shank nails or machine nailing using a portable nailing machine is permissible; in both cases, the manufacturer's recommendations regarding usage should be followed.

11.9 Woodscrews

Woodscrews should conform to BS 1210 and should be not less than size no. 8.

Section 3: Design and installation

12 Design and installation considerations

12.1 Suitability for loads expected in use

Point, uniformly distributed and rolling loads to which the floor is likely to be subjected should be considered and reference should be made to load classes in BS EN 1995-1-1 and BS EN 1991-1-1. Imposed loads to be allowed for should be as given in NA to BS EN 1991-1-1.

Resistance to indentation arising, for example, from fork lift trucks or from machinery, can be considered as one of the attributes of resistance to wear, and species suited to heavy duty industrial floors as listed in Table B.5 should be specified when resistance to indentation is required.

NOTE 1 Additional information often is available from manufacturer's literature.

NOTE 2 The performance characteristics of area elastic or sprung floors which are designed to give resilience and good shock absorbency can be compromised by the extra reinforcement needed to take heavy static or rolling loads such as from retractable seating units. It is advisable to consult the manufacturers for design advice on this.

12.2 Avoidance of squeaking

*COMMENTARY ON **12.2***

Floating floors involving boarding or panel products fastened to battens laid on resilient mineral fibre (see Figure 2) or floating timber floors laid on an underlay over uneven subfloors can make squeaking noises when walked upon.

Deeper battens and improved nails or screws should be used to minimize squeaking, and bases or subfloors should be levelled out to the required flatness tolerances.

For floating panel floors, there should be a gap of not less than 3 mm between the floor panel and the bottom of the skirting.

NOTE Screws allow for later adjustment to accommodate any drying shrinkage. Squeaking of softwood tongued and grooved boards can be largely eliminated by the use of a latex or other suitable adhesive between boards and joists. Squeaking of tongued and grooved particleboard sheets can be reduced by the use of a polyvinyl acetate emulsion adhesive in the tongued and grooved joints.

12.3 Construction of fixed and floating floors

*COMMENTARY ON **12.3***

The floating floor is the most usual form of construction. Some typical configurations of these floors are shown in Figure 2. By virtue of their resilience, these methods provide effective reduction in impact sound. Other designs of fixed and floating floors are available including several proprietary systems.

Systems selected with should be designed for the particular situation in which it is to be used, and the designer's and manufacturer's advice should be followed.

NOTE For further information on floating floors, see the WPIF "Code of practice for particleboard and oriented strand board (OSB) floating floors" [9].

12.4 Construction of bases

12.4.1 Access to underfloor services

Proper provision for access covers should be incorporated at critical points, e.g. pipe junctions (see **12.6.6**).

NOTE Attention is drawn to the Building Regulations [4, 5, 6].

12.4.2 Surface finish and level of subfloor

12.4.2.1 General

A base should be rigid and adequately level and flat.

The surface finish of a concrete or screed base should be in accordance with BS 8204-1. Particular attention should be paid to movement joints and to screed and bay junctions so as to avoid undulations and other surface irregularities as these could prevent proper bedding of the flooring or impair its adhesion. The designer should detail the required tolerance within the specification. In the absence of a tolerance specification, the finished floor flatness should be in accordance with BS 8204-1. There should be a flatness tolerance of a gap no more than 3 mm showing under a 2 m long straight edge.

The variation in surface level of a timber subfloor should be within the same limits recommended for relevant concrete bases.

12.4.2.2 Deviation from datum

The maximum permissible deviation of the level of the finished floor from a specified or agreed plane should be specified, taking into account the area of floor and its end use.

NOTE For large areas (greater than 25 m^2), a deviation of 15 mm from the datum is generally considered to be satisfactory. Greater accuracy to datum can be necessary in small rooms, along the line of partitions walls, in the vicinity of door openings and where specialized equipment is to be used or installed directly to the floor. See BS 8204-1. For an area under 5 m × 5 m, a maximum deviation of 5 mm from datum is considered acceptable.

12.4.2.3 Cupping

Owing to the natural movement of in-service timber flooring because of the changing ambient environment in which it is installed, some convex or concave cupping across the face of the boards can be expected. The limits that are considered acceptable should be no more than 0.2% of the face width for engineered multi-layered wood flooring products and 0.3% of the face width for a single piece of machined solid wood flooring. In both cases, up to 0.5 mm maximum should be regarded as acceptable.

12.4.2.4 Lipping

The maximum permissible lipping between wood flooring product when in service should be no greater than 0.5 mm.

12.4.3 Battens in screed

Some forms of construction involve the placing of a cement/sand screed around timber battens [see Figure 1a) and Figure 3b)] and where this form of base construction is used, the subsequent stability of the batten should be assisted by inserting clout nails in the battens as illustrated. The clout nails should be located at 450 mm centres along each side of the batten, staggered centrally. To provide a key with the screed, each nail should be left not less than 6 mm proud of the timber surface.

NOTE Preservative treatment of timber battens might also be necessary.

12.4.4 Protection against fungal attack of battens in screed

Where timber battens are to be used in contact with screed, they should be treated with a preservative in accordance with BS 8417:2011, use class 2, 60-year service life.

NOTE Fungal attack is unlikely to occur in wood and wood-based materials when their moisture content is less than 20%.

12.4.5 Protection against ground water and vapour

To maintain wood flooring or any timber subfloor within safe moisture content limits, any concrete/sand cement base which is in contact with the wood flooring or timber subfloor and in contact with the ground should be provided with a damp-proof membrane against the ground (see Figure 1 and Figure 3), and a suitable vapour check membrane against the wood flooring. If it is suspected that an existing concrete base does not have a damp-proof membrane, an appropriate membrane should be installed on the surface of the concrete/sand cement base.

NOTE It is important to note that the sole function of any adhesive in the system is to bond the flooring to the base and it is not to be regarded as performing the function of a vapour check membrane unless specifically designed to do so.

With joisted suspended ground floors, even with a layer of oversite concrete, with or without a damp-proof membrane, adequate through-ventilation of the void between the concrete and the floor should be provided to prevent a build-up of moisture and/or moisture vapour.

With concrete plank or beam and block ground floors, adequate through-ventilation of the void under the ground floor should be provided to prevent a build-up of moisture and/or moisture vapour. Beam and block construction floors, whether finished with cement-sand or screed, should incorporate a vapour control layer on the top surface.

12.4.6 Eliminating construction moisture

Before moisture sensitive flooring is laid on any concrete or screeded base, it should be ensured not only that the floor is constructed to prevent moisture from reaching it from the ground, but also that sufficient of the water used in the construction has dissipated. The excess water or residual dampness in the concrete base (above any membrane) should be allowed to evaporate, and the time that this is likely to take should be taken into account at the planning stage.

Timber flooring which is to be floated or nailed to a batten system incorporating a vapour check membrane should not be laid until a hygrometer test carried out in accordance with Annex A gives a reading of not more than 75% relative humidity (RH).

For floors which are to be directly stuck down with full-spread adhesive without a vapour check membrane, this figure should not be more than 65% RH but for materials with a width-thickness ratio of 4:1 or less, 75% RH may be considered acceptable.

NOTE 1 Independent studies have shown that non-invasive tests or hygrometer sleve tests described in Annex A are the only suitable methods relevant for use in conjunction with installation of floor coverings. Other methods of test are available including conductivity instruments but these are only to be regarded as an approximate guide.

The 75% RH figure is regarded as the level to which a protected floor of wood or wood-based panels can be fitted, so a vapour check membrane or surface damp-proof membrane should still be installed over the subfloor to protect the wood floor from this low level of moisture.

NOTE 2 Without the vapour check membrane, the wood or wood-based panels are exposed to these low levels of moisture.

For cement-sand screeds laid directly over a membrane, as a guide, approximately one day should be allowed for each millimetre of thickness for the first 50 mm, followed by one and a half days for each millimetre above this thickness. It should be noted, however, that even under good drying conditions (20 C and 65% RH), a 50 mm thick cement sand screed need at least two months to dry. Tests in accordance with Annex A should always be carried out.

NOTE 3 Estimated drying times are necessarily only very approximate as drying is influenced by ambient conditions, screed quality, surface finish and thickness; of these, thickness is the most important.

For thick concrete bases laid directly over a damp-proof membrane, longer drying times are required. The time/thickness relationship used to predict the drying time of cement(s) and sand screeds does not apply to concrete bases. In practice it has been found that even under good drying conditions concrete bases 150 mm thick often take more than one year to dry from one face only. Moderate and heavy use of power-float or power-trowel finishing methods further delays drying.

Suspended concrete bases laid on to permanent metal shuttering or other impermeable materials have similar drying times to those laid over damp-proof membrane.

For slabs which can dry from both sides, about half the thickness can be considered to dry downwards and, in consequence, drying times are reduced in these cases.

Commonly, where floor coverings are to be laid, time schedules do not permit extended drying times for concrete bases. The use of sandwich damp-proof membranes between the base concrete and the screed significantly reduces the time that needs to be allowed for drying.

Proprietary systems either based on admixtures for normal screed and concrete mixes or special cements are available to produce early drying screeds and concrete.In these instances the test method for residual moisture indicated in Annex A might not be appropriate and screed/concrete manufacturer's guidelines need to be followed (see also BS 8204-7).

Where screeds are laid directly on to the concrete bases, without a damp-proof membrane between them, account should be taken of the time required to dry the total thickness of the construction.

Where time scales do not allow sufficient drying times and the use of a sandwich damp-proof membrane is inappropriate, the need for a surface damp-proof membrane either ventilated or surface applied to control the excess construction moisture in the subfloor should be taken into account at the design stage.

NOTE 4 The moisture content of any supporting concrete can be of great importance when impermeable floor coverings are to be laid over parts of the wood floor area.

12.4.7 Surface treatments (where floors are to be stuck down)

12.4.7.1 Chemical hardening solutions

Chemical hardening solutions and resinous seals should not be used on bases and screeds because of the risk of interaction between the hardener and the floor covering adhesives. In cases where hardening solutions have been used and the floor is to be adhered directly to the subfloor, the treated surfaces should be mechanically removed.

12.4.7.2 Curing membranes

Curing membranes might affect adhesion and should be removed using appropriate mechanised equipment.

12.4.7.3 Power floating/power trowelling directly finished concrete

Power floating/power trowelling of directly finished concrete can affect adhesion and the advice of the adhesive manufacturer should be sought regarding the specification for surface preparation.

12.4.8 Use of an existing floor as base for new floor

Where an existing wood floor is to be used as a base for a new wood floor, the existing floor should be sound and dry. It should be inspected thoroughly for possible defects including particularly, any infestations by wood boring insects or attack by wood-rotting fungi in the floor supporting members as well as in the floor itself, and if required, treated in accordance with The Property Care Association's Remedial Timber Treatment Code of Practice [N1]. Sources of moisture should be eliminated, masonry appropriately treated and ventilation improved where necessary. It should be ensured that the structure is strong enough to support the increased weight.

Consideration should also be given to the thickness of the floor as skirting boards and thresholds might need to be raised.

Loose boards should be fixed securely, and defective or worn boards replaced. Before new flooring is laid, any unevenness should be eliminated.

NOTE 1 Underlays accomodate some fine limited unevenness but do not overcome timber subfloors which are not flat.

For any floating floors, other than those which can be levelled, there should be a flatness tolerance of a maximum 3 mm gap showing under a 2 m long straight edge.

The maximum moisture content of existing boards should be within ±2% Mc of the timber floor to be installed. The timber subfloor should be tested using a proprietary moisture metre in accordance with the manufature's instructions.

Existing concrete or stone floors should either meet the criterion for dryness given in **12.4.6** or a specialist surface membrane should be installed to protect the wood flooring.

Where flooring such as mosaic or parquet is to be laid over an existing wood floor, the existing floor should be covered first either with hardboard at least 6 mm thick, or sanded plywood, or blockboard. This covering layer should be laid so that the joints do not coincide with the joints between the existing boards, and should be fixed down securely, starting at the centre of the boards and working outwards, with screws or improved nails at 100 mm centres around the board edges and at joist positions. All fixings should be finished below the surface of the hardboard, plywood, or blockboard layer.

*NOTE 2 For recommendations specific to a new floor of board or strip which makes use of an existing timber floor as base, see **13.2**. For recommendations relating to the renovation of worn floors by covering with wood-based panel products, see Clause **6**dd) and **31.3.5**.*

12.4.9 Other bases

Some existing bases such as clay tiles, concrete tiles or terrazzo are unaffected by dampness, but might be sufficiently permeable to allow moisture to pass through to the back of the floor covering; these bases, which should be otherwise sound, should be damp-proofed when necessary by covering with a surface damp-proof membrane.

NOTE 1 Joints between tiles might cause problems with thin surface damp-proof membranes.

Existing bases such as magnesium oxychloride (magnesite) or those based on polyvinyl acetate/cement or gypsum based screeds are adversely affected by dampness rising through concrete from the ground and should not be covered with a damp-proof layer or with relatively impervious floor coverings. Unless it can be established that there is an effective damp-proof course below these materials, they should be removed.

