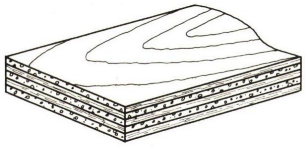
Panel Guide

ANNEX 2D

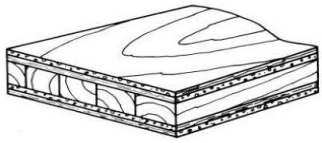
PLYWOOD

Plywood is a versatile product that can combine attractive surface appearance with superior performance under hazardous conditions whilst retaining comparatively high strength to weight ratios. It is available in a range of wood species (both hardwood and softwood) and a range of glue types for interior and exterior conditions. It was developed to provide panels with dimensional stability and good strength both along and across the panel.

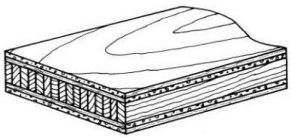
The term "plywood" includes both the true "veneer plywood" and also the core plywoods of which "blockboard" and "laminboard" are examples. Typical examples of these products are shown in the figures below.



Traditional plywood construction with odd number of veneer plies in alternate directions with neutral axis being in the plane of the middle of the centre veneer. May be any number of odd plies depending predominantly on thickness.



5-ply blockboard consisting of central core of sawn timber battens sandwiched between two veneers each side of the panel



Laminboard consisting of a central core of slats or veneers at right angles to the two veneers each side of the panel, producing a long grain appearance.

Description

Veneer plywood (the official term for what is usually called plywood) is defined as plywood in which all the plies are made of veneers orientated with their plane parallel to the surface of the panel.

The term plywood also includes core plywoods such as blockboard and laminboard and is a 'wood-based panel product consisting of an assembly of plies bonded together, some or all of which are wood'. In veneer plywood, the direction of the grain in adjacent plies is normally at right angles, with the outer and inner plies placed symmetrically on each side of a central ply or core. However, as long as veneer plywood is 'balanced' about its centre line, plies may consist of two adjacent veneers bonded with their grain parallel. This structure usually results in plywood having higher mechanical properties in the direction parallel to the grain of the face veneer.

Plywoods are produced with glue bonds which range from those suitable only for interior use to those which will withstand external exposure. Typical adhesives used are:

- Urea-formaldehyde (UF)
- Phenol-formaldehyde (PF)
- Melamine-urea-formaldehyde (MUF)

Plywood is produced on a world-wide basis using a wide range of timber species including softwoods and temperate and tropical hardwoods. Almost any species can be used, provided that it can be reliably peeled. Softwoods commonly used include spruce, pine and fir. Hardwoods used include birch and beech. The quality of the finished plywood depends both on the quality, species and lay-up of the veneers, as well as on the glue type and bonding quality.

Blockboard and Laminboard are "core plywoods" having a core made up of strips of wood, each not more than 30 mm wide, or strips of "on-edge" veneer, laid separately and glued or otherwise joined together to form a slab, to each face of which is glued one or more veneers, with the direction of the grain of the core strips running at right angles to that of the adjacent veneers.

Composition

Veneer plywood

Standard plywood veneer is still produced using a lathe, which peels a log in a similar manner to a blade pencil sharpener. Most decorative veneer is sliced from flitches after the log is cut into quarters. Prior to peeling or slicing, the logs are normally soaked or steamed in order to increase the moisture content. This helps to produce a smoother veneer. The veneers are then dried to a moisture content of about 4-8%. In some cases, small strips of veneer may be jointed into full-size sheets by edge gluing, stitching or using perforated paper adhesive tape. Open defects, such as knot holes, may be repaired using plugs or filler to upgrade the panel in accordance with grading rules. The dried, clipped or reconstituted veneers are sorted into grades, usually by visual inspection.

Synthetic resin adhesive is applied to the veneers by roller spreader, spray, extrusion or curtain coating and veneers are assembled with the grain of each normally at 90° to the adjacent veneer. (Plywood with special characteristics is produced when this rule of bonding at right angles is not followed.) The resultant assembly is known as a lay-up.

Two main types of glue are used for plywood manufacture.

- *Urea-formaldehyde* (UF)
  Panels made with this type of glue are normally only suitable for interior use. Some panels may also be suitable for use in humid environments but not for use in exterior situations.

