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Wood Information Sheet

WIS 2/3-11

Subject: Panels
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Specification and use of wood-based panels in exterior and high humidity situations

Certain types of wood-based panels can be used in demanding exterior and high humidity situations. However, they must be correctly specified, detailed, installed and maintained to provide the desired performance and service life.

Exterior and high humidity use covers a wide range of situations. Panels may be fully exposed to wetting by salt or fresh water, or be more protected with a risk of occasional wetting, such as soffits under porches or lorry decks, or may be covered but with a high risk of wetting due to condensation.

This Wood Information Sheet (WIS) is an overview of the subject with signposts to more detailed sources that are listed at the end. It includes BM TRADA's advice for specifying plywood in exterior situations. It should be noted that 'Exterior' plywood may still require preservative treatment.

TRADA's *WIS 2/3-23: Introduction to wood-based panel products* [1] summarises the range of wood-based panels available in the UK.

The Wood Panel Industries Federation's *PanelGuide* [2] is a comprehensive guide to the use of wood-based panels in the UK.

TRADA's *WIS 2/3-17: Wood-based sheet materials for formwork linings* [3] deals with the use of wood-based panels for concrete formwork, a particularly onerous application.

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Figure 1: Woodstain finished plywood soffit lining at The Stonebridge Hillside Hub, West London
Photo: Cullinan Studio

Key points

- Appropriate specification is the main consideration when using wood-based panels in high humidity and exterior situations.
- There is a range of risk factors for wood-based panels associated with high humidity and exterior applications that are not present for applications in dry conditions.
- When specifying a wood-based panel for exterior or high humidity use, designers must consider the degree of exposure as described by the service class or the use class.
- For each sort of wood-based panel, BS EN product standards define a range of product types. Some of these types have a moisture resistance that is suitable for high humidity or exterior applications.
- Depending on the desired service life, exterior grade panels may require preservative treatment, edge coating/sealing or other protective measures to improve their resistance to biodegradation.
- Plywood is the panel product most likely to be specified for exterior use, but its specification must consider the bond quality, the biological durability of the veneer species and the need for any additional preservative treatment or coatings.
- Wood-based panels are more susceptible to moisture ingress at the panel edges than the faces, so edge protection and detailing should be carefully considered.
- Panels used in exterior situations usually need a protective finish to preserve their appearance.
- Correct design, detailing, workmanship and maintenance can help to minimise the impact of exterior exposure factors.

Exterior exposure

When specifying a wood-based panel for exterior use, designers must consider two important concepts to describe the in-service conditions – service class and use class.

Like all wood products, the mechanical properties of wood-based panels vary with moisture content, which depends on the environment where the panel is used. Specifiers use service classes and use classes to describe the environment and so determine the suitability and treatment of products for construction purposes, where failure of the product would not be acceptable in terms of safety or aesthetics.

The Wood Protection Association's *Manual: Industrial wood preservation specification and practice* [3] contains guidance on preservation treatments for wood-based panels.

Service classes

Service classes are used in structural design to define the in-service environmental conditions and to specify appropriate modification factors to the product's characteristic values. *Table 1* summarises the three service classes defined in Eurocode 5 [4,5].

The service class is determined by the highest relative humidity that might occur for a few weeks per year and hence the highest moisture content of the product. In some of the European (EN) panel product Standards, the conditions for service classes 1, 2 and 3 are referred to as 'dry', 'humid' and 'exterior' respectively.

Table 1: Service classes and examples from Eurocode 5

Service class	Temperature	Approx RH*	EMC**	Examples from the UK National Annex to Eurocode 5 [5]
1	20°C	65%	12%	Warm roofs, intermediate floors, timber-frame walls – internal and party walls
2	20°C	85%	20%	Cold roofs, ground floors, timber-frame walls – exterior walls, exterior uses where member is protected from direct wetting
3	Conditions leading to higher moisture contents than service class 2		>20%	Exterior uses – fully exposed

*RH Relative humidity: level not to be exceeded for more than a few weeks each year
**EMC Maximum equilibrium moisture content for most softwoods. In similar conditions the EMC of panel products will typically be lower

Use classes

Use classes are the means of specifying the risk of biological attack by fungi or invertebrates on wood and wood-based products. *Table 3* summarises the use classes defined in *BS EN 335 Durability of wood and wood-based products. Use classes: definitions, application to solid wood and wood-based products* [6].