NOTE 2 Specialist bases designed to improve the thermal and/or the acoustic properties of the subfloor need particular care when installing timber flooring over them as excessive vertical movement adversely affects the performance of the finished floor.

12.5 Anticipated heating conditions and moisture content of wood flooring

12.5.1 General

Flooring should be protected at all stages of storage, laying and in use to ensure that it is retained at the recommended moisture content (see **12.5.3** and Clause **35**).

NOTE Wood is a hygroscopic material; its moisture content, therefore, depends on its environment. The moisture content which the wood attains depends primarily upon the humidity of the atmosphere and, to a lesser extent, upon the temperature. Wood shrinks as the moisture content decreases and swells as it increases. This movement, which varies according to the species, occurs mainly across the grain of the wood and is usually greater in a direction tangential to the growth rings than in a radial direction. The movement values of various species are given in Table B.1 to Table B.11. For most flooring purposes, the longitudinal movement of wood may be ignored.

The importance of using wood at correct moisture content cannot be over-emphasized. If, at the time of fixing, the moisture content is too great, shrinkage is inevitable and it results in unsightly open joints. If the moisture content is too low, swelling can occur, causing lateral pressure to solid floors which can produce lifting. Engineered flooring will move in its length and width.

12.5.2 Method of heating the building

To reduce the dimensional changes which take place after wood is fixed in a building, the temperature and humidity in the building before, during and after laying the flooring should be approximately the same as those which are likely to prevail during occupation. At an early stage, the flooring contractor should be informed of the form of heating to be installed and should also be consulted as to when it would be advisable to turn on the heating for the first time.

Adequate ventilation should be provided and laying should not commence until the initial drying out is complete; this period varies widely with the type of construction and weather and local environmental conditions.

NOTE When heat is first applied, latent moisture within the structure of the building is drawn out and this tends initially to increase the atmospheric humidity.

12.5.3 Recommended moisture content at laying

*COMMENTARY ON **12.5.3***

The range of moisture content at laying depends mainly on the type and intensity of heating to be employed in the building. As a guide, normally the following moisture content ranges are encountered for various heating conditions:

- *Unheated: 15% to 19%*

- *Intermittent heating[1]: 10% to 14%*
- *Continuous heating[2]: 9% to 11%*
- *Underfloor heating: 6% to 8%*

These apply specifically to solid softwood and hardwood but they also provide guidance for wood-based panels. These board materials are commonly manufactured at comparatively low moisture contents, lower sometimes than the value suggested for intermittent heating situations.

Floors for which the quality of finish is of prime importance should be laid at a moisture content within the range likely to be encountered in service. They should be laid after the initial drying out period is complete (see **12.5.2**).

NOTE If floors are laid at higher moisture content or earlier in the building process it can result in unsightly shrinkage gaps.

Before being fixed, hardboard should be conditioned to adjust the moisture content to approximately the recommended levels.

12.5.4 Variability of moisture content

*COMMENTARY ON **12.5.4***

Species of wood can differ in the equilibrium moisture content they attain under given air conditions, and allowance for this might have to be made when specifying the moisture content of the wood. Some guidance on this can be obtained from BRE Technical note no. 38 [10], and in uncertain cases, it is advisable that expert advice [3] is sought.

When measuring moisture content with an electrical moisture meter, the adhesive incorporated in panel products can give rise to misleading meter readings; in such cases the appropriate correction factor should be obtained from the meter manufacturer.

NOTE 1 If a precise moisture is required, oven-dry testing in accordance with BS EN 322 or EN 13183-1 is necessary.

NOTE 2 Panel products have a lower equilibrium moisture content than solid timber for any given relative humidity.

12.6 Underfloor heating and other services

12.6.1 Problems connected with underfloor heating

*COMMENTARY ON **12.6.1***

Underfloor heating beneath wood flooring presents special problems because of the wide range of temperature to which the flooring is subjected.

During the summer or when the heat is turned off for long periods, high atmospheric humidity causes an increase in the moisture content of wood flooring which has been specially dried for heated conditions. This produces lifting or distortion if the floor has been too tightly jointed at the time of laying. When the heat is turned on again, the moisture content decreases, therefore a greater seasonal moisture content variation is to be expected with underfloor heating than with other forms of heating.

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1) "Intermittent heating" implies that the temperature drops substantially between periods of heating.
2) "Continuous heating" implies that the temperature is maintained day and night throughout the year at a reasonably constant level.
3) For example, from the Building Research Establishment (www.bre.co.uk); Timber Research and Development Association (www.trada.co.uk); independent consultants.

Where underfloor heating is involved, particular attention should be paid to selection of species (see **12.6.2**) and dimensions of materials, methods of installation and to moisture content at laying.

The temperature on the top surface of the wood floor should not exceed 27 °C.

Some electrical underfloor heating systems are not compatible with timber flooring and the manufacturer of the timber flooring should always be consulted before installing over underfloor heating systems, particularly regarding the moisture content, species of the timber and specific installation guidelines.

12.6.2 Selection of species for use with underfloor heating

Selection of species for use in floors subject to underfloor heating should be limited to those with particularly small thermal and moisture movement or should be as recommended by manufacturers who have extensive experience in the supply of flooring to be used over underfloor heating.

Construction which permits an air space directly under the floor should be avoided as this can cause undesirable temperature fluctuations but advice on this should be taken from the manufacturers of the underfloor heating.

12.6.3 Precautions prior to handover

Means of keeping the flooring dry and stable in the period between laying and handing over should be provided.

12.6.4 Precautions prior to laying where underfloor heating is to be used

Before floor laying begins, the following procedure should be followed.

The screed should be dried in accordance with **12.4.6**

Once the screed is dry to a maximum level of 75% RH, or 65% RH for floors directly bonded to the screed, the underfloor heating should be commissioned in accordance with the underfloor heating manufacturers guidelines where available.

Where no guidelines are indicated the following protocol should be followed:

a) *Heating up*. The flow temperature should be heated to a specific temperature as follows:

   1) Day 1: 20 °C
   2) Day 2: 30 °C
   3) Day 3: 40 °C
   4) Day 4: 50 °C or the maximum planned operating temperature. This should be maintained constantly for a minimum of 7 days.

b) *Cooling Down*. The flow temperature should be cooled to a specifc temperatire as follows:

   1) Day 12: 40 °C
   2) Day 13: 30 °C
   3) Day 14: 30 °C
   4) Day 15: The underfoor heating should be switched off.

At least 4 days should elapse before final moisture readings are recorded (see **A.4.1**).

If more than 7 days elapse between the last cooling-down day (day 14) and the start of laying, the underfloor heating should be run at a minimum operating temperature of 40 °C for 2 days. The underfloor heating should then be switched off for at least 4 days before a further moisture check is carried out prior to laying.

With some adhesives it is necessary to allow the screed to cool before laying the floor but the ambient humidity and temperature conditions within the area should always be maintained, and it might be necessary to have the moisture content of the screed at a lower level than 65% RH. The adhesive manufacturer's recommendations should be followed.

12.6.5 Testing underfloor services

The flooring installer should ensure that all services (not only heating services) running beneath the floor have been tested fully by the services installer before laying starts.

12.6.6 Access to underfloor services

Adequate provision should be made for subsequent access to services. Sockets or service ducts set in the base should be positioned and fixed before laying commences. Access covers should be adjusted to the final floor level and, where applicable, depth left to suit the overall thickness of the floor finish for infilling of recessed access covers. The design should take into account the required movement/expansion of the wood flooring.

NOTE At access points, it might be necessary to remove the tongue from tongued and grooved boards.

12.6.7 Treatment of pipes

Where hot water or steam pipes (other than those for underfloor heating purposes) pass under the flooring, they should be lagged or otherwise insulated to reduce localized shrinkage of the flooring in that area and they should be fixed at a sufficient depth to avoid possible damage from fixings for the new flooring. Compliant insulation materials should be used to accommodate thermal movement of pipes.

12.7 Fixing

12.7.1 Reference to particular requirements for certain fixings

Flooring should be fixed using either nails or adhesives, or proprietary systems such as clips or tongued and grooved interlocking systems. In some cases, particular types of nail are preferable and in others there are special recommendations regarding nail spacing, pairing, etc.

The use of screws, panel pins or staples is also recommended in certain identified situations but is not recommended in others; where not specifically mentioned, they should not be used.

Reference should be made to the relevant clauses in Section **4** to Section **8** for recommendations applicable to, or advice on suitability of, certain fixings to particular types of flooring and to particular circumstances.

12.7.2 Nails

Nails should be of one of the types listed in **11.8**. Those with plain shanks should have a diameter in accordance with the manufacturer's recommendations and should have a length not less than 2.5 times the thickness of the flooring through which the nail is driven, except in the case of thin sheet materials when the penetration into a timber base should be not les than 19 mm.

NOTE Normal or improved nails may be either hand driven or machine applied. The greater holding power of improved nails much increases resistance to nail-popping but can add to the risk of the wood splitting. Care needs to be taken when nailing close to ends of solid wood components. Pre-drilling at ends obviates the risk of splitting.

12.7.3 Screws

Screws, where used, should conform to **11.9** and should have a length of not less than twice the thickness of the flooring being fixed, except in the case of thin sheet materials when the minimum penetration into a timber base should be 19 mm.

12.7.4 Adhesives

Where adhesives are used, the adhesive manufacturer's instructions should be followed.

Adhesives should be stirred thoroughly in the containers before and during use and should not remain exposed to air long enough for a covering film to form.

Where underfloor heating is to be installed, the adhesives used should be suitable for use on heated subfloors, i.e able to withstand the effects of the heat.

NOTE It is important that the effectiveness and durability of the adhesive is not compromised by use under high temperatures and that any release of harmful volatile organic compounds (VOCs) remains within permitted levels.

Choice of the type of resin adhesive should be made in the light of conditions expected in use and flooring type.

Where the floor is to have a structural function, the use of adhesive should be in accordance with the flooring manufacturer's instructions. For decorative flooring, adhesive conforming to BS EN 204 is usually considered suitable.

12.7.5 Stapling

Staples should be used only for fixing hardboard and plywood not exceeding 9 mm thick but might not be visually acceptable when floors are to be left uncovered.

Where machine stapling is used, the stapling pressure and size of staple should be adjusted to suit the thickness and type of board being fixed.

12.7.6 Clips

The manufacturer's instructions should be followed in terms of size selection and method of installation.

12.7.7 Tongued and grooved interlocking systems

The manufacturer's instructions should be followed.

12.7.8 Corrosion and staining where wood preservatives are present

Care should be taken to ensure compatibility of metal fixings when these are used with treated timber.

NOTE Some preservative treatments used for wood have a corrosive effect on some metals, and some preservative treatments affect uncoated ferrous screws to the extent of causing stains on the timber.

12.7.9 Battens

Softwood battens which are securely fixed to the subfloor should be not less than 22 mm thick and those for floating floors not less than 36 mm thick. Laminated battens for floating floors should be not less than 22 mm thick.

They may be rectangular or splayed in cross-sections and should be of sufficient depth to accommodate the length of fixing.

Spacing of battens should be determined by the design loading and thickness and length of flooring available.

Thickness of battens when incorporated into cradle systems should be in accordance with manufacturer's instructions and the spacing of the battens and cradles should be determined by the design loading of the floor.

Batten ends should be staggered by at least 600 mm and not in line with each other in adjacent rows.

Other specialist systems are available and should be used strictly in accordance with the manufacturer's instructions.

12.8 Preservative treatment

In situations where permanent dampness might occur, wood flooring should not be installed unless appropriate and effective moisture barriers are achievable to ensure that wood and wood-based panel flooring elements remain dry.

Ground floor joists should be treated with preservative in accordance with BS 8417:2011, use class 2, 60-year service life.

NOTE Attention is drawn to the Building Regulations [4, 5, 6] for ventilation of the void under the joists.

The joists should be dried to a moisture content comparable with that of the flooring (see **12.5.3**); before the flooring is fitted, otherwise moisture is absorbed by the flooring and swelling can occur (see **12.5.1**). Any preservative treatment should be carried out prior to delivery of the joists to the site.

12.9 Provision for movement

*COMMENTARY ON **12.9***

*The hygroscopic nature of wood is discussed in **12.5.1** and the movement classification of the many timber species suitable for flooring is explained in **B.1**. Wood-based panel products have special movement characteristics and these are explained in **12.9.6**.*

Changes in ambient conditions (especially changes in humidity) can cause wood floors to move appreciably. Unless suitable provision is made to accommodate movement, the stability of surrounding walls can be affected or undesirable changes in the floor surface might result. In addition, unforeseen expansion can be caused by burst pipes or similar accidents.

12.9.1 Normal expansion provision

In most circumstances, an unfilled expansion gap around the perimeter of the floor should be provided to accommodate movement in a wood floor.

NOTE This gap is referred to subsequently in this standard as a "normal expansion gap". The size of the gap is dependent on the type of wood floor and method of installation, with manufacturer's recommendations followed where appropriate. See Annex C for further guidance.

These expansion gaps should also be provided at all other abutments such as radiator pipes, thresholds, door linings, floor sockets, etc.

Every expansion gap should be kept clear of debris and should be masked by a skirting board or similar detail. The skirting board should not be fixed to the flooring.