- *Phenol-formaldehyde* (PF)
  Panels made with this type of glue are normally suitable for use in humid or in exterior situations. The durability of the veneer species should also be taken into account when selecting plywood for uses where it may be exposed to prolonged high moisture content. (see DD ENV 1099 for guidance on plywood durability. At the time of writing the way in which durability is treated is under review and revised guidance may be published.)

A third type of adhesive, urea-formaldehyde fortified with melamine and known as 'MUF' is used in some types of plywood. Bonds tend to be between UF and MUF in resistance to moisture/weather. However, some manufacturers make exterior or even marine plywoods using a melamine based adhesive.

The lay-ups are then subjected to pressure and heat in batches, most commonly in a multi-opening (multi-daylight) press. This results in a compressed and cured panel which, after cooling, is trimmed to size and, if necessary, sanded.

Core plywood (Blockboard/Laminboard)

The technique of manufacturing blockboard and laminboard developed alongside the plywood industry from the turn of the century. Blockboard uses strips of wood about 25mm wide for its core, whilst laminboard cores are composed of strips of veneer on edge (or occasionally strips cut from plywood). Plywood mills may introduce block or laminboard manufacturing facilities to use residues and to produce lower cost utility types of panels suitable for some interior purposes. The method of production is similar to that for plywood and the 'wet' stages of veneer manufacture are identical.

Appearance

Surface appearance

The surface appearance of plywood depends upon the species and grade of veneer used for the surface layers. The classification of surface appearance is covered in the five parts of EN 635 "Plywood – Classification by surface appearance", as follows:

- EN 635-1 Plywood – Classification by surface appearance. Part 1. General.
- EN 635-2 Plywood – Classification by surface appearance. Part 2. Hardwood
- EN 635-3 Plywood – Classification by surface appearance. Part 3. Softwood
- DD ENV 635-4 Plywood – Classification by surface appearance. Part 4. Parameters of ability for finishing. Guideline.
- EN 635-5 Plywood – Classification by surface appearance. Part 5. Methods for measuring and expressing characteristics and defects.

The characteristics listed in EN 635 Parts 1, 2 & 3 include:

- knots
- splits
- insect holes
- bark and resin pockets
- decay
- veneer joints
- repairs
- edge defects

Limits are set for 5 different grades of veneer with the best grade "E" being virtually clear of all defects. The limits vary between softwood (EN 635-3) and hardwood (EN 635-2), so care has to be taken to select the correct definition of the grades. The final colour of the panel is also affected by any finish applied and by the effects of weathering and ageing. These factors are also affected by the species of veneer used.

Part 4 of EN 635 deals with parameters that affect the surface finishing/coating of plywood and includes factors such as:

- surface e.g. sanded
- minimum appearance class
- thickness of face veneer
- defects in first inner ply
- bonding class

Although the quality of veneer used in the manufacture of plywood will affect its mechanical properties, the veneer classes given in EN 635 are intended only for use in determining the visual appearance of the panel. They are not intended to be used as a basis for defining a structural grade of plywood.

Edge appearance

An examination of the edges of plywood panels can quickly distinguish between veneer plywood and core plywood. Veneer plywood will be seen to be constructed from a series of veneers laid with their plane parallel to the panel surface. In core plywood, the core material (solid strips or strips of veneer glued face to back and laid on edge) can normally be clearly seen beneath the surface veneers.

Density, weight and sizes

The density of plywood is not normally controlled as part of the product specification but is a function of the species of timber used. As such the density can have a wide range, but most construction plywoods have a density in the range of 400kg/m^3 to 700kg/m^3. Thus a 2400 x 1200 x 12mm panel could typically weigh between 14kg and 24kg. Some highly compressed, specialist plywoods can have densities in excess of 1000kg/m^3 and some have "bullet resistant" qualities.

Plywood is available in thicknesses ranging from about 1.5mm to 40mm but the most commonly used thicknesses are in the range 8mm to 25mm. Supply outside of this range is limited to a small number of specialist products.

Common sheet sizes are:

- 2440 x 1220mm
- 2440 x 610mm (normally t&g)
- 2500 x 1220mm
- 3050 x 1525mm
- 3050 x 1220mm

Some specialist products, for applications such as lorry sides, are however, available to order in much larger sizes of up to about 14m x 3m. Some manufacturers offer cut to size panels.