The use class determines whether the natural durability of the timber used is sufficient or whether preservative treatment, or other protective measures, are needed to achieve the desired service life.

Panels may be used in a higher service class than that appropriate to their type, but only where failure or degradation of the product would not be dangerous, or where a reduced service life is acceptable.

Correspondence between service and use classes

BS EN 335 provides an indication of the overlap between service and use classes as shown in *Table 2*.

Table 2: Correspondence between service and use classes

Service class	Corresponding use classes
Service class 1	Use class 1
Service class 2	Use class 1 Use class 2 if the component is in a situation where it could be subjected to occasional wetting caused by e.g. condensation
Service class 3	Use class 2 Use class 3 or higher if used externally

Service class 2 stipulates very similar in-service conditions to use class 2. However, service class 3 is characterised by material moisture contents higher than that of service class 2, which requires use classes 3, 4 and 5 to be considered. As shown in *Table 3*, wood-based panel products in use classes 2 to 5 are at risk of some degree of biological attack. For construction purposes, some wood-based panel product types may be suitable in these situations and others may not.

This wood information sheet refers to use classes unless it is discussing loadbearing applications, but the information applies equally to the corresponding service classes.

Factors affecting performance

The factors of high humidity and exterior exposure that can have a significant effect on the performance of wood-based panels include:

Table 3: Use classes and indicative risks

Use class	Situation	Risk to wood-based panels		
		Moisture content	**Mould and fungal attack**	**Insect (and/or other invertebrate) attack**
1	Under cover, fully protected from weather and not exposed to wetting	No higher than that resulting from exposure to a temperature of 20°C and RH of 65%	Regarded as being dry, and thus the risk of attack by surface moulds or by staining or wood-destroying fungi is insignificant	For plywood, attack is possible, its frequency and importance depends upon the geographical region. Attack by beetles can also depend upon veneer species and thickness. However, insect attack of plywood in service is infrequent in exterior situations in the UK For all other panel products, no risk of attack. All panel products* are at risk of attack by termites in geographical locations where this occurs.
2	Under cover and fully protected from the weather but where high environmental humidity can lead to occasional but not persistent wetting	Can occasionally attain or exceed that which would result from exposure to a temperature of 20°C and RH of 90%	Moisture content can occasionally increase to a level which can allow growth of wood-destroying fungi. Disfigurement of decorative panels can also occur as a result of surface moulds and staining fungi	
3 (3.1)	Not covered and not in contact with the ground. Subject to frequent wetting but water does not accumulate	Frequently above 20%	Often liable to attack by wood-destroying fungi. Disfigurement of decorative panels can also occur as a result of surface moulds and staining fungi. The use of particleboards* and fibreboards is appropriate only if the inherent and/or conferred properties of the board are adequate	
3 (3.2)	Not covered and not in contact with the ground. Remains wet – water may accumulate			
4	In contact with the ground or fresh water and thus permanently exposed to wetting	Permanently above 20%	Liable to attack by wood-destroying fungi. The use of plywood is only appropriate if the inherent and/or conferred board properties are adequate. This often involves treatment with a chemical preservative. Current EN product standards do not include types of particleboard,* oriented strand board (OSB) or fibreboard that are suitable for use in this class, but there are panels with enhanced performance that may be suitable for use, when used in accordance with the manufacturer's guidance.	
5	Permanently exposed to salt water	Permanently above 20% and wholly or partially submerged in salt water	Liable to attack by wood-destroying fungi. The use of plywood is only appropriate if the inherent and/ or conferred board properties are adequate. This often involves treatment with a chemical preservative. No particleboards*, OSB or fibreboards are currently manufactured for use in this use class.	Attack by invertebrate marine borers is the principal problem. For the above-water portions, risk of insect attack is similar to use class 1-4.

* Except cement-bonded particleboard

- rainfall (particularly wind-driven) and standing water where the panel is in contact with the ground
- the ease with which drying out is possible
- fluctuations in relative humidity and temperature
- moisture content arising from the above environmental factors
- sunlight, particularly on south-facing aspects and for dark coloured surfaces
- fungal organisms and insect attack
- frost and freeze-thaw action
- degradation from contact with chemical contaminants, such as salt.