12.9.2 Other expansion provision

The particular types of floor where the expansion gap should vary from normal are as follows.

a) In some cases movement might need to be accommodated by provision of a resilient joint.

b) For large floors, neither an expansion gap nor a compliant joint alone would be sufficient because cumulative expansion could be far greater than any reasonable width of gap or compliant material could accommodate and fixings would become loose if such large movements occurred. With these floors, irrespective of the flooring material used, there is a practical limit to the acceptable size of an expansion gap. The exact provision for expansion varies according to the circumstances in each case but, in general, arrangements should be made to accommodate movement within the space between each individual board or panel or at predefined regular intervals.

12.9.3 Board, strip, pre-assembled boards and multi-layered boards

These products do not expand significantly along their length, so a smaller expansion gap across the lie of the boards may be provided. However, a normal expansion gap should be provided at the floor edges parallel to the lie of the boards.

All solid boards should have provision for movement within the space between each individual board or panel or at predefined regular intervals.

As the boards and strips expand mainly across the width, boards and strips should be laid in such a direction that the number of boards or strips is kept to a minimum. Expansion gaps at doorways should be provided if necessary where timber is laid through rooms. Usually, the boards or strips should be laid parallel to the longest wall. The position of doors and windows should also be considered and the direction of existing floor boards or joists.

Boards and strips should be laid in as random a pattern as is possible and header joints and stave ends should not fall in line with each other and should be at least two strip widths apart in adjacent runs.

Narrow width boards should be used to obviate excessive shrinkage, as the shrinkage gap per board is related to width. To avoid unacceptably wide gaps between boards or splits between fastenings, species classified as "classification 3, large movement" should not be used.

12.9.4 Block and mosaic

Wood block or mosaic flooring should be dealt with similarly to board and strip (see **12.9.3**) except that provision should be allowed for the fact that these items laid in patterns other than brick pattern [see Figure 4a)] expand and contract in both directions. Thus, a normal expansion gap or a compliant joint should be provided around the perimeter at or near the edges.

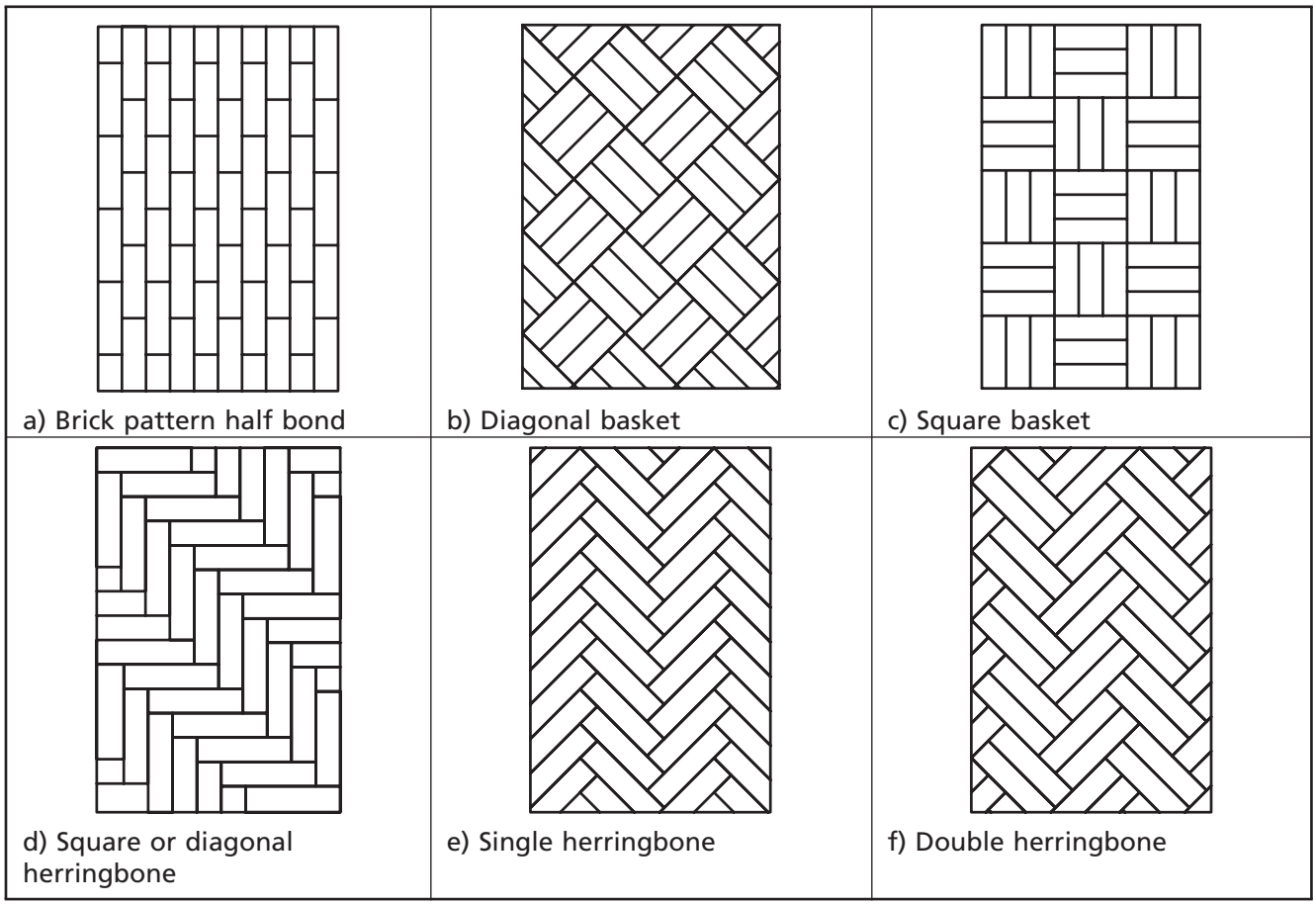
NOTE Blocks or mosaic laid in brick pattern expand only across the width of the floor, and in such a pattern, provision for movement need only be made at the edges parallel to the lie of the brick courses.

The floor should generally be set out so as to achieve a symmetrical layout but dimensional variations might dictate that an alternative be considered. The first two lines of blocks should be laid on each side of an approximate centre line (crown line) and should then continue outwards leaving appropriate expansion to the perimeter, including border detail where appropriate. A range of designs for wood block flooring is shown in Figure 4.

Larger rooms should be considered in the same way as described for board and strip (see **12.9.3**). In these rooms, species classified as "classification 3, large movement" should not be used. As an additional precaution, the blocks should be dried, on average, near to the upper of the two limits of moisture content given in **12.5.3**.

NOTE This approach is likely to give rise to a small amount of shrinkage but expansion problems might be avoided.

Figure 4 **Typical range of designs for wood block flooring**



12.9.5 Overlay and parquet

Overlay and parquet is generally in an inherently stable form but, as a precaution, floors of overlay and parquet nevertheless should be provided with a normal expansion gap (see **12.9.1**).

12.9.6 Panel products

*COMMENTARY ON **12.9.6***

*Different panel products react differently from one another. Plywood, due to cross banding of veneers tends to be inherently restrained, and movement of plywood is in consequence small. Particleboard, however, even though conditioned (see **30.2**), expands and contracts with changes in moisture content more significantly than plywood. Normally hardboard is conditioned (see **30.3**) and is fixed firmly in place. Because of this, hardboard in general is unlikely to provide a movement problem; rebated hardboard panels, however, are fixed differently and involve special considerations.*

In floors using plywood, blockboard, OSB or particleboard, a normal expansion gap (see **12.9.1**) should be provided for all floors.

NOTE In the case of plywood this is a sensible precaution, but for the other products the gap is essential.

A gap should be provided around the perimeter of a floor to upstands or abutting construction to allow for possible expansion of the flooring, see Table C.1. The gap should be left open and covered by a skirting board, or filled with a suitable compressible strip.

For floors where the movement gap cannot be incorporated at the perimeter alone or which are in excess of 10 m long, e.g. corridors, intermediate movement gaps (minimum 10 mm) should be incorporated.

12.10 Barrier matting zone

The size, position and design of the barrier matting should be considered at the design stage.

Section 4: Board and strip

13 General considerations

13.1 Joists and battens

Joists and battens should be sound, rigid, level and of a moisture content not exceeding 12% to 14%. Where necessary, they should be treated with a preservative (see **12.8**). However, where water-borne preservative has been used, the joist or batten should be re-dried to a moisture content not exceeding 12% to 14%.

Solid softwood battens for fixed floors should be not less than 36 mm basic width and those for floating floors not less than 40 mm basic width. They may be rectangular or splayed in cross-section depending upon the method of fixing (see Figure 1) and should be of sufficient depth to accommodate the length of the fixing used with a minimum depth of 36 mm. Laminated softwood battens may be used with a minimum depth of 22 mm. This minimum depth should be related to the spacing of any support cradles where these are used (see **15.4**).

Spacings of joists and battens should be determined by the designed loading and the thickness and length of flooring available.

Maximum spans for hardwood boards depend upon the thickness, species and use such as sports halls, gymnasia, etc. and should be as determined by the manufacturers.

13.2 New floors over existing wood floors

All existing floor coverings should be removed before laying new flooring

If the new flooring is to be directly nail fixed and in contact with existing wood floorboards (see **12.4.8**) it should preferably be laid at an angle of 45° or 90° to the lie of the existing boards. If, however, it is desired to fix the new flooring in the same direction as the existing boards, separating battens of softwood or strips of plywood should be fixed to align with the joists. The new flooring then should be nailed through the battens into the joists.

When adhering new floors to hardboard and plywood not exceeding 9 mm thick is the boards should be well fixed to the existing subfloor.

14 Work off site

Processing to accurately finished size should be completed before the flooring is delivered to the site. For softwood boards, finished sizes should conform to BS 1297. Tolerences of hardwood board and strip should conform to BS EN 13226 (solid parquet) or BS EN 13228 (solid wood overlay).

NOTE In this context, "finished" size means size before sanding.

15 Work on site

15.1 Preparation of concrete base

The subfloor should be dry in accordance with **12.4.6**. If there is any question about the dryness of the cementitious base, a suitable surface damp-proof membrane should be applied before the flooring is installed. All new and existing cementitious subfloors should be overlaid with a vapour check before installing the timber battens or timber flooring.

The concrete or screed base should be adequately flat and level (see **12.4.2**) but where some unevenness is unavoidable special measures might be needed (see **15.4**). Unless special packing points are to be used to level out the battens, the texture of the concrete surface should be not inferior to that normally achieved with a wood float. If cradles are to be used, the concrete should not be coarser than a fine tamped finish.

15.2 Fixing battens

Battens should be either fixed to the concrete or screed with screws and plugs or bedded in mastic. If bedded in mastic, battens should be overlapped and should not exceed 1 m in length. Any concrete or mortar infilling used should be placed as dry as possible and the aggregate should not be hygroscopic. If this method is used, allowance should be made to protect the wooden flooring from residual dampness in the subfloor.

15.3 Floating battens

*COMMENTARY ON **15.3***

Currently, the most popular method is to install battens as floating, i.e. not fixed down to the subfloor. They are usually set out at centres to suit the thickness and length of the flooring and anticipated loading on the floor and might incorporate foam or rubber to create a sprung area elastic or acoustic performance.

If installed without packing, the subfloor should conform to BS 8204-4:2004, flatness tolerance SR1.

Batten ends should be staggered by at least 600 mm and should not be in line with each other in adjacent rows.

Other specialist systems are available and should be used in accordance with the manufacturer's instructions.

15.4 Cradles

Where cradles are used to support the battens, they should be spaced along the batten at centres dependent upon the cross-section of the battens and the traffic or loadings which are expected to be imposed upon the floor during use.

Any packing incorporated in the cradle system should be permanently fixed with adhesive or be locked into the system to ensure continuity of support.

15.5 Laying, fixing and jointing

15.5.1 Thickness of flooring

Flooring products which are to be fitted to battens or joists should be not less than 18 mm thick.

15.5.2 Acclimatization

Unless a manufacturer clearly instructs otherwise, the delivery of the timber flooring should be programmed to ensure the shortest possible storage period on site.

All materials should be stacked carefully to retain flatness and kept in an environment with temperature and relative humidity levels that maintain the moisture content of the timber flooring at the recommended level, i.e. 7%–10% under normal circumstances.

15.5.3 Provision for expansion

Expansion gaps should be provided at the perimeter and all other abutments such as radiator pipes, thresholds, floor sockets, etc. for all of the floors covered by this standard and some provision might be necessary within the body of the floor.

NOTE The size of the perimeter expansion gaps varies from one flooring product to another and depends on the length and width of the floor, the type and thickness of the material and the method of installation.

Blocks, wedges, etc. can be used to form the expansion gaps between the flooring and the walls and these are left in place until the installation of the flooring has been completed.

Perimeter gaps are usually covered with a skirting board or perimeter trim but the expansion spacers should be removed first.

Timber floors expand mainly across their width and boards and strips should be laid so that the number of boards or strips is kept to a minimum. Expansion gaps at doorways should be provided where necessary where timber is laid through rooms. Usually, the boards or strips should be laid parallel to the longest wall. The position of doors and windows and the direction of existing floor boards or joists should also be considered.