The density range of blockboard/laminboard is not significantly different from that of plywood, the density being largely controlled by the species and form of the core material. Some panels with low density cores are available for applications where weight is critical. Panels are available in thicknesses ranging from about 10mm up to 30mm. Common sheet sizes are 2440 x 1220mm and 3050 x 1525mm.

Applications

The range of species and bond qualities means that plywood can be engineered to have specific properties, making it suitable for a wide range of applications. It is the only wood-based panel having established design values that can be used in structural applications under external conditions in accordance with EN 1955-1-1 Eurocode 5 (EC5) or BS 5268-2. Some of the typical "types" of plywood and their applications are listed below.

Structural plywoods

Plywoods for use in construction must now meet the requirements of the Construction Products Directive. The most straightforward route to demonstrating this is by complying with the requirements of EN 13986. Annex ZA defines the procedures necessary in order to affix a CE mark for construction use and whilst this is not mandatory in the UK many products are expected to carry the CE mark in future. (see Section 2 for further information on structural use)

Permissible design stresses for a range of plywood types are included in *BS 5268-2 "The structural use of timber. Part 2 Code of practice for permissible stress design, materials and workmanship"*. They are manufactured to national Standards that ensure minimum strength properties in the finished product and which are subject to approved quality control procedures. Currently such plywoods are available only from Canada, Finland, Sweden and the USA. Such plywoods also need to demonstrate compliance with the CPD, by meeting the requirements of EN 13986, or by other means.

For use with EN 1955-1-1 (Eurocode 5), characteristic values will have to be supplied by the manufacturer following testing and calculation in accordance with EN 789 and EN 1058, as specific values for plywood are not included in EN 12369 Part 1. The latest version of EN 636 includes a series of bending strength and modulus classes for plywood and EN 12369-2, includes corresponding characteristic values for these classes. Conversion factors in BS 5268-2 allow these characteristic values to be converted to permissible stresses for use with BS 5268-2.

Common uses for structural plywoods are in:

- floor decking
- wall sheathing
- flat roofing
- concrete formwork
- external cladding

Marine plywood (BS 1088)

Marine plywood to BS 1088 is manufactured using timbers having a durability rating of Class 3 (moderately durable) or better in accordance with EN 350-2. Exceptionally, low density species such as gaboon, with a durability rating of Class 4 (slightly durable) or better may also be used. In both cases, high quality veneers are used and must be bonded using either a phenolic resin or a melamine-formaldehyde (amino) resin to meet bonding Class 3 of EN 314. Marine plywood is available from UK, Israel, France, Singapore, Malaysia and other sources.

Marine plywood was developed for ship/boat building and has a very high performance under severe exposure conditions. It is also commonly used in construction applications where high performance is required or where the cost of replacement or consequences of failure warrant the additional cost. In the case of construction applications, the plywood must demonstrate compliance with the CPD, e.g. by complying with EN 13986.

Utility plywoods

Utility plywoods comprise non-structural plywoods that are available in a surface appearance grade suitable for joinery, furniture and limited exterior uses. These plywoods are available from East and South East Asia, Brazil, France, Israel, Bulgaria, Czechoslovakia, Romania, Spain, Portugal, West Africa and other countries.

Decorative/overlaid

Special end-use plywoods are commonly available from Finland, Canada, USA, Malaysia, Singapore and other East and South East Asian countries. These can be overlaid with veneers, phenolic films or other finishes to give a decorative or hard- wearing finish.

Speciality plywood

There are a wide range of speciality products available aimed at specific applications, these range from flexible plywoods, able to be bent into complex curves, to highly compressed, "bullet proof" plywoods. Lightweight panels and panels with an aggregate or non-slip finish are also available. All these products should be used in accordance with the manufacturer's specification.

Blockboard/Laminboard

These products are targeted at applications requiring a product similar to plywood in appearance but at a lower cost. They are normally restricted to interior applications such as joinery, door blanks, furniture and shopfitting.

Specification

Plywood used in the UK is sourced from all over the world and is often manufactured to overseas standards. Plywood manufactured in Europe for construction purposes is specified in accordance with EN 636. Products claiming compliance with this standard must also carry the specified markings, which includes a reference to EN 636. This standard was originally in three parts, but was re-issued in 2003 in a single part as follows

- EN 636 : 2003 : Plywood – Specifications.

The 2003 edition of EN 636 retains the designations –1, -2 and –3 from the previous three part standard to represent dry, humid or exterior conditions of use.