Correct design, detailing, workmanship and maintenance can help to minimise the impact of some of these factors. Wood-based panel products, because of their nature, will perform differently to large sections of solid timber of the same species, and differently to each other, especially in an exterior environment.

Moisture

TRADA's *WIS 4-14: Moisture in timber* [7] describes the effect that moisture has on wood, a particular problem for wood in exterior situations.

Wood-based panels are susceptible to moisture ingress through both faces and, in particular, via the panel edges. Direct wetting or an increase in the local humidity can result in an increase in moisture content and lead to swelling of the panel. Therefore, in exterior situations, it is imperative that all edges of all panels are protected to achieve satisfactory performance.

The edges of fibreboards, particleboards and OSB are coarser textured than the faces and are susceptible to moisture ingress. In plywood, exposed end grain and/or wood fibres at the edges facilitate moisture ingress. The presence of core gaps or veneer overlaps can create localised areas of ridging on plywood faces as a result of changes in moisture content.

Moisture ingress can cause swelling and unsightly staining behind a translucent/clear finish. Fungal decay may lead to severe degradation of wood-based panels if they remain wet in service for prolonged periods. Adequate ventilation can help to reduce the effects of wetting. Coatings or other protective design measures can help reduce the rate of moisture change.

Water will penetrate into wood-based panels much more rapidly than it is lost by drying to air under normal conditions. This is particularly the case if its entry is localised, such as through an area of improperly applied edge sealant or a large exposed core gap in plywood. Under these conditions, water can be trapped for long periods behind fairly impermeable finishes, putting considerable demands on the adhesion between the wood substrate and the surface coating or finish. Continuous fluctuations in relative humidity can also be problematic and cause dimensional changes to wood-based panels, particularly fibreboards, particleboards and OSB that are more susceptible to swelling in thickness. Panels that have swelled usually recover partially when dried. However, some swelling is usually irreversible.

Repeated wetting and drying of unfinished plywood panels can result in lathe checks opening up on the face veneer surface.

Similarly, the surface strands/flakes of wood used to produce OSB panels can degrade and peel off, if left permanently exposed to the elements and without an appropriate coating.

Sunlight

Exposure to direct sunlight can cause a rapid change of colour of unprotected wood-based panels. Prolonged exposure will lead to general lightening/greying of the wood surface. A rough, bleached, weathered appearance may be acceptable; otherwise, specify a protective finish.

Specification

Correct specification should cover the properties required of the basic material as well as treatments, finishes, fixing details and structural properties. It is worth considering each property although not all items will be appropriate to every situation and others may also be involved, for example, specific structural applications. See also TRADA's *WIS 2/3-57 Specifying wood-based panels for structural use* [8].

Check these factors when specifying wood-based panels in exterior situations:

- use class suitability with respect to the type and grade of panel to be used
- whether a load-bearing panel is required
- intended service life
- aspect and prevailing weather conditions
- thickness
- veneer thickness and lay-up (plywood only)
- desired aesthetic qualities
- timber species durability (plywood only)
- preservative treatment requirements
- edge sealing treatment
- finish type (such as paint and stain)
- moisture content at time of installation compared to that in service (shrinkage /contraction)
- sanding or preparation requirements before finishing
- maintenance requirements
- type and suitability of fixings
- ease of replacement.

Suitability for use classes 2 and 3

The suitability of a wood-based panel for a particular use class depends largely on the glue bond quality and its ability to withstand certain in-service conditions for prolonged periods of

time. *Table 5* summarises the requirements for a use class 2 or 3 environment, for each wood-based panel product Standard. A panel suitable for use class 3 is also suitable for use classes 1 and 2. The table shows all the types given in the Standards, but they may not all be commercially available.

Table 4: Panel types suitable for loadbearing applications in service class 2

Standard	Panel type
EN 636	Plywood: 636-2 S, 636-3 S
EN 300	Oriented strand board: OSB/3, OSB/4
EN 312	Particleboard: P5, P7
EN 622-2	Fibreboard, hard: HB.HLA1, HB.HLA2
EN 622-3	Fibreboard, medium: MBH.HLS1*, MBH.HLS2*
EN 622-3	Fibreboard, MDF: MDF.HLS*

* Only for short term and instantaneous actions

Loadbearing applications

For loadbearing applications it is more appropriate to refer to service classes than use classes. For panels in service class 2, Eurocode 5 gives design factors for some panel types (*Table 4*).