Boards and strip ends should be laid in as random pattern as possible and header joints and stave ends should not fall in line and should be not less than two strip widths apart in adjacent runs.

In large floors, over 12 m wide, to be fixed bv nailing, the first two lines of panels or strips should be laid one each side of an approximate centre line dividing the narrowest width of the area to be covered. Laying should then be continued outwards from the centre line.

15.5.4 Nails

Nails with a diameter in accordance with the flooring manufacturer's recommendations and with plain shanks should have a length not less than 2.5 times the thickness of the flooring through which the nail is driven.

NOTE Normal or improved nails may be either hand or machine driven. The greater holding power of improved nails increases resistance to nail-popping but depending on type might add to the risk of the wood splitting.

15.5.5 Screws

Screws, where used, should have a length at least twice the thickness of the flooring being fixed, except in the case of thin sheet materials when the minimum penetration into a timber base should be not less than 19 mm.

15.5.6 Adhesives

Where adhesives are used, the adhesive manufacturer's instructions should be followed.

15.5.7 Clips

The manufacturer's instructions should be followed.

15.5.8 Staples

Staples should only be used for fixing timber floors where approved by the flooring manufacturer.

15.5.9 Solid softwood board flooring, square-edged without tongued and grooved edges

Solid softwood board flooring, square-edged without tongued and grooved edges, should conform to BS 1297 (see Note to **11.1**).

Boards of this type should be pulled together with care. All header joints should bear directly on a joist or batten to give the maximum load bearing area and should be staggered so that end joints in line are at least two board widths apart. All boards should be mechanically fixed by face nailing to every joist, batten or support or when laying over existing subfloors at centres appropriate to the type of product. Care should be taken not to damage the timber when fixing, particularly within 50 mm of the end of the board.

For boards up to and including 175 mm wide, two nails should be used at each intersection being between 15 mm and 20 mm from the board edges. Where wider boards are used, a minimum of three nails should be used and these should be spaced uniformly between the two outer nails. All nails should be punched below the surface.

NOTE Screws are not used generally for softwood boards because of the cost and labour involved but they provide for ease of access when fastening boards over electric cables, pipework runs and junction boxes for when future access is needed.

15.5.10 Solid hardwood board flooring, square-edged without tongued and grooved edges

Solid hardwood board flooring, square-edged without tongued and grooved edges, should conform to BS EN 1313-2.

Boards of this type should be mechanically fixed to timber joists, existing timber floors, or to battens by face nailing and should be laid and fixed either in the same manner as softwood boards (**15.5.9**) or using woodscrews (see **12.7.3**). Expansion allowances should be installed as recommended in **12.9.3**.

Woodscrews should be countersunk and (except at access points) all holes should be pelleted. Lost head nails should be punched below the surface and the holes filled with stopping.

15.5.11 Solid hardwood board flooring, tongued and grooved boards

Solid hardwood board flooring, tongued and grooved boards, should be mechanically fixed to timber joists, existing timber floors, or to battens by secret nailing through the tongue. The first and last rows of boards should generally be face fixed. Intermediate expansion allowances should be installed in accordance with **12.9.3**.

The timber flooring should be fixed to every joist or batten or, when laying over existing subfloors, at centres appropriate to the type of product. Care should be taken not to damage the timber when fixing, particularly within 50 mm of ends.

On existing timber floors, mechanical fixings should correspond to the joists' centres.

When strips are end-matched, the header joints need not occur over a support unless heavier point loading is anticipated, as in the case of a gymnasium floor or in commercial floors, in which case all header joints should be supported. Whether or not occurring over a support, header joints should be stagerred at least two boards or two support spaces apart

Solid hardwood tongued and grooved boards can also be directly adhered to a subfloor but should only be fixed by adhesive where this is expressly approved by the timber flooring manufacturer.

Site conditions and the preparation of the subfloor should be in accordance with **12.4.6**.

Adhesive should be applied in accordance with the manufacturer's instructions, taking care that the coverage application and open assembly times are observed.

Some boards are also designed to be installed as floating systems, i.e. not fixed to the subfloor or supports, but they should only be installed by this method where this is expressly approved by the timber flooring manufacturer. These systems should incorporate an underlay or resilient layer and, with the exception of timber subfloors, a vapour check.

Boards should be installed by interlocking joints, or with proprietary clips in accordance with manufacturer's instructions. Solid timber boards should not be glued together unless so recommended by the manufacturer.

15.5.12 Hardwood and softwood strip flooring, square-edged

All header joints should bear directly on a joist or batten to give the maximum bearing area and should be staggered so that joints are at least two board widths or two support spaces apart. All boards should be mechanically fixed by face nailing either in the same manner as softwood boards (**15.5.9**) or using screws (see **12.7.3**). The timber flooring should be fixed to every joist or batten or, when laying over existing subfloors, at centres appropriate to the type of product. Care should be taken not to damage the timber when fixing, particularly within 50 mm of the end.

Intermediate expansion allowances should be installed in accordance with **12.9.3**.

15.5.13 Hardwood and softwood strip flooring and pre-assembled hardwood flooring and multi-layered tongued and grooved boards

In most cases tongued and grooved flooring of this type should be mechanically fixed by secret nailing through the tongue to each joist or batten or when laying over existing subfloors at centres appropriate to the type of product. Intermediate expansion allowances should be installed in accordance with **12.9.3**.

The first and last rows of boards should generally be face fixed. Care should be taken not to damage the timber when fixing, particularly within 50 mm of the end of the board or strip.

When strips are end-matched, the header joints need not occur over a joist or batten but if heavier point loading is anticipated, as in the case of a gymnasium floor or in commercial floors, all header joints should be supported. Whether or nor occurring over a support, header joints should be stagerred at least two boards or two support spaces apart.

Some solid hardwood strip flooring and pre-assembled hardwood flooring and multi-layer tongued and grooved boards can also be directly adhered down to a subfloor but should only be fixed by adhesive where this is expressly approved by the timber flooring manufacturer.

Site conditions and the preparation of the subfloor should be in accordance with **12.4.6**.

Adhesive should be applied in accordance with the manufacturer's instructions, taking care that the coverage application and open times are observed.

Some solid hardwood strip flooring, pre-assembled hardwood flooring and multi-layer tongued and grooved boards are also designed to be installed as floating systems, i.e. not fixed to the subfloor or any battens or joists, but these should only be fixed by this method where this is expressly approved by the timber flooring manufacturer These systems should incorporate an underlay or resilient layer and, with the exception of timber subfloors, a vapour check.

Solid strip flooring, solid pre-assembled hardwood flooring and multi-layer tongued and grooved boards should be installed by interlocking joints, or with proprietary clips in accordance with manufacturer's instructions; multi-layer boards may also be glued along the tongue and groove joints. Solid strip flooring and pre-assembled hardwood flooring should not be glued together unless so recommended by the manufacturer.

15.6 Surface finish

The choice of surface finish and treatment should be dependent upon the intended duty and required appearance of the floor.

Softwood board flooring in typical domestic situations is not normally finished as it is usually covered over by another flooring material but any surface irregularities, e.g. cupping, should be removed by sanding.

NOTE 1 Hardwood strip flooring, hardwood boards, multi-layered and pre-assembled hardwood flooring is usually prefinished and generally needs no further treatment but in certain circumstances they might require further coats of seal after installation is completed.

Unfinished flooring should be screen meshed cleaned or sanded and finished with a polyurethane seal, wax polished or given an oil treatment.

There are a considerable number of floor seals available and the following factors should be taken into account when specifying the product to be used:

a) how the seal affects the appearance of the timber flooring;

b) the resistance to wear;

c) the drying time; and

d) the amount of odour the seal produces during the application and drying period, particularly when working in occupied buildings.

NOTE 2 The performance of the flooring is very much dependant on the choice of seal, the number of coats and the site application.

All finishes should be applied strictly in accordance with the manufacturer's instructions.

16 Inspection

When completed, floors should be inspected from a normal viewing position either standing or seated. When viewing the floor, only those features which are immediately obvious to any independent party should be considered as potential defect issues.

NOTE Careful positioning of backlighting or unusual viewing angles (crouching or kneeling, etc.) would not be considered reasonable criteria for identifying a visual defect.

The overall appearance of the floor should be consistent (product and installation) unless intentional as part of the product design or pattern.

Special attention should be paid to the following possible defects.

a) *Movement, loose boards or strips*.

NOTE In addition to flooring which is obviously not fixed well enough, movement underfoot and surface distortion caused by excessive moisture can also affect this. The firmness underfoot of floating hardwood flooring is dependent on the density and thickness of the underlay and the flatness and stiffness of the subfloor. All floating floors deflect underfoot.

As a guide, with normal residential and commercial floating floors (not sports flooring), the products chosen and installed should not create deflection any greater than 4 mm underfoot.

b) *Unintentional excessive gaps at joints*.

NOTE 1 Floor boards contain gaps between them; this is normal and the size of the gaps vary throughout the year as the wood expands or contracts. The size of the longitudinal edge gap can be up to 2 mm wide at times; however, subfloor flatness and manufacturing tolerances mean that this varies.

Header joint gaps should be no more than 0.6 mm and the gaps should be relatively even across the floor. Uneven, inconsistent or single gaps which stand out in an otherwise closely fitted floor should be investigated.

c) *Bad fitting*, e.g. in areas of doorways and hearths; nails or screws projecting above the surface; and defective filling of nail or screw holes.

d) *Strips or boards out of level with the plane of the floor*. Horizontal surface lipping at the joints in hardwood flooring is present but it should be very fine.

NOTE European manufacturing tolerances (see BS EN 13629, BS EN 13226 and BS EN 13228) state that 0.2 mm to 0.3 mm is acceptable but unevenness of subfloors can increase this.

e) Inadequate provision for expansion both at perimeters and between boards.

f) *Chips or splinters*. Heel marks are well recognized as causing minor indentations in the surface of the hardwood. This occurs more if the heel is damaged or has exposed nails. Point loads from stationary or moving items can also cause indentations.

g) *Inadequate colour matching* (where selected wood is specified). Wood has natural variances which are sorted into differing grades supplied by the manufacturers. The manufacturer's grading charts and information on the difference between the grades should be referred to.

h) *Excessively deep marks not removed by sanding*. Hardwood flooring, whether prefinished or site finished, should have a smooth appearance with an even sheen to the floor (either matt, satin or gloss dependent on the product). Uneven sheen patches should be addressed.

NOTE Some uses, such as sports, demand a specific level of sheen and reflectance.

Section 5: Blocks

17 Subfloor construction

The subfloor should be of sound construction, permanently dry and free of excessive construction moisture and contamination.

18 Work off site

Wood blocks should be machined to produce an accurate uniform finished size, conforming to BS 1187.

19 Work on site

19.1 Design criteria

The subfloor design should ensure that building movement joints are not present beneath a wood block floor and day joints can be covered where no further anticipated movement is likely to occur.

19.2 Adhesives

The following adhesives should be used as appropriate:

- Bitumen rubber emulsion;
- solvent or solvent free resin emulsions; or
- flexible and ridged reactive.

19.3 Preparation of bases

The subfloor should be dry in accordance with **12.4.6**. If there is any uncertainty about the dryness of the cementitious base, a suitable surface damp-proof membrane should be applied before the flooring is installed. With the exception of a timber subfloor, all new and existing cementitious subfloors should be overlaid with a vapour check before installing the timber battens or timber flooring.

The concrete or screed base should be adequately flat and level (see **12.4.2**). The subfloor tolerance should conform to BS 8204-4:2004, SR1.

Any high spots, nibs or major irregularities should be removed (see **12.4.2**) and the surface should be swept clean before laying begins.

Particular attention should be paid to bay junctions in concrete or screed bases, to avoid undulations and any other surface irregularities on the base which could prevent proper bedding and adhesion (see **12.4.2**).

If new block flooring is to be laid over an existing timber floor, the existing floor should be thoroughly inspected first and then covered with a suitable material as described in **12.4.8**.

New wood block floors should not be installed over existing decorative floor coverings.

If wood-based panels on joists or battens are used as a base or subfloor, they should be of a suitable flooring grade and well supported to ensure proper rigidity as described in **29.2**.

19.4 Laying and fixing

When laying blocks, the pattern should be as requested by the customer, e.g.:

- diagonal basket;
- square basket;
- square herringbone;
- single herringbone;
- double herringbone.

NOTE See Figure 4.

Wood blocks should be acclimatized in accordance with the manufacturer's instructions.

A centre line (crown line) should be determined within the area to ensure that as near as possible full blocks fall at the perimeter. Two lines of blocks should then be secured either side of the centre. Fitting of the blocks should continue to the edges of the room, allowing for an expansion gap and border if appropiriate.

When fitting the blocks, they should either be dipped into a dip grade adhesive or placed into an adhesive film applied using a trowel of the type specified by the adhesive manufacturer. Full transfer of adhesive should occur between the under face of the block and the subfloor and the wood block flooring should remain in contact with the adhesive film whilst it sets.

An expansion space of minimum 15 mm should be left around perimeter of installation.