The environmental conditions for which each of these types of plywood are considered suitable are defined according to the parameters laid down for hazard classes in *EN 335-3 : 1996 "Durability of wood and wood-based products – Definition of hazard classes of biological attack. Part 3. Application to wood-based panels"*:

Dry conditions: for interior applications with no risk of wetting, defined in hazard class 1, with a moisture content corresponding to environmental conditions of 20°C and 65% relative humidity.
Humid conditions: for use in protected exterior applications as defined in hazard class 2, with a moisture content corresponding to environmental conditions of 20°C and 85% relative humidity
Exterior conditions: for use in unprotected external applications, as defined in hazard class 3, where the moisture content will frequently be above 20%.

The new EN 636 also introduces bending strength and modulus classes based on bending tests to EN 310. These give a designated strength (F) and modulus (E) parallel and perpendicular to the face grain. An example designation would therefore be F10/20, E30/40. EN 636 gives minimum values for each of the classes and EN 12369-2 gives corresponding characteristic values for use with each of these classes.

Plywood for use in construction must demonstrate compliance with the Construction Products Directive (CPD). The most straightforward route to achieving this is by demonstrating compliance with EN 13986, which can also involve the application of a CE mark.

The properties required of panels in EN 636 are shown in Table A2d.1.

Table A2d.1 Requirements for plywoods as defined in EN 636

Property		**Standard**	**Plywood type to EN 636**		
			Dry	**Humid**	**Exterior**
dimensional tolerance		EN 315	✓	✓	✓
bonding quality		EN 314-2	Bonding Class 1	Bonding Class 2	Bonding Class 3
mechanical properties	structural -characteristic values -bending strength	EN 636/ EN 310/ EN 12369-1 or EN 789 /EN 1058	✓	✓	✓
	non-structural -bending strength	EN 310	✓	✓	✓
formaldehyde emission	Construction	EN 13986	E1 or E2	E1 or E2	E1 or E2
	Non-construction	EN 636/DD ENV 717-1/EN 717-2	E1 or E2	E1 or E2	E1 or E2

Three bonding classes are defined in *EN 314 1993 Plywood - Bonding Quality Part 2 Requirement*s. The bonding classes relate to the hazard classes laid down in *EN 335-3 Hazard classes of wood and wood-based products against biological attack. Part 3 Wood-based panel*s. Under EN 314, samples of plywood are tested to evaluate the glue bond performance following exposure to conditions appropriate to the end-use environment class.

For structural applications, design may be carried out in accordance with BS 5268-2, or EN 1995-1-1 (EUROCODE 5). For floors, walls and roofs compliance with EN 13986 requires performance tests for point load and soft body impact to be carried out in accordance with EN 12871.

BS 5268-2 lists a series of plywood types, from North America and Europe, that are considered suitable, are subject to acceptable quality control procedures and for which design stresses are given. The products must also demonstrate compliance with CPD, e.g. via compliance with EN 13986.

If characteristic values are available either from testing to EN 789 or from EN 12369-2, BS 5268-2 now gives conversion factors to enable them to be used with that standard.

Alternative justification, e.g. load testing, is another option if plywood is to be used in specific structural applications.

Marine plywood, manufactured to BS 1088 is also available in the UK. Marine plywood was developed for ship/boat building and has a very high performance under severe exposure conditions. It is also commonly used in construction applications where high performance is required or where the cost of replacement or consequences of failure warrant the additional cost. **Marine plywood must now demonstrate compliance with CPD if it is to be used in construction.**

For non-structural/non-load-bearing applications, there are many types/grades of plywood available on the market, from various sources. **If these are to be used in construction, they must now meet the requirements of the CPD.** The user should still satisfy himself that the manufacturing specification, be it a national or industry standard, provides a product suitable for his end-use. Particular attention should be paid to the glue bond quality if the product is to be exposed to moisture.

Blockboard and laminboard are not commonly marketed as being in accordance with any particular standard. **However, blockboard and laminboard are covered by the definition of plywood and should comply with the CPD if they are to be used in construction.**

It should be noted that VS 3444 has now been withdrawn

Physical properties

Climate

Like other wood-based panel products, plywood is hygroscopic and its dimensions will change in response to changes in humidity. However, wood tends to shrink/expand much more across the grain than along the grain and the cross-laminated structure of plywood means that the longitudinal veneers in one ply tend to restrain the perpendicular veneers in the adjacent ply. As a result, the dimensional movement of plywood is quite small, typically, a 1% change in moisture content increases or decreases the length and width of plywood by about 0.15 mm per metre run. The corresponding change in thickness is likely to be in the region of 0.3%-0.4% per 1% change in moisture content. These figures should be taken as a guide only as they will vary with the species and lay-up of the plywood concerned.