For service class 3, design factors are given in Eurocode 5 for BS EN 636-3 for plywood only. The other use class 3 boards shown in *Table 5* are unsuitable for loadbearing applications.

Cement-bonded particleboard may well have sufficient strength and stiffness for loadbearing applications, but Eurocode 5 offers no design factors in any service class.

Durability of wood species for wood-based panels

Methods for determining the biological durability of solid wood and wood-based products, including panel products, are given in

Table 5: Panel types according to use class

Panel type	Product Standard	Type for use class 2	Type for use class 3
Plywood	*BS EN 636 Plywood. Specifications* [9]	EN 636-2 EN 636-3	EN 636-3
Oriented strand board (OSB)	*BS EN 300 Oriented strand boards (OSB). Definitions, classification and specifications* [10]	OSB/3 OSB/4	–
Medium density fibreboard (MDF)	*BS EN 622-5 Fibreboards. Specifications. Requirements for dry process boards (MDF)* [11]	MDF.H MDF.HLS L.MDF.H MDF.RWH**	Exterior MDF (products are commercially available but not defined in a BS or EN product Standard)
Hardboard	*BS EN 622-2 Fibreboards. Specifications. Requirements for hardboards* [12]	HB.H HB.HLA1 HB.HLA2	HB.E *
Mediumboard	*BS EN 622-3 Fibreboards. Specifications. Requirements for medium boards* [13]	MBL.H MBH.HLS1 MBH.HLS2	MBL.E *
Softboard	*BS EN 622-4 Fibreboards. Specifications. Requirements for softboards* [14]	SB.H SB.HLS	SB.E *
Particleboard (also known in the UK as chipboard):	*BS EN 312 Particleboards. Specifications* [15]	P3 P5 P7	–
Cement-bonded particleboard	*BS EN 634-1 Cement-bonded particle boards. Specification. General requirements* [16] and *BS EN 634-2 Cement-bonded particleboards. Specifications. Requirements for OPC bonded particleboards for use in dry, humid and external conditions* [17]	Class 1 Class 2	Class 1 Class 2

* Should only be used in exterior situations if a treatment of proven exterior durability (coating or otherwise) has been applied to relevant surfaces and edges

** MDF.RWH is intended for use as a rigid underlay in roofing and walls where it may be used in applications subject to instantaneous (e.g. wind) or short-term (e.g. snow) load duration only

– No suitable products defined

BS EN 350 *Durability of wood and wood-based products. Testing and classification of the durability to biological agents of wood and wood-based materials* [18]. The standard provides classification systems for resistance to most types of wood-destroying insects and fungi based on the test results. The classifications may be applied to both solid wood and wood-based products, including standard panels and those that are treated or modified in some way to enhance their durability.

In practice, the classification systems are of most use for solid wood species, and BS EN 350 provides an extensive list of the natural durability of commercially available species. The resistance of the heartwood to attack by decay fungi is taken as the characteristic durability of the species.

For wood-based panels other than plywood and cement-bonded particleboard, a level of durability is implicit in the use class designation for the product type as shown in *Table 5*. However, as the product type places no restriction on the wood species or proportion of sapwood in the product this should not be understood as equivalent to the biological durability classes of BS EN 350. It is better understood as an indication of the product type's resistance to degradation by moisture.

The durability of plywood is a special case and is discussed in detail below.

Because of the cement, the risk of attack on cement-bonded particleboard by wood-destroying organisms is insignificant in all use classes.

Most wood-based panels are intrinsically resistant to attack by wood-boring insects. The fibres or particles are usually too small to provide a suitable substrate for the larvae and the adhesive forms a barrier that is difficult to penetrate. Strands or veneers that are thicker than around 2mm may be more susceptible to attack, but the adhesive bonds will limit its extent. This intrinsic resistance does not extend to termite attack, but products are available that incorporate appropriate insecticides.

With the exception of plywood, wood-based panels are not generally suitable for preservatives that are applied as water-borne treatments under pressure. Fibreboards, including MDF, and particleboards will swell in their thickness and not recover their initial dimensions or properties on drying. If the glue bond does not have sufficient moisture resistance the panel may even disintegrate. OSB is less susceptible to thickness swelling, but the differential movement between individual strands is likely to cause local glue bond fractures so that the panel loses its integrity.