To allow for possible expansion, a gap should be provided around any rigid upstand such as a perimeter wall/internal load-bearing wall, column, pipe or fireplace surround, see Table C.1 for typical expansion gaps.

19.5 Finishing

The type of finish should be determined by the customer, e.g.:

- prefinished;
- polish;
- seal;
- oil;
- hard wax oil.

20 Inspection

Inspection should be carried out in accordance with Clause **16**.

Section 6: Mosaic

21 Subfloor construction

The subfloor should be of sound construction, permanently dry and free of excessive construction moisture and contamination.

22 Work off site

Wood mosaic panels should be machined to produce an accurate uniform finished size and can be paper, felt, scrim or resin boned. They should conform to BS 4050-2.

23 Work on site

23.1 Design criteria

The subfloor design should ensure that building movement joints are not present beneath a wood block floor and day joints can only be covered where no anticipated further movement is likely to occur.

23.2 Adhesives

The following adhesives should be used as appropriate:

- bitumen rubber emulsion;
- solvent or solvent free resin emulsions;
- flexible and ridged reactive.

23.3 Preparation of bases

The subfloor should be dry in accordance with **12.4.6**. If there is any uncertainty about the dryness of the cementitious base, a suitable surface damp-proof membrane should be applied before the flooring is installed. With the exception of a timber subfloor, all new and existing cementitious subfloors should be overlaid with a vapour check before installing the timber battens or timber flooring.

The concrete or screed base should be adequately flat and level (see **12.4.2**). The subfloor tolerance should conform to BS 8204-4:2004, SR1.

Any high spots, nibs or major irregularities should be removed (see **12.4.2**) and the surface should be swept clean before laying begins.

Particular attention should be paid to bay junctions in concrete or screed bases, to avoid undulations and any other surface irregularities on the base which could prevent proper bedding and adhesion (see **12.4.2**).

If new block flooring is to be laid over an existing timber floor, the existing floor should be thoroughly inspected first and then covered with a suitable material as described in **12.4.8**.

New wood mosaic floors should not be installed over existing decorative floor coverings.

If wood-based panels on joists or battens are used as a base or subfloor, they should be of a suitable flooring grade and well supported to ensure proper rigidity as described in **29.2**.

23.4 Laying and fixing

When laying mosaic, the pattern should be as requested by the customer.

Wood mosaic should be acclimatized in accordance with manufacturer's instructions.

A centre line (crown line) should be determined within the area to ensure that as near as possible full mosaic panels fall at the perimeter. Two lines of mosaic panels should then be secured about the centre line. Fitting of the blocks should continue to the edges of the room, allowing for an expansion gap and border if appropiriate.

When fitting mosaic panels, they should be laid into an adhesive film applied using a trowel of the type specified by the adhesive manufacturer. Full transfer of adhesive should occur between the under face of the mosaic panel and the subfloor and the wood mosaic panel flooring should remain in contact with the adhesive film whilst it sets. The adhesive should be applied in accordance with the manufacturer's instructions.

23.5 Finishing

The type of finish should be determined by the customer, e.g.:

- prefinished;
- polish;
- seal;
- oil;
- hard wax oil.

24 Inspection

Inspection should be carried out in accordance with Clause **16**.

Section 7: Overlay and parquet

25 Construction

Parquet and overlay flooring is generally thinner and should therefore be supported on a base of concrete, wood or wood-based panel products.

When plywood is used as a base, it should be of the (factory) sanded quality (at least good one side) and laid with the face uppermost (see **3.7**).

The floor base should be dry and should be so maintained.

26 Work off site

26.1 Processing

Solid parquet flooring should be processed to accurate finished size, in a form ready for laying, before the flooring is delivered to the site.

NOTE Pre-assembled flooring, multi-layer parquet flooring and overlay flooring, being proprietary items, can be expected to be supplied fully processed and ready for laying.

26.2 Assembly

Parquet panels should be supplied square, framed and grooved around the edges to accommodate tongues.

27 Work on site

27.1 Preparation of bases

The subfloor should be dry in accordance with **12.4.6**. If there is any question about the dryness of the cementitious base, a suitable surface damp-proof membrane should be applied before the flooring is installed. With the exception of a timber subfloor, all new and existing cementitious subfloors should be overlaid with a vapour check before installing the timber battens or timber flooring.

The concrete or screed base should be adequately flat and level (see **12.4.2**). The subfloor tolerance should conform to BS 8204-4:2004, SR1.

Any high spots, nibs or major irregularities should be removed (see **12.4.2**) and the surface should be swept or vacuumed cleaned and be free of all debris before laying begins.

Particular attention should be paid to bay junctions in concrete or screed bases, to avoid undulations and any other surface irregularities on the base which could prevent proper bedding and adhesion (see **12.4.2**).

If parquet or overlay is to be laid over an existing timber floor, the existing floor should be thoroughly inspected first and then covered with a suitable material as described in **12.4.8**.

If plywood or particleboard on joists or battens is used as a base or subfloor, it should be of a suitable flooring grade and well supported to ensure proper rigidity as described in **29.2**.

27.2 Acclimatization

Unless a manufacturer clearly instructs otherwise, the delivery of the timber flooring should be programmed so as to ensure the shortest possible storage period on site.

All materials should be stacked carefully to retain flatness and kept in an environment that maintains the moisture content at the recommended level, i.e. not less than 7% nor more than 10% under normal circumstances.

27.3 Provision for expansion

Expansion gaps should be provided at the perimeter and all other abutments such as radiator pipes, thresholds, floor sockets, etc. for all of the floors covered by this British Standard and some provision might, on occasions, be necessary within the body of the floor.

NOTE The size of the expansion gaps varies from one flooring product to another and depends on the length and width of the floor, the type and thickness of the material and the method of installation.

Blocks, wedges, etc. can be used to form the expansion gaps between the flooring and the walls and these are left in place until the installation of the flooring has been completed.

Perimeter gaps are usually covered with a skirting board or perimeter trim but the expansion spacers should be removed first.

Pre-assembled and multi-layer overlay floors should be laid in as random a pattern as possible and header joints and stave ends should not fall in line and should be at least two strip widths apart in adjacent runs.

The floor should be laid out to suit the style of the overlay or parquet flooring being used, proprietary systems of multi-layer overlay being laid in accordance with manufacturer's instructions.

In large floors, over 12 m wide, the first two lines of panels or strips with the tongues facing outwards and with a double tongue board or loose tongue at the centre, should be laid on either side of an approximate centre line dividing the narrowest width of the area to be covered. Laying should then be continued outwards from the centre line.

27.4 Fixing

27.4.1 Use of adhesive

Adhesive should be spread evenly, using a serrated trowel in accordance with the manufacturer's instructions.

To enable the flooring to be accurately and firmly bedded into position before the adhesive dries, only as much adhesive as can be covered by flooring in the time scale allowed by the manufacturers of the adhesive should be spread.

27.4.2 Fixing to a concrete base

Parquet panels or parquet flooring should be fixed to concrete or screed using an adhesive recommended by the manufacturers. In addition, the general recommendations given in **12.4.8** and **12.7.4** should be followed.

27.4.3 Fixing to a wood base

Overlay, usually a thin boarding approximately 8 mm thick, tongued and grooved with ends matched, should be fixed by secret pinning to a wood base through the bottom lip of the groove formed around the board.

Parquet, a square edged strip, should be fixed only by surface pinning using panel pins punched below the surface and filled. Over an existing floor, it should be glued to a plywood underlay.

27.4.4 Installation of multi-layered overlay

Multi-layered overlay, a prefinished tongued and grooved ends matched board approximately 14 mm to 15 mm thick, may be installed over most dry level surfaces; contact flooring manufacturers for guidance. It should be either glued on the side tongues and grooves and on the ends matching or installed using proprietory interlocking edge joints. It creates a floating floor finish beneath which a thin underlay should be laid.

27.4.5 Installation of solid strip or pre-assembled overlay

*COMMENTARY ON **27.4.5***

These are usually prefinished tongued and grooved ends matched boards approximately 14 mm to 15 mm thick and are usually installed over any dry level surface.

These boards should be installed using a metal clip system. They create a floating floor finish beneath which a thin underlay should be laid.

27.5 Surface finish

The choice of surface finish and treatment should be dependent upon the intended duty and required appearance of the floor.

Solid parquet flooring should be lightly sanded to ensure a consistent level, and should then be finished with a seal or wax or an oil treatment. The advice of the manufacturer should be sought before applying any water based seals having high gluing properties as there is a possibility of pattern shrinkage with this type of seal.

NOTE 1 Proprietary pre-assembled, strip and multi-layer overlay flooring is generally supplied prefinished with a seal and needs no further treatment but in certain circumstances it might require further coats of seal after installation is completed.

There are a considerable number of floor seals available and the following factors should be taken into account when specifying the product to be used:

- how the seal affects the appearance of the timber flooring;
- the resistance to wear;
- the drying time;
- the amount of odour the seal produces during the application and drying period, particularly when working in occupied buildings.

NOTE 2 The performance of the flooring is very much dependant on the choice of seal, the number of coats and the site application.

All finishes should be applied strictly in accordance with the manufacturer's instructions.

28 Inspection

Inspection should be carried out in accordance with Clause **16**.

Section 8: Flooring of wood-based panel products

29 General considerations

29.1 Choice of floor construction

The floor base should be dry and should be so maintained.

Where decorative wood or wood-based panel flooring is to be installed on concrete or screed bases, reference should be made to individual clauses for any material specific requirements.

NOTE Typical forms of construction for panel flooring over concrete are shown in Figure 1 to Figure 3.

29.2 Joists and battens

Joists and battens should be sound, rigid, level and of moisture content not exceeding 14%. Where necessary, they should be treated with preservative (see **12.8**). However, where water-borne preservative has been used, the joist or batten should be re-dried to a moisture content not exceeding 14%.

NOTE If appropriate, joists of lower than 14% moisture content are available.

Battens for fixed floors should be not less than 36 mm wide, and for floating floors not less than 50 mm wide. They may be either rectangular or splayed in cross section, depending upon the method of fixing (see Figure 1 and Figure 3), and should be of sufficient depth to accommodate the length of the fixing used with a minimum depth of 36 mm.

29.3 Spacing and support

Spacing of joists and battens should be determined by the designed loading and the thickness and length of the flooring available.

Blockboard should be used only in situations where it is fully supported.

30 Care and conditioning of panel products

30.1 Delivery and storage

Delivery should be programmed to ensure the shortest possible storage period. Wood-based panel products should be stored under conditions that retain the moisture content at the level recommended in **12.5.3**. The materials should be stored in a way that prevents distortion of the panels. Where panel products are supplied pre-packed, the packaging should not be removed until the flooring is required for conditioning or for laying.

All panel products liable to be exposed to the weather should be provided with protection.

NOTE This particularly applies to type P4 particleboard, as this material might suffer loss of strength if wetted.

If any panel product is wetted by rain, either in storage or during construction, adequate time should be allowed for drying before inspecting for soundness and suitability for use.

30.2 Conditioning of wood-based panels

Wood-based panels (other than hardboard, see **30.3**) should be conditioned by loose laying or loose stacking in the intended area of use and with as close to in-use conditions as possible for at least 24 h, but ideally one week, prior to fixing.

NOTE This enables the panels to be conditioned so that subsequent movement is minimized.

30.3 Conditioning hardboard

Hardboard panels should be conditioned to the appropriate moisture content (see **12.5.3**) before laying, which can be achieved by one of two methods:

a) conditioning by air; and

b) conditioning by water.

Standard and tempered hardboards for use in unheated buildings should be conditioned by water. Thick sheets and hardboards for use in buildings with central heating should be conditioned by air.

To condition in air, the panels should be stacked with separators between each sheet. This is to permit free air circulation around all surfaces. The conditioning period should cover at least the 48 h immediately before laying.

To condition with water, 0.5 L of water should be scrubbed into the screen side face of standard hardboard 1 220 mm × 2 440 mm × 3.2 mm thick. For a panel of the same size but 6.4 mm thick, 1.0 L of water should be used. The treatment should be carried out 24 h to 48 h before fixing, the panels being stacked horizontally, mesh side to mesh side, on a flat surface out of direct sunlight. Tempered hardboard should be treated in the same way but 48 h to 72 h before use.

31 Work on site

31.1 Concrete and screed bases

31.1.1 General considerations

When installing wood-based panels as a decorative floor over concrete or on cement/sand screed bases, consideration should be given to appropriate use of timber battens or proprietary supports. Blockboard should be used only when continuously supported.

NOTE Typical forms of construction for panel flooring over concrete are shown in Figure 1 to Figure 3.

31.1.2 Preparation of concrete base

A concrete or screed base should be allowed to dry in accordance with **12.4.6**. Any high spots, nibs or major irregularities should be removed and the surface should be swept clean before laying begins (see **12.4.2**). Particular attention should be paid to bay junctions in the base to avoid undulations and other surface irregularities.

31.1.3 Vapour-check membrane

In all cases where panel flooring is used over concrete a vapour check membrane should be positioned to protect the flooring.

31.2 Preparation of existing timber base

The boards or blocks comprising the existing timber base should be made secure and level. Any protruding nails should be removed or driven fully home. The base should be thoroughly inspected and then brought to a smooth surface by planing, sanding or by the application of a smoothing compound (see also **12.4.8**).