The following table gives approximate moisture contents likely to be attained by plywood in certain environments.

Relative humidity at 20°C	Approximate equilibrium moisture content
30%	7%
65%	12%
85%	18%

Like all wood-based materials, the strength and stiffness of plywood will vary with moisture content. In structural design this is accounted for by applying modification factors to the material properties. Relevant factors are given for plywood in BS 5268-2 and in EN 1955-1-1 (Eurocode 5).

Biological attack

The overall durability of plywood is a function not just of the glue bond quality, but of the durability of the veneers used and of the lay-up of the plywood.

The risks of biological attack of plywood are given in EN 335-3 in relation to hazard classes 1, 2 and 3. The use of plywood in hazard class 4 (in contact with ground or fresh water) and 5 (in contact with sea water) is noted as being appropriate only if the inherent and/or conferred properties of the panels are adequate.

Some guidance on the selection of plywood for use in different environmental conditions, ie hazard classes, is included in *DD ENV 1099 Plywood - Biological durability - Guidance for the assessment of plywood for use in different hazard classes*. The durability of plywood is affected by the wood species used in the plies, the ply thickness and the gluelines. In DD ENV 1099, for resistance to fungal attack, the durability class of the wood species used in the plies (from *EN 350-1 1994 Durability of wood and wood-based products - Natural durability of solid wood. Part 1 Guide to the principles of testing and classification of the natural durability of solid wood)* is related to the hazard class in which the plywood is to be used. Recommendations as to whether the natural durability of the plywood is sufficient or whether preservative treatment is advisable or required are included. Ratings for the resistance of plywood to common species of insects, including termites and marine borers are included.

General guidance on the use of preservative treatments for panel products can be found from the Wood Protection Association manual 'Industrial Wood Preservation – specification and practice Commodity Specification C11. This guidance helps make the right choice of preservatives for the end use and the panel product to be treated as not all panel products need to be treated for particular end uses or are indeed suitable for some treatments. It also stresses that the preservative and/or the panel manufacturer should be consulted before any treatment is carried out as treatment may alter the physical and/or visual properties of the panel product.

Water vapour permeability

Water vapour permeability will vary with plywood species, density and structure, but the water vapour resistance factor (μ) will generally be between 50 and 110 when tested in accordance with EN 12572 using test conditions C (the wet cup method). This equates to a range of 150 to 250 when using test conditions A (the dry cup method). Values for various densities of plywood are given in Table 9 of EN 13986.

Thermal conductivity

The thermal conductivity of plywood is largely dependent on its density and is likely to be in the range 0.09 to 0.24 W/mK. Values for various densities of plywood are given in Table 11 of EN 13986.

Fire

Under the new Euroclass system for characterising the reaction to fire performance of materials, an untreated plywood may be assumed to achieve the following:

Product	EN Product standard	End use condition[5]	Minimum density (kg/m^3)	Minimum thickness (mm)	Class [6] (excluding floorings)	Class [7] (floorings)
Plywood[1] [2] [4]	EN 636	Without an air gap behind the wood-based panel	400	9	D-s2,d0	D_{fl}-s1
Plywood[3] [4]	EN 636	With a closed air gap behind the wood-based panel	400	15	D-s2,d1	D_{fl}-s1
Plywood[3] [4]	EN 636	With an open air gap behind the wood-based panel	400	18	D-s2,d0	D_{fl}-s1
Plywood[4]	EN 636	Any	400	3	E	E_{fl}

(1) Mounted without an air gap directly against class A1 or A2-s1, d0 products with minimum density 10kg/m^3 or at least class D-s2, d2 products with minimum density 400 kg/m^3.

(2) A substrate of cellulose insulation material of at least class E may be included if mounted directly against the wood-based panel, but not for floorings.

(3) Mounted with an air gap behind. The reverse face of the cavity shall be at least class D-s2, d2 products with minimum density 400 kg/m^3.

(4) Veneered phenol- and melamine-faced panels are included for class excl. floorings.