Other methods of preservative application, such as dipping or coating, will be more or less damaging depending on the amount of wetting they cause. This implies that it may be difficult to achieve anything other than a shallow depth of preservative penetration without damaging the panel.

Preservative treatment may confer additional resistance to biodegradation, but it will not change the use class of the panel, since that is determined by the moisture performance of the glue bond.

Chemically modified MDF is available that has significantly improved resistance to moisture and biodegradation compared with standard MDF.

Durability of plywood

An exterior bonded plywood is probably the most commonly used panel for exterior construction applications, but there is understandable confusion among specifiers concerning the properties of 'exterior grade' plywood.

Most confusion arises because the BS EN 636 classes do not provide the clarity of specification that they seem to offer. BS EN 636 classifies plywood for use in dry conditions (EN 636-1), humid conditions (EN 636-2) and exterior conditions (EN 636-3) and for each class states that 'plywood shall be appropriate for prevailing climatic conditions'. However, for the plywood manufacturer, allocation to one of these classes is determined only by the moisture resistance of the glue bond between veneers without any specific requirements relating to resistance to biological attack. The standard recognises the risk of biological attack in exterior conditions, so this leaves the specifier with some work to do.

Guidance on measures to ensure plywood durability are given in DD CEN/TS 1099. DD CEN/TS 1099 *Plywood. Biological durability. Guidance for the assessment of plywood for use in different use classes* [19]. This Technical Specification advises taking account of factors such as the natural durability of the species, the degree of exposure, protection and maintenance, ease of replacement and desired service life. Since the plywood manufacturer is unlikely to be aware of the eventual end use, the onus rests on the specifier to consider these factors and determine whether or not the product has sufficient durability for a specific application 'as-supplied'.

It is recommended that specifiers consider the following three variables in light of the intended use class and desired service life:

- glue bond class
- natural durability of the plies
- protective treatments and coatings.

Table 6: Plywood specifications suitable for use classes 2 – 5 (DD CEN/TS 1099)

Wood species durability to EN 350	Use class 2	Use class 3	Use class 4	Use class 5
With glue bond class EN 636-2				
Very durable (class 1)	U	–	–	–
Durable (class 2)	U	–	–	–
Moderately durable (class 3)	U	–	–	–
Slightly durable (class 4)	UT	–	–	–
Not durable (class 5)	UT	–	–	–
With glue bond class EN 636-3				
Very durable (class 1)	U	U	U	U
Durable (class 2)	U	U	UT	UT
Moderately durable (class 3)	U	UT	TU	TU
Slightly durable (class 4)	UT	TU	T	T
Not durable (class 5)	UT	TU	T	T

– not suitable
U untreated
UT left untreated is normally sufficient but, under certain end uses, treatment can be advisable
TU treatment is normally advisable but, in certain end uses, the panel may be left untreated
T treatment necessary

Table 6 shows how these variables are combined for each of the use classes 2 to 5. The guidance is taken from DD CEN/TS 1099.

Species durability in plywood

Plywood made from a wood veneer species that is classified as 'moderately durable' in BS EN 350 or better and with an EN 636-3 glue bond should perform well in exterior applications (use class 3). 'Durable' and 'very durable' species may even be suitable for use classes 4 or 5 (see *Table 6*). However, sapwood is always 'not durable' (class 5 in BS EN 350) and often difficult to identify and exclude from production. It is reasonable to assume that all plywood boards contain sufficient sapwood to be classed as 'not durable' unless the manufacturer has procedures to limit its amount, as is the case for marine plywood.

BS EN 636 requires plywood to be marked with the commercial or botanical name(s) of the wood species it contains. Although it can be very difficult to determine the constituent species of many types of plywood in the finished product, particularly species of tropical origin, the manufacturer should know the species that have been used.

In practice, with good design, installation and maintenance, decay in plywood used in exterior situations is relatively uncommon, despite the fact that it may well contain sapwood.

Protective treatments and coatings for plywood

BS EN 636 states that (for exterior use): '…the performance of most plywood will be compromised if suitable preservative treatment and/or relevant surface and edges coating is not applied and if the panels are not properly maintained and installed'.

In most cases an exterior grade plywood will need preservative treatment or other protective measures if it is to have an acceptable service life in use class 3, or perhaps even 4 or 5. These would normally be applied under factory conditions.