31.3 Laying and fixing panel products

31.3.1 Fixing of access covers

Where access to a floor void is likely to be needed, the necessary access cover should be provided with countersunk head screws and cups (see **12.6.6**) set below the upper surface.

31.3.2 Fixing panels to battens

Panel products should be fixed and positioned to battens in accordance with **31.3.3** to **31.3.8**, as relevant.

31.3.3 Fixing and laying plywood panels

Plywood should be firmly screwed, nailed or glued to joists, battens or existing timber floors, subject to the following recommendations.

Improved nails have superior holding power, and in most circumstances are preferable to lost head nails but where a floor is to be left uncovered, lost head nails should be used. This applies particularly to proprietary brands of plywood which have been selected primarily for their appearance; in these cases any additional manufacturer's instruction should also be followed.

Panels should be nailed or screwed at 150 mm centres along the edges and 300 mm elsewhere along the joists. Fixing should be at least 8 mm from the edge of the panel. Where panels perform a structural function, the minimum screw or nail length should be 50 mm or 2 times the panel thickness, whichever is the greater. The minimum nail or screw diameter should be 0.16 times the panel thickness.

With both square-edged and tongued and grooved panels, the end joints should be staggered transversely across the floor and all longitudinal joints should be in line. Edges at the perimeter of the floor should be supported on joists or noggings except where the insulation manufacturer specifies that the particleboard can be supported on a layer of rigid insulation.

Where adhesives are to be used to fix plywood (e.g. on a cement/sand screed), the adhesives should be either polyvinylacetate conforming to BS EN 204 or a suitable bitumen preparation (see **12.7.4**).

31.3.4 Positioning plywood panels over joists and gluing joints

For maximum strength, square-edged plywood panels should be positioned with the grain of the face ply at right angles to the line of the joists.

Edges occurring at right angles to the joists should be supported on noggings. Edges parallel to the joists should be supported on the joists, noggings or trimmers.

Tongued and grooved plywood panels over joists should be positioned as for square-edged panels, with the end joints occurring over the centre of the joists. However, the panel manufacturer or supplier should be asked to confirm the suitability of the chosen method and advise on the need for noggings. Nailing (see **31.3.3**) should be through the face of the panel or, if preeferred for visual reasons, by secret nailing.

NOTE 1 Except in the case of insulated ground floor construction, adhesives are not necessary in joints of tongued and grooved plywood.

Tongued and grooved plywood panels can also be placed on a continuous layer of insulating material [see Figure 3a)]. In this application, adhesives should be used in the panel joints.

With both square-edged and tongued and grooved panels, the end joints should be staggered a minimum of two joists apart (for insulated ground floor construction, a minimum of 800 mm apart) transversely across the floor, and all longitudinal joints should be in line.

An expansion gap should be provided (see **12.9.6**).

NOTE 2 The recommendations for laying and fixing plywood panels are summarized in Table 1.

31.3.5 Supporting and fixing blockboard

As stated in **31.1.1**, blockboard should only be used where it can be continuously supported. It should be fixed either to a properly prepared concrete or cement/sand screed base or to an existing timber floor (see **12.4.8**).

Blockboard laid on a concrete floor or cement/sand screed should be firmly fixed by using adhesive conforming to BS EN 301 or BS EN 204.

Blockboard laid on an existing timber floor should be fixed with screws or by nailing with improved nails (see **12.4.8**).

31.3.6 Fixing and laying particleboard and OSB panels

Except for tongued and grooved panels for special requirements as described in the next paragraph, or where the panel manufacturer has a nail-free structural flooring system, particleboard and OSB panels should be screwed or nailed to joists, battens or existing timber floors. Panels should be nailed or screwed at 150 mm centres along the edges and 300 mm elsewhere along the joists. Fixing should be at least 8 mm from the edge of the panel. Where panels perform a structural function, the minimum screw or nail length should be 50 mm or 2 times the panel thickness, whichever is the greater. The minimum nail or screw diameter should be 0.16 times the panel thickness.

NOTE 1 Improved nails have superior holding power and in most circumstances are preferable to lost head nails.

If tongued and grooved panels are to be glued to joists or battens, adhesives conforming to BS EN 204 should be used and the general recommendations of **12.7.4** should be followed.

Square-edged panels should be laid with the long edges of the panels supported along the centre of the joists and with the short edges carried on noggings.

Tongued and grooved particleboard panels should be positioned with the long edges across the joists, the short edges being supported by the joists.

Tongued and grooved particleboard panels may also be placed on a continuous layer of rigid insulating material [see Figure 3a)], but this is not recommended for OSB; in this application, adhesives should be used in the tongued and grooved panel joints. Under thresholds and internal partitions, the particleboard should be fixed to battens supported by the subfloor.

NOTE 2 For further information on floating floors, see the WPIF "Code of practice for particleboard and oriented strand board (OSB) floating floors" [9].

With both square-edged and tongued and grooved panels, the end joints should be staggered transversely across the floor and all longitudinal joints should be in line. Edges at the perimeter of the floor should be supported on joists or noggings except where the insulation manufacturer specifies that the particleboard can be supported on a layer of rigid insulation.

NOTE 3 For the convenience of readers, the recommendations for laying and fixing particleboard and OSB panels are summarized in Table 2.

31.3.7 Fixing hardboard and plywood not exceeding a thickness of 9 mm to timber

NOTE The method of fixing hardboard is dependent upon the type of structural floor and the appearance required.

Lost head nails, although generally preferred where a floor is to be uncovered, are adequate only where no flexing is expected and they should be spaced evenly at intervals not greater than 100 mm centres at edges and at 150 mm centres throughout the remainder of the board. Improved nails have greater frictional resistance and larger heads so this type of nail should be used on floors likely to flex. Other types of nail should not be used.

Nails or staples in hardboard should be located in such a way that no fixing is closer than 8 mm to the edge of any board.

Wide crown (9 mm to 12 mm) staples give greater resistance to pull-through, and these should be used on floors likely to flex.

To fix hardboard to timber with adhesive, styrene-butadiene rubber (SBR) emulsion adhesive should generally be used. Otherwise, adhesives conforming to BS EN 204 or bitumen rubber emulsion should be used. They should be spread evenly (see **12.7.4**). Resin based adhesives should not be used for bonding hardboard to wood block floors, but they are suitable for bonding hardboard to insulating board. For bonding hardboard to smooth surfaces of wood, an impact type or gap filling type adhesive such as latex emulsion should be used.

Bitumen based adhesives which incorporate water should not be used with tempered hardboard.

31.3.8 Fixing hardboard to cement/sand screed

Where adhesives are to be used to fix hardboard to a cement/sand screed, they should be preferably styrene-butadiene rubber (SBR) emulsion adhesive, but either polyvinyl acetate emulsion adhesive conforming to BS EN 204 or a suitable bitumen rubber emulsion (see **31.3.7**) adhesive may be used.

31.4 Laying hardboard not exceeding 9 mm in thickness on non-floating floors

Boards may be laid either side up, but where floor finish is an important consideration, they should be laid best face up as this is easier to maintain.

If the hardboard is intended as an underlay for another floor covering, the panel should be laid screen face upwards to prevent hammer driven nails from standing proud.

The end joints should be staggered transversely across the floor and all longitudinal joints should be in line.

*NOTE No provision for movement is necessary for hardboard (see **12.9.6**).*

Table 1 **Summary of recommendations for laying and fixing plywood panels**

<table>
<tr><th rowspan="2">Form of panel</th><th rowspan="2">Intended use</th><th rowspan="2">Laying (see 31.3.4)</th><th colspan="3">Fixing</th><th rowspan="2">Notes</th></tr>
<tr><th>With nails (see 12.7.2)</th><th>With screws (see 12.7.3)</th><th>With adhesive (see 12.7.4)</th></tr>
<tr><td rowspan="3">Square-edged</td><td rowspan="2">To be covered</td><td rowspan="3">Grain of face ply to be at right angles to line of joist
Edges at right angles to line of joist to be supported on noggings
End joints between panels to be staggered transversely across the floor: all longitudinal joints to be in line</td><td>3.35 mm, improved preferable</td><td rowspan="5">To BS 1210, not less than size 8
Spacing as for nails</td><td></td><td rowspan="5">NOTE 1 Lost head nails are particularly to be preferred for use with proprietary brands of plywood which have been selected primarily for their appearance. In these cases any additional manufacturer's instructions are also to be followed.
NOTE 2 For expansion gap recommendations, see 12.9.6.</td></tr>
<tr><td>At edges of panels: at 150 mm centres and not nearer to edge than 12 mm
Elsewhere, at 300 mm centres along joist
At least 12 mm from edge of panel</td><td>Either: polyvinylacetate to BS EN 12765 or suitable bitumen preparation</td></tr>
<tr><td>To be exposed</td><td>As above but "lost head" preferred (see Note 1)</td><td>Adhesives at joints not necessary</td></tr>
<tr><td rowspan="3">Tongued and grooved</td><td>To be exposed</td><td>As above plus:
position with end joints occurring over the centre of the joists</td><td>As above for square edged to be covered</td><td></td></tr>
<tr><td>To be covered</td><td>check method and need for noggings with panel manufacturer</td><td>As above for square edged to be exposed</td><td></td></tr>
<tr><td>For use in floor carried on continuous layer of insulation</td><td>End joints between panels to be staggered transversely across the floor: all longitudinal joints to be in line</td><td>Not permitted</td><td>Not permitted</td><td>As above but in this case joints should be glued</td><td>NOTE 3 See Figure 3a).</td></tr>
</table>

Table 2 **Summary of recommendations for laying and fixing particleboard and OSB panels**

Form of panel	Intended use	Laying (see 31.3.4)	Fixing (see 31.3.6)			Notes
			With nails (see **12.7.2**)	With screws (see **12.7.3**)	With adhesive (see **12.7.4**)	
Square-edged	All uses	Long edges of intermediate panels supported along centre of joists Short edges carried on noggings End joints between panels to be staggered transversely across the floor: all longitudinal joints to be in line Edges and ends at perimeter to be supported	Spacing at edge: 100 mm centres Spacing elsewhere along joist or batten: 300 mm centres At least 12 mm from edge of panel	To BS 1210, not less than size 8 Spacing as for nails	Not recommended	*NOTE 1 For expansion gap recommendations, see **12.9.6**.*
Tongued and grooved	Normal	Long edges across joists or battens Short edges supported on joists	As for square edged boards			
	Floor without visible fixing	End joints between panels to be staggered transversely across the floor: all longitudinal joints to be in line Edges and ends at perimeter to be supported	—	—	See **12.7.4** Structural floor: follow the flooring manufacturer's instructions. Decorative flooring: adhesive conforming to BS EN 204.	
	For use in floor carried on continuous layer of rigid insulation	End joints between panels to be staggered transversely across the floor: all longitudinal joints to be in line	Not permitted	Not permitted	As above but in this case joints between panels should be glued	*NOTE 2 See Figure 3a).*

31.5 Surface finish and treatment

Plywood or blockboard panels should be lightly sanded and then should be clear finished, painted, stained or waxed. Particleboard, OSB and hardboard are not normally waxed or stained but should be painted or sealed using any coating suited to wood floors.

32 Inspection

All work should be inspected whilst in progress and after completion. Special attention should be paid to the following possible defects:

a) poor fixing to base;

b) gaps at joints;

c) bad fitting in areas of doorways and hearths;

d) faults in pattern, if appropriate;

e) inadequate provision for expansion;

f) extrusion of adhesive;

g) damaged or dented surface;

h) nails or staples projecting above the surface;

i) defective filling of nail holes;

j) sheets out of level with the plane of the floor;

k) inadequate colour matching (where selected wood is specified).

Section 9: Upkeep and maintenance

33 General

Preventative maintenance to the finish on timber floors should be carried out to reduce the number of scratches, etc. The sealed surface should be regarded as the sacrificial finish which is resealed from time to time; it is designed to wear down over time and so is flexible.

Scuff and scratch marks are inevitable on a smooth surface such as hardwood so a proper maintenance schedule should be developed to deal with this.

Manufacturers of the floor finishes should be consulted regarding regular maintenance as this helps to extend the life of the sealed finish.

The customer should be provided with details of the maintenance required to enable the floor to perform satisfactorily in use. This Section gives recommendations that the customer might need to be provided with, although it is not exhaustive and the information given should be considered on a case-by-case basis.

34 Routine maintenance

34.1 General

Routine maintenance procedures for all types of floor should be in accordance with the floor finish manufacturer's recommendations.

34.2 Short term maintenance

Floors should be swept or vacuumed as often as is necessary.

Cleaning of wooden floors should be carried out using damp cleaning methods only to minimize water damage to the surface.

34.3 Long term maintenance

The floor's finish should be renewed either by cleaning and resealing the floor or by sanding and resealing the floor.

34.4 Slip resistance

An increase in slipperiness is almost certainly linked to surface contamination owing to improper or insufficient maintenance.

Generally, finishes on wood or wood-based panel floors have a low potential for slip in dry conditions. However, if they are allowed to get wet, for example with spillages, the potential for slip increases. Specialist slip resistant site applied coatings should be applied if the spillages cannot be managed (see **4.6**).