(5) A vapour barrier with a thickness up to 0,4mm and a mass up to 200 g/m^2 can be mounted in between the wood-based panel and a substrate if there are no air gaps in between.

(6) Class as provided for in Table 1 of the Annex to Decision 2000/147/EC.

(7) Class as provided for in Table 2 of the Annex to Decision 2000/147/EC.

NOTE The classes given in this table are for unjointed panels, T&G jointed panels installed according to DD CEN/TS 12872 and fully supported joints installed according to DD CEN/TS 12872.

If the manufactured product does not satisfy any of these minimum requirements then it must be tested and classified according to EN 13501-1.

Further information on the reaction to fire of the various panel products in both the BS and EN systems is provided in Section 2.2.3 of PanelGuide.

Storage and Handling

Bad handling and poorly organised storage of timber and wood-based products are major causes of wastage on building sites. Being reasonably durable and resilient, most timber products can withstand considerable abuse without damage, but lack of care before and during construction can affect wood products adversely.

Plywood should be stored flat and dry, off the ground, with all four edges flush. Storage in an enclosed building is preferable and external storage should be avoided whenever possible. Stacking on edge should be avoided wherever possible. Panels should be stacked on a close-boarded or slatted pallet, or if this is not possible on battens at no more than 600mm centres. The battens should all be of equal thickness and should be vertically aligned with any others in the same stack, in order to avoid distortion of the panels.

Panels should be protected by a waterproof covering during transport and the edges properly covered. Edges should also be protected against damage by lashings or other banding, this is particularly important for panels with profiled edges e.g. tongued and grooved panels. It is particularly important that plywoods with "dry" or "humid" bond qualities are protected from wetting during storage and construction. "Humid" panels may tolerate limited wetting, but in order to avoid problems with delamination and distortion, this should not be prolonged. Whilst "exterior" quality panels will tolerate a high level of wetting, this should still be avoided as far as possible, especially if they are to be installed in a "dry" environment where shrinkage could then be a problem on drying out.

All panels should be installed at a moisture content as close as possible to that which they will attain in service, in order to minimise any movement problems. Allowing "exterior" panels to become wet can lead to construction delays as the necessary drying out period may be prolonged, if they are to be installed under internal conditions or are to be coated.

Once on site, it is preferable for individual panels to be "stickered" before installation in order to allow air to circulate and to allow the panels to attain a moisture content as close to their final in-service moisture content as possible.

Further guidance on storage and handling can be found in Section 4 of PanelGuide.

Working with Plywood

Cutting

Satisfactory results can be achieved using hand tools, but quicker and more consistent results can be achieved using either portable or fixed power tools.

When hand sawing, use a cross-cut saw of 10 to 15 TPI for best results.

If a circular saw is used then the saw blade should enter the panel on the good face. A tungsten carbide tipped saw will give good performance. The best finish will be obtained using a fast material feed speed in the opposite direction to the saw rotation and with minimum protrusion of the saw above the panel surface.

When band sawing, the best finish will be obtained with a fast cutting speed and slow material feed speed.

Where material routing or moulding is required, the cutter type, tool and material feed speed all affect the quality of the finish. Trials may be required to establish the optimum conditions.

Fixing

Because plywood normally has higher mechanical properties in a direction parallel to the face grain, the direction in which the panels are to be laid must normally be specified, particularly in structural applications such as floors. In structural applications, the direction of installation must be as assumed in the design calculation.

If panels are laid edge to edge, such as in a floor, it is essential that suitable expansion gaps are provided to allow for any, moisture related, dimensional movement during service. Guidance on the necessary allowances can be found in Section 4.5.3 of PanelGuide.

Plywood can be fixed by nails, screws, and staples or by gluing, depending upon the application and requirements.

The structure of plywood makes it possible to use nails and other mechanical fastenings quite close to the panel edges without the risk of pull out. Whilst pre-drilling is required for screws and larger connectors, nails can normally be driven without pre-drilling. When

fastening plywood to timber, ring shanked nails give improved performance to plain wire nails. More guidance on fastener sizes and spacings for specific applications can be found in Section 2 of PanelGuide.

Glued joints provide stiffer joints than ones made with mechanical fixings alone. A wide range of adhesive types is available but care should be taken to ensure that the adhesive used is suitable for the environmental conditions of the end use.

Finishing

Sanding.

Plywood is available with both sanded and unsanded surfaces according to the end-use requirements. The quality of the surface finish is also affected by the species and the grade of the surface veneer.