Plywood can be pressure impregnated with wood preservatives, provided the glue bond has sufficient moisture resistance. In practice this means an EN 636-3 bond should usually be specified, although an EN 636-2 bond may be acceptable in some cases. Note that there is little published guidance on the levels of penetration and retention required for plywood, particularly for use classes 4 and 5. It is necessary to consult preservative manufacturers or treatment companies to identify a suitable treatment for a specific use.

For use in construction, BS EN 13986 requires plywood that has been preservative treated to be marked 'PT'.

Coatings are discussed in more detail in the section on 'Finishes' on page 8.

Marine plywood

If it is important that the plywood has a recognised level of biological durability without further treatment or coating, standard marine plywood may be specified.

Marine plywood, manufactured and marked in accordance with BS 1088:2018 *Marine plywood. Requirements* [20], can be manufactured to standard or lightweight classes. The standard class requires the use of timber species with a durability class 3 or better, and is intended to be suitable for marine environments. The lightweight class allows the use of timber species with a durability class 4 or better and is suitable for use classes 1, 2 or 3.1 only. The quality of the veneer and the proportion of sapwood is controlled by the standard.

Even if a marine plywood is made from a durable species, constant wetting and drying and exposure to the elements can lead to surface checking and roughness. The timber will also weather to a grey colour unless a coating or finish is applied and maintained.

Marine plywood is available with third-party certification intended to verify that manufacturers maintain their compliance with the standard. If BS 1088 plywood is used in construction it must also be CE marked in accordance with BS EN 13986.

Specifying plywood – use classes 1 or 2

Much of the exterior grade plywood used in construction is in situations that are generally dry with only occasional wetting during the construction process or in service, for example internal flooring, wall and roof sheathing applications. These are typically use class 1 situations if the plywood is within the heated envelope of the building or use class 2 situations if at least one face is exposed to an unheated environment.

EN 636-1 plywood is only appropriate for use class 1 while EN 636-2 or EN 636-3 plywood is appropriate for use class 1 or 2. For such applications wood durability is of less importance. Plywood manufactured using wood veneers classified as 'not durable' has been used satisfactorily in these situations for more than 50 years in the UK.

Specifying plywood – use classes 3, 4 or 5

The factors to consider when deciding whether to specify preservation include the severity of the use class, the desired service life and the consequences of deterioration. If there is a risk of prolonged wetting and an extended service life is required, then specify that the wood component of plywood is sufficiently resistant to fungal or insect attack as well as being adequately bonded. For satisfactory long-term service, most exterior uses demand that either a durable veneer species is used, and/or an appropriate preservative treatment or coating/finish is applied. Use classes 4 and 5 are very challenging environments for plywood, so protective measures must be considered and executed with particular care.

Where plywood contains wood that is 'not durable' (that is, durability class 5) then this will normally require treatment where the plywood is exposed to use class 3, 4 or 5 situations. As noted above, virtually all plywood types may contain some sapwood, which for all species is rated as not durable.

The final choice of plywood, treatment and coating must be based on an individual assessment of the exposure condition, maintenance schedule, risk of failure in service and intended service life.

Finishes

Except perhaps for short-life non-construction uses, such as site hoarding or boarding-up purposes, a protective finish is generally necessary to preserve the appearance of exterior grade wood-based panels in exterior situations. TRADA's *WIS 2/3-1: Finishes for external timber* [21] offers guidance.

For most applications, wood-based panel manufacturers recommend that any exterior grade panel used in exterior situations should be fully coated prior to installation. This includes both faces and all edges, including those cut on site. This will help to minimise moisture ingress and provide more balance to the panels, for example to reduce the risk of thinner panels, such as those used for soffits, warping in service. There are several types of paint finish available and specifiers should seek guidance from the paint/coating manufacturer on their suitability and use for the particular wood-based panel type and use class, their methods of application and maintenance cycles.

Some panel types are available with face and edge coatings applied by the manufacturer. Cut edges must be coated to the manufacturer's specification to maintain the performance of these panels.