This should be considered at the design/specification stage (see **4.6** and Clause **6**).

35 Maintenance of moisture content after installation

The originally designed and specified heating and ventilation regime in any building having a wood floor should not be neglected even when the building is unoccupied.

*NOTE This is to ensure that the flooring is maintained continually at or near the moisture content recommended in **12.5.3**.*

Annex A (normative) Hygrometer test for dampness of concrete, cementitious and anhydrate bases

A.1 Basis of test

The basis of the test is to use a hygrometer or hygrometer probe to measure the relative humidity in a pocket of air entrapped air in a sleeve or between an impervious thermally insulated housing and the screed/concrete base. Sufficient time is allowed for moisture equilibrium to become established between the pocket of air and the base.

Concrete under normal conditions is never completely dry. Those responsible for laying floor coverings need to know when the moisture level of the concrete has been reduced to a value where flooring can be safely laid. Water in the coarse pores of concrete is relatively mobile and can lead to damage to flooring, whereas water in the fine pores is relatively immobile and harmless.

When concrete is allowed to dry, the coarse pores become empty first because water in coarse pores exerts a higher vapour pressure, and hence evaporates more quickly than water in fine pores. Because the size of the pores controls the vapour pressure that arises in them, it also controls the vapour pressure of a small volume of air entrapped between the concrete surface and an impervious housing (or box). The vapour pressure determines the relative humidity of that entrapped air so a hygrometer or probe reading indicates the extent to which harmful moisture is still present.

Experimental evidence has shown that when the measured relative humidity falls to 80% RH, the water has evaporated from the coarse pores and the screed is sufficiently dry to allow installation of resilient floor coverings. If some allowance is made for errors in determining the relative humidity, the concrete should be considered dry when the relative humidity falls to 75% or less.

For these reasons, the hygrometer probe or sleve methods for dampness measurement are recommended over and above other methods.

A.2 Apparatus

A.2.1 *Insulated impermeable box*, which can be sealed to the floor surface to create an enclosed pocket of air which is isolated from the humidity and fluctuations in temperature of the outside air. (See Figure A.1.) It is essential that this is sealed to the floor using a preformed butyl sealant tape and that readings can be taken while the apparatus is in position on the floor without breaking the seal and releasing the trapped pocket of air.

NOTE Other forms of apparatus might be suitable but the width of the area should not be less than 150 mm and it is essential that the principles of thermal insulation and vapour barrier are followed, so that an insulated vapour-proof space is created. Suitable vapour barrier materials are sheet metal, glass, 2 mm thick clear acrylic sheet, or 2 mm thick PVC-U (polyvinyl chloride, un-plasticized), and the apparatus should have a maximum U-value of 1.0 W/(m^2·K).

A.2.2 *Hygrometer or relative humidity (RH) probe*, for measuring relative humidity to an accuracy of ±3% RH. This can be a hair, paper, synthetic fibre or electronic hygrometer of the clock type, or an electronic relative humidity probe.

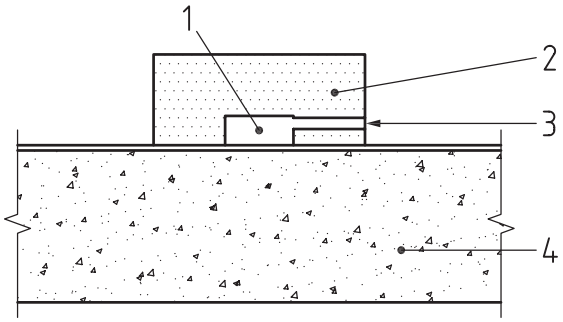
A.2.3 *Preformed butyl sealant tape*.

A.2.4 *Adhesive tape*.

A.2.5 *Protective mats (rubber or polyethylene)*.

A.2.6 *Hygrometer sleeve* if using procedure 2, **A.5**

Figure A.1 **Apparatus for hygrometer test**



Key

1 Space

2 Polystyrene box

3 Entry for hygrometer

4 Concrete and screed

A.3 Suitability

The method of test is appropriate for measurement of percentage relative humidity values above porous surfaces such as screeds and concretes. Low porosity surfaces such as power floated concrete require extended testing periods before true readings can be achieved, and any surface treatment such as concrete curing compounds or waxes should be removed.

NOTE The method might not be suitable for use on proprietary screeds and is not suitable for performance assessment of surface applied moisture barriers.

A.4 Hygrometer probe method

A.4.1 Turn off any artificial aids used for accelerating drying at least four days before final readings are attempted. Accelerated drying should not be used for screeds.

A.4.2 Seal the apparatus firmly to the floor and allow sufficient time for the entrapped air to reach moisture equilibrium with the screed or base.

A.4.3 For an unbonded screed, where the damp-proof membrane is placed between the base and screed as described in BS 8204-1 allow a period of not less than 4 h before taking the first reading.

NOTE Equilibrium may be assumed when two consecutive readings taken at 4 h intervals show no change.

A.4.4 For very thick constructions, i.e. direct finished base slabs or bonded screeds (where the damp-proof membrane is placed below the base slab as described in BS 8204-1) allow a period of at least 72 h to elapse before taking the first reading.

NOTE Equilibrium may be assumed when two consecutive readings taken at 24 h intervals show no change.

A.4.5 Constructions with thickness greater than 200 mm can take considerably longer than one week before moisture equilibrium is established. To prevent edge effects with these very thick constructions, the area of 1 m^2 surrounding the instrument should be covered with an impervious sheet material during the test.

A.4.6 To minimize the time required for the instrument to be in a position on the floor, the following technique can be applied. Cover the positions to be measured with impervious mats (**A.2.5**) not less than 1 m × 1 m, taped to the

floor at their edges. Leave in position for at least three days in the case of screeds and seven days in the case of thick constructions. After removing the mat (**A.2.5**), immediately seal the instrument to the centre of the covered area. The instrument should be left overnight for equlibrium to be reached.

A.4.7 To avoid expensive equipment being left on site, the probe (**A.2.2**) should be removed from the apparatus shown in Figure A.1 and the hole plugged before the box (**A.2.1**) is sealed to the subfloor.

A.4.8 After allowing time to reach equilibrium, remove the plug, insert the RH probe (**A.2.2**) promptly, and allow at least thirty minutes for this to reach equilibrium before readings are taken.

A.4.9 A number of simultaneous measurements might be necessary to give a representative survey. This should take into account the size and layout of the installation, as well as any variation in the subfloor construction.

A.4.10 If readings greater than 75% RH are obtained, remove the equipment and allow the floor to dry before further readings are attempted.

A.5 Hygrometer sleeve method

A.5.1 Before drilling into the concrete, check that there are no services within the base.

A.5.2 Drill the correct size diameter hole into the concrete to a depth of 40% of the concrete subfloors overall thickness.

A.5.3 Using a small brush, clean the inside of the hole free from dust and vacuum away any loose debris from within the hole.

A.5.4 Place the proprietor sleeve into the hole ensuring it is a firm fix and finishes flush with the concrete surface and the cap is firmly in place.

A.5.5 After a minimum of 72 h, remove the cap and immediately inset a proprietary relative humidity reading probe into the sleeve.

A.5.6 After a minimum of 30 min, a reading can be taken and recorded. The probe is then removed and the cap firmly replaced.

A.5.7 After a further minimum 24 h period, repeat the procedure (**A.5.1** to **A.5.6**) at a minimum of 24 hr intervals until two consecutive readings are identical to each other. At this point the trapped air is in equilibrium.

A.6 Verification of hygrometer or probe

As the accuracy of a hygrometer can drift with time or in transit, it should be recalibrated frequently. The accuracy of the hygrometer or RH probe at 75% RH can be checked by sealing it in a desiccator or humidity cabinet over a saturated solution of analytical or general purpose reagent grade sodium chloride, at a constant temperature of (20 ±2) °C for a minimum of 12 h.

Annex B (informative) Guidance on selection of wood species

When using Table B.1 to Table B.11, the following should be taken into consideration.

a) Movement classification.

In Table B.1 to Table B.11, the movement data are taken from BRE Technical Note No. 38 “Movement of timbers” [10]. Technical Note No. 38 lists timber species according to their movement in response to changes in atmospheric conditions. Classification 1 signifies small movement and classification 3 signifies large movement. Where no movement classification is given, it means that no information is available.

b) Densities.

Densities are the appropriate average densities in kg/m³ at 12% moisture content. For more precise averages or ranges, see "The handbook of hardwoods"[11] and "The handbook of softwoods" [12].

c) Sourcing of wood and environmental responsibility.

The UK government, through its Central Point of Expertise on Timber (CPET) programme, has provided an information resource to assist in the responsible sourcing of wood and wood products. CPET provides guidance on how to meet the UK Government's timber procurement policy (for public sector buyers) and information on what evidence demonstrates legality and sustainability. See www.cpet.org.uk for details.

Table B.1 to Table B.11 make no reference to provenance or environmental circumstance or situation as, with the appropriate forest management practices, all forests, and, by association, all wood species from those forests, are sustainable. Use of CPET details and additional information from the UK Timber Trade Federation is likely to be useful for those wishing to source only wood species from sources which have been assessed as being both legal and sustainable.

Table B.1 **Timbers suitable for floors for heavy pedestrian traffic**

Movement classification	Timber	Density
1	African padauk (*Pterocarpus soyauxii*)	770
1	Banga wanga (*Amblygonocarpus obtusangulus*)	995
	Bubinga (*Guibourtia demeusei*)	800
	Burma padauk (*Pterocarpus macrocarpus*)	835
2	Danta (*Nesogordonia papaverifera*)	755
3	East African olive (*Olea hochstetteri*)	880
3	European beech (*Fagus sylvatica*)	705
2	European oak (*Quercus robur and Q.petraea*)	705
	Haldu/kwao (*Adina cordifolia*)	675
2	Hornbeam (*Carpinus betulus*)	735
	Japanese maple (*Acer spp.*)	705
1	Loliondo (Olea *welwitschii*)	800
	Makarati (*Burkea africana*)	975
2	Malaysian keruing (*Dipterocarpus spp*.)	785
1	Missanda (*Erythrophleum guineense and E. ivorensis*)	895
3	Mora (*Mora excelsa*)	1 025
2	Muhimbi (*Cynometra alexandri*)	865
1	Muhuhu (*Brachylaena hutchinsii*)	960
1	Panga panga (*Millettia stuhlmanii*)	800
2	Pillarwood (*Cassipourea elliottii*)	755
1	Purpleheart (*Peltogyne spp*.)	865
2	Pyinkado (*Xylia dolabriformis*)	930
	Rhodesian copalwood (*Guibourtia coleosperma*)	800
1	"Rhodesian teak" (*Baikiaea plurijuga*)	915
2	Rock maple (*Acer saccharum*)	735
	Spotted gum (*Eucalyptus maculata*)	960

NOTE Heavy pedestrian traffic is assumed to be intensities of 2 000 persons per day and upwards, usually concentrated in definite traffic lanes, as experienced in public institutions, barracks, industrial canteens, corridors in large schools, colleges, etc.

Table B.2 **Timbers suitable for floors for normal pedestrian traffic**

Species *listed in Table 1* plus:

Movement classification	Timber	Density
2	African celtis (*Celtis spp.*)	785
1	Afrormosia (Peric*opsis elata*)	735
1	Afzelia (*Afzelia spp.*)	815
	American pitch pine (*Pinus palustris and P.elliottii*) mainly quarter-sawn	655
3	Apitong (*Dipterocarpus spp.*)	690
1	Ayan (*Distemonanthus benthamianus*)	675
1	Dark red meranti/dark red seraya (*Shorea spp.*)	690
2	Grevillea (*African silky-oak*) (*Grevillea robusta*)	560
1	Guarea (*Guarea spp.*)	610
3	Gurjun (*Dipterocarpus spp.*)	705/735
1	Iroko (*Chlorophora excelsa*)	655
2	Jarrah (*Eucalyptus marginata*)	865
3	Karri (*Eucalyptus diversicolor*)	915
	Kempas (*Koompassia malaccensis*)	865
2	Keruing (*Dipterocarpus spp.*)	800
1	Makore (*Mimusops heckelii*)	610
2	Malayan kapur/North Borneo kapur (*Dryobalanops spp.*)	770/705
1	Mengkulang (*Heritiera spp.*)	705
1	Merbau (*Intsia bijuga*)	770
2	Mersawa/krabak (*Anisoptera spp.*)	625
1	Muninga (*Pterocarpus angolensis*)	655
3	Musine (*Croton megalocarpus*)	705
2	Okwen (*Brachystegia nigerica*)	675
2	Opepe (*Sarcocephalus diderrichii*)	755
3	Ramin (*Gonystylus spp.*)	655
2	Sapele/utile (*Entandrophragma spp.*)	640
1	Selangan batu (*Hopea spp. and Shorea spp.*)	865/945
1	Swamp sepetir (*Pseudosindora palustris*)	655
	"Tasmanian myrtle" (*Nothofagus cunninghamii*)	675
1	Teak (*Tectona grandis*)	690
3	Yang (*Dipterocarpus spp.*)	705
3	Yellow birch (*Betula alleghaniensis*)	690

NOTE 1 Normal pedestrian traffic is assumed to be intensities less than 2 000 persons per day, as experienced in large village halls and in large assembly halls, in school and college classrooms; and in hospitals, hotels, canteens, offices, shops, etc.