Coatings.

When exposed to weather in an unprotected state, most species of plywood will weather quickly to a dull grey colour. Further weathering can result in checking and splitting of the surface and the loss of wood fibre. The application of a suitable finish can protect the material and enhance its appearance. The application of a finish to plywood under interior conditions is normally only for decorative purposes.

The surface finish that can be achieved will vary with species. Fine grained species such as Birch can have a very finely textured surface, whereas coniferous species tend to be more heavily textured.

A range of paints, stains and varnishes are suitable for use on plywood, but care should be taken to ensure that the finish is suited to the end-use. Products used in exterior or other changeable environmental conditions require a flexible coating to accommodate dimensional changes. If the plywood is installed in a heated environment then it is important that the moisture content is allowed to stabilise before the coating is applied.

Plywoods with a medium density paper overlay are specially designed to be painted and subjected to fully exposed service. With normal plywood, adequate performance of the finish requires great care with design, surface preparation and application of the finish, if surface checking is to be avoided. Low-build exterior wood stains possess certain advantages over film-forming finishes by being more able to cope with the behaviour of exposed plywood. Exterior wood stains will not prevent surface checking but are less likely to react to it by flaking off than paint. Redecoration with a pigmented product will protect the checked surface and should present an acceptable appearance.

Some water-based acrylic paints show high levels of extensibility and can tolerate the surface movements of plywood. However, dark coloured versions of such paints should not be specified for areas sheltered from rainfall to prevent the appearance of salt efflorescence on the surface. Blockboards and laminboards are not generally recommended for use in exposed exterior applications.
Guidance on the specification of plywood on the basis of surface appearance and its ability for finishing is given in EN 635 "Plywood. Classification by surface appearance". (see Appearance section). TRADA Wood Information Sheet 2/3-1 also gives guidance on the use of timber finishes under exterior conditions.

Under exterior conditions, it is important to coat both surfaces of the plywood panel and to effectively seal the panel edges with a suitable sealing compound. There are many materials that have a potential edge sealing role, including liquids, pastes and hot melts, but none should be relied upon to compensate for poor design or detailing. Designs should seek to

ensure that the wetting of panel edges is minimised, see TRADA Wood Information Sheet 4-20 for guidance on "Durability by design".

Ineffective edge sealing can result in dimensional changes/swelling due to water ingress and can lead to staining, failure of the coating, decay, delamination and ultimately to premature failure of the plywood. Guidance on the selection and specification of edge sealants can be found in TRADA Wood Information Sheet No 2/3 – 20.

Health and Safety

In common with other wood products, plywood is safe when it is handled and used correctly. Contact with some species of timber can cause irritation to sensitive individuals, but such species are rarely used in the manufacture of plywood.

When cutting or machining plywood, wood dust is produced and as this can be hazardous, measures must be taken to control the dust. This is normally carried out with the use of a suitable personal dust mask or by dust extraction systems in a workshop environment.

Dust from cutting operations can be controlled by complying with the Control of Substances hazardous to Health (COSHH) Regulations 2002. Under these regulations, wood dust has a Workplace Exposure Limit (WEL) of 5mg/m^2, which is appropriate to wood dust from the machining of plywood. Exposure must be reduced as far as possible below this limit.

The formaldehyde content of plywood is very low and emission of formaldehyde is not normally an issue with plywood.

As with all wood-based panels, there may be handling hazards and COSHH Regulation 6 requires an assessment to be made, and recorded, of health risks associated with wood dust and handling. Common risks and control measures are shown in the table below.

Activity	**Hazard**	**Control**
Manual handling of full sheets	Large sheet sizes present a risk of strain or crush injuries if not handled correctly.	Store carefully in uniform stacks on a flat level base. Use mechanical handling equipment. Adopt correct manual handling procedures.
Carpentry work. Activities likely to produce high dust levels include: • Sanding by machine and hand • Sawing, routing • Hand assembling machined or sanded components	Wood dust in general may cause dermatitis and allergic respiratory effects. Wood dust is flammable.	Off-site: preparation under exhaust ventilated plant. On-site: enclosure and exhaust ventilation. Dust extraction on portable tools. Good ventilation. Respiratory protection equipment. *Note:* Any health hazards arising from the use of plywood at work can and should be controlled by compliance with the requirements of the Control of Substances Hazardous to Health (COSHH) Regulations 2002.