NOTE 2 In addition, all those species listed in Table 3 may be used for normal pedestrian traffic as defined in Table 2, but before specifying these species in circumstances where the traffic intensity is expected to approach the maximum permitted in Table 2, careful consideration should be given to the factors involved.

Table B.3 **Timbers suitable for floors for light pedestrian traffic**

Species listed in Table 1 and Table 2 with:

Movement classification	Timber	Density
1	Abura *(Mitragyna ciliata)*	545
1	Afara *(Terminalia superba)*	495
1	African mahogany *(Khaya spp.)*	495
1	"African walnut" *(Lovoa klaineana)*	545
1	Agba *(Gossweilerodendron balsamiferum)*	545
2	Dahoma *(Piptadenia africana)*	690
1	"Douglas fir" *(Pseudotsuga taxifolia)*	495
1	East African camphorwood *(Ocotea usambarensis)*	595
2	European birch *(Betula spp.)*	675
1	Gedu nohor *(Entandrophragma spp.)*	545
1	Idigbo *(Terminalia ivorensis)*	545
1	Light red meranti/light red seraya *(Shorea spp.)*	530
	Manio *(Podocarpus spp.)*	515
	Matai *(Podocarpus spicatus)*	610
2	Niangon *(Tarrietia utilis)*	625
2	"Parana pine" *(Araucaria angustifolia)*	530
	Podo *(Podocarpus spp.)*	515
2	Redwood/Scots pine *(Pinus sylvestris)*	480
	Saligna gum *(Eucalyptus saligna)*	755
2	"Tasmanian oak" *(Eucalyptus spp.)*	675
1	Western hemlock *(Tsuga heterophylla)*	480
1	White seraya *(Parshorea plicata)*	530
1	Whitewood *(Picea abies)*	465
1	Yellow meranti/yellow seraya *(Shorea spp.)*	640

NOTE Light pedestrian traffic is assumed to be intensities less than 500 persons per day as experienced in domestic situations, small classrooms, small offices, small village halls and small assembly rooms.

Table B.4 **Timbers suitable for decorative floors**

Movement classification	Timber	Density
1	"African walnut" *(Lovoa klaineana)* mainly quarter-sawn	545
1	African padauk *(Pterocarpus soyauxii)*	770
1	Afrormosia *(Pericopsis elata)*	735
	Andaman padauk *(Pterocarpus dalbergioides)*	785
	Burma padauk *(Pterocarpus macrocarpus)*	835
3	East African olive *(Olea hochstetteri)*	880
2	European oak *(Quercus robur and Q.petraea)* selected, quarter-sawn material	705
1	Gedu nohor *(Entandrophragma angolense)* selected, quarter-sawn material	545
2	Grevillea African silky-oak *(Grevillea robusta)*	560
2	Muhimbi *(Cynometra alexandri)*	865
1	Muhuhu *(Brachylaena hutchinsii)*	960
1	Muninga *(Pterocarpus angolensis)*	655
1	Panga panga *(Millettia stuhlmannii)*	800
1	Purpleheart *(Peltogyne spp.)*	865
2	Pyinkado *(Xylia dolabriformis)*	930
2	Redwood/Scots pine *(Pinus sylvestris)*	480
	Rhodesian copalwood *(Guibourtia coleosperma)*	
1	"Rhodesian teak" *(Baikiaea plurijuga)*	915
2	Sapele *(Entandrophragma cylindricum)* selected, quarter-sawn material	640
1	Whitewood *(Picea abies)*	465
	Yew *(Taxus baccata)*	610

NOTE A decorative floor is a floor selected for its appearance, bearing in mind that the species should be chosen according to duty requirements.

Table B.5 **Timbers suitable for heavy duty industrial floors**

Movement classification	Timber	Density
1	Banga wanga (*Amblygonocarpus obtusangulus*)	995
	Billian (*Eusideroxylon zwageri*)	1 025
	Brush box (*Trstania conferta*)	930
	Bubinga (*Guibourtia spp*.)	865
3	East African olive (*Olea hochstetteri*)	880
2	Greenheart (*Ocotea rodiaei*)	1 040
2	Muhimbi (*Cynometra alexandri*)	865
1	Muhuhu (*Brachylaena hutchinsii*)	960
	Nkunya (*Manilkara cunifolia*)	1 040
1	Okan (*Cylicodiscus gabunensis*)	1 040
2	Pillarwood (*Cassipourea elliottii*)	755
2	Pyinkado (*Xylia dolabriformis*)	930
1	"Rhodesian teak" (*Baikiaea plurijuga*)	915
2	Rock maple (*Acer saccharum*)	735
1	Wallaba (*Eperua falcata*)	835

NOTE Heavy duty industrial floors are assumed to withstand exceptionally severe traffic including truking and other impact loads as in factories, mills, sorting sheds, workshops, warehouses, etc.

Table B.6 **Timbers suitable for light duty industrial floors**

Hardwoods listed in Table 5 plus:

Movement classification	Timber	Density
2	Danta (*Nesogordonia papaverifera*)	735
3	European beech (*Fagus sylvatica*)	705
	Haldu kwao (*Adina cordifolia*)	675
1	Loliondo (*Olea welwitschii*)	800
1	Missanda (*Erythrophleum guineense and E. ivorensis*)	895
3	Mora (*Mora excelsa*)	995
	Rapanea (*Rapanea spp*.)	880
1	Swamp sepetir (*Pseudosindora palustris*)	720
2	Tallowwood (*Eucalyptus microcorys*)	1 010
	"Tasmanian myrtle" (*Nothofagus cunninghamii*)	675
3	Yellow birch (*Betula alleghaniensis*)	690

NOTE Light duty industrial floors are assumed to withstand traffic such as would be found in clothing and food processing and other industrial establishments with trucking of a light nature.

Table B.7 **Timbers suitable for floors with high resistance to chemicals and acids**

Movement classification	Timber	Density
1	Afrormosia *(Pericopsis elata)*	735
1	Afzelia *(Afzelia spp.)*	815
	Burma padauk *(Pterocarpus macrocarpus)*	835
1	East African camphorwood *(Ocotea usambarensis)*	595
2	European oak *(Quercus robur and Q. petraea)*	705
3	Gurjun *(Dipterocarpus spp.)*	735
1	Iroko *(Chlorophora excelsa)*	655
2	Jarrah *(Eucalyptus marginata)*	865
3	Karri *(Eucalyptus diversicolor)*	915
	Kempas *(Koompassia malaccensis)*	865
2	Keruing *(Dipterocarpus spp.)*	800
2	Malayan kapur *(Dryobalanops spp.)*	770
3	Mora *(Mora excelsa)*	995
2	Opepe *(Sarcocephalus diderrichii)*	755
1	Purpleheart *(Peltogyne spp.)*	865
2	Pyinkado *(Xylia dolabriformis)*	930
2	Redwood/Scots pine *(Pinus sylvestris)*	480
1	"Rhodesian teak" *(Baikiaea plurijuga)*	915
	Spotted gum *(Eucalyptus maculata)*	960
2	Tallowwood *(Eucalyptus microcorys)*	1 010
1	Whitewood *(Picea abies)*	465

NOTE Floors with high resistance to chemicals and acids are assumed to have an inherent resistance (i.e. with no surface treatment), e.g. floors in science laboratories.

Table B.8 **Timbers suitable for floors with small movement**

Movement classification	Timber	Density
(a) Where industrial processes are carried out involving wide variations in temperature and humidity		
1	Banga wanga *(Amblygonocarpus obtusangulus)*	495
1	Loliondo *(Olea welwitschii)*	800
1	Missanda *(Erythrophleum guineense* and *E. ivorensis)*	895
1	Muhuhu *(Brachylaena hutchinsii)*	960
1	Panga panga *(Millettia stuhlmannii)*	800
1	"Rhodesian teak" *(Baikiaea plurijuga)*	915
(b) For residential and other buildings with underfloor heating		
Hardwoods listed under 8(a) plus:		
1	Abura *(Mitragyna ciliata)*	545
1	African mahogany *(Khaya spp.)*	495
1	Afrormosia *(Pericopsis elata)*	735
1	Afzelia *(Afzelia spp.)*	815
1	Agba *(Gossweilerodendron balsamiferum)*	495
1	Ayan *(Distemonanthus benthamianus)*	675
1	East African camphorwood *(Ocotea usambarensis)*	595
1	Gedu nohor *(Entandrophragma angolense)*	545
1	Guarea *(Guarea spp.)*	610
1	Iroko *(Chlorophora excelsa)*	655
1	Makoré *(Mimusops heckelii)*	610
1	Muninga *(Pterocarpus angolensis)*	655
2	Opepe *(Sarcocephalus diderrichii)*	755
1	Teak *(Tectona grandis)*	690

Table B.9 **Timbers suitable for gymnasium floors**

Movement classification	Timber	Density
1	Ayan *(Distemonanthus benthamianus)*	675
2	Danta *(Nesogordonia papaverifera)*	735
1	"Douglas fir" *(Pseudotsuga taxifolia)* quarter-sawn only	495
3	East African olive *(Olea hochstetteri)*	880
3	European beech *(Fagus sylvatica)*	705
1	Guarea *(Guarea spp.)*	610
3/2	Gurjun/keruing *(Dipterocarpus spp.)*	735/800
	Haldu/kwao *(Adina cordifolia)*	675
3	Japanese beech *(Fagus spp.)* quarter-sawn only	610
	Japanese maple *(Acer spp.)*	705
1	Loliondo *(Olea welwitschii)*	800
1	Muninga *(Pterocarpus angolensis)*	655
2	Pillarwood *(Cassipourea elliottii)*	755
2	Rock maple *(Acer saccharum)*	735
2	"Tasmanian oak" *(Eucalyptus spp.)*	675
1	Western hemlock *(Tsuga heterophylla)* quarter-sawn only	480
1	White seraya *(Parashorea plicata)*	530
3	Yellow birch *(Betula alleghaniensis)*	690

Table B.10 **Timbers suitable for ballroom floors**

Movement classification	Timber	Density
2	Danta (*Nesogordonia papaverifera*)	735
3	East African olive (*Olea hochstetteri*)	880
2	European oak (*Quercus robur and Q. petraea*)	705
	Haldu/kwao (*Adin cordifolia*)	675
1	Guarea (*Guarea spp.*)	610
	Japanese maple (*Acer spp.*)	705
1	Loliondo (*Olea welwitschii*)	800
2	Muhimbi (*Cynometra alexandrii*)	865
2	Pillarwood (*Casipourea elliottii*)	770
1	"Rhodesian teak" (*Baikiaea plurijuga*)	915
2	Rock maple (*Acer saccharum*)	735
2/1	Sapele/gedu nohor (*Entandrophragma spp.*)	640/545
3	Yellow birch (*Betula alleghaniensis*)	690

Table B.11 **Timbers suitable for skating rink floors**

Movement classification	Timber	Density
	Brush box (*Tristania conferta*)	930
3	East African olive (*Olea hochstetteri*)	880
	Japanese maple (*Acer spp.*)	705
	Nkunya (*Manilkara cuneifolia*)	1 040
2	Rock maple (*Acer saccharum*)	735
2	Tallowwood (*Eucalyptus microcorys*)	1 010

Annex C (normative) Examples of the size of expansion gaps at perimeters of floors

Table C.1 shows typical examples ot the size of expansion gaps at perimeters of floors.

Table C.1 **Typical examples of size of expansion gaps at perimeters of floors**

Product	Method of fixing		
	Nail	Adhere	Floating
Solid boards	1.5 mm per m width of floor	1.5 mm per m width of floor	2 mm to 3 mm per m width of floor
Pre-assembled boards	1.5 mm per m width of floor	1.5 mm per m width of floor	2 mm to 3 mm per m width of floor
Strip	1.5mm per m width of floor	1.5 mm per m width of floor	2 mm to 3 mm per m width of floor
Mosaic	N/A	1.5 mm per m width of floor	N/A
Overlay	1.5 mm per m width of floor	1.5 mm per m width of floor	2 mm to 3 mm per m width of floor
Parquet	1.5 mm per m width of floor	1.5 mm per m width of floor	N/A
Endgrain flooring	1.5 mm per m width of floor	1.5 mm per m width of floor	N/A
Multi layer flooring	1.5 mm per m width of floor	1.5 mm per m width of floor	2 mm to 3 mm per m width of floor
Wood-based panels	1 mm per m length/ width of panel in addition to gaps left between individual boards	1 mm per m length/ width of panel in addition to gaps left between individual boards	1 mm per m length/ width of panel in addition to gaps left between individual boards

NOTE Instructions vary but all products need a minimum gap size. Manufacturer's guidelines should be followed.

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BS 7976-2, *Pendulum testers – Part 2: Method of operation*

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Futher reading

BS EN 13489 *Wood flooring. Multi-layer parquet elements*

BS EN 14354 *Wood-based panels. Wood veneer floor covering*

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Websites

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