For coating plywood, specify the appearance class of the face veneers in accordance with CEN/TS 635-4 *Plywood. Classification by surface appearance: Parameters of ability for finishing, guideline* [22]. This Technical Specification contains guidance on which surface veneer grades are suitable for which type of coating under each use class. For example, an appearance class

1 plywood that is sanded or textured, with a face veneer thickness of 0.4mm to 3mm and inner plies of a maximum thickness of 5mm with no open defects on the first inner ply, is suitable for all finishes including varnish in use class 2 conditions.

For OSB, a completely smooth finish is more difficult to achieve than with other panel types as it is produced from individual flakes or strands.

MDF exterior grade generally requires a surface coating to be applied; see manufacturer's guidance. Make sure that edges have taken up enough coating to be an effective barrier to moisture.

For hardboards, mediumboards and softboards, a coating may not be suitable due to the uptake of moisture causing movement or swelling. Additives, which are components incorporated in the panel during manufacture, such as oil, may also affect the choice of coating.

On all panels intended for exterior use take care with the surface preparation and the application of finishes. For example, MDF (which can be finely machined) must have the corners of all the edges rounded if a satisfactory paint finish is to be achieved.

Use low-build exterior wood stains with plywood only, as they are not suitable for other panel types. Stains possess certain advantages over film-forming finishes by being more able to cope with the movement of exposed plywood. Exterior wood stains will not flake off in response to checking of the veneer as a result of wood movement. If surface checking occurs, redecoration with a pigmented product will protect the checked surface and should present an acceptable appearance. Patches, inserts, filler and overlaps on plywood face veneers will show up with a light coloured stain finish.

Some plywood/exterior finish combinations in use class 2 situations, such as soffits or under eaves, can cause salts to migrate and appear on the surface of the coating. Light colours are less vulnerable to this effect.

Factory-applied finishes/modifications

There is now a range of panel products with factory-applied coatings, some of which provide a degree of protection from wetting, either short or long term. The manufacturer's guidance should be followed in relation to installation, protection and degree of exposure, as there are no specific requirements for coatings given in the relevant BS EN standards.

Plywood is available overlaid with specialist slip-resistant coatings that are used in applications such as lorry decking, scaffold platforms, ramps and mezzanine floors. These types of plywood do not require further surface preparation or finishing, but resealing of cut edges and drilled holes is essential if a prolonged service life is to be achieved. Other speciality plywoods are available with a resin-impregnated paper overlay for painting. The impregnated paper substrate provides a smooth defect-free surface, ideal for painting. Some end uses for this product are signboards, fascia panels, playground equipment, formwork for concrete and vehicle building.

Certain types of OSB are available with a factory-applied, exterior, impregnated paper overlay, or painted surfaces. These can be used for applications such as site hoarding, where the coating is intended to extend the service life of the panel.

Particleboard flooring is available with a waterproof coating or film, which is intended to provide protection from temporary wetting during construction. Particleboard is not intended for long-term exterior use.

MDF made with chemically modified fibres is also available. These products can have improved stability and durability for use in exterior conditions, but should be used in accordance with manufacturer's guidance.

Another advantage of many overlaid panel types is that factory sealing of edges is standard and specialist edge sealing is also available on request from many mills. Reseal cut edges and drilled holes prior to installation.

Design and workmanship

Good design and site workmanship are essential in all cases. TRADA's *WIS 4-28: Durability by design* [23] contains guidance on life and risk assessment.

When correctly specified and utilised, wood-based panels are robust materials. Much depends on the actual conditions, but it is possible to state some general rules applicable to all but very temporary exterior use of wood-based panels.

Edges of panels must be sealed to minimise absorption of water. Such sealing may be with:

- special sealing compounds, such as 2-part epoxy
- non-setting mastics, if the panel is set in frames
- polyurethane, acrylic or rubber-based paints
- wooden beading bonded with exterior adhesives
- metal or plastic capping or channels fixed with non-setting mastic
- two or three coats of paint applied to all edges.

Proprietary edge sealing is also available from some plywood manufacturers on request.

In addition to edge sealing, the top and bottom edges of panels should be chamfered, bevelled or rounded to promote shedding of water and to maintain good paint adhesion. Consider designs that incorporate a measure of protection to wood-based panels as this can prolong the service life of panels when subject to exterior conditions. For example, consider large eaves overhang to prevent driving rain from hitting panels; slopes or gradients to decks in order to shed water; and designs that allow for the free flow of air around panels to promote drying. Detailing and design must ensure that water is shed effectively and does not soak into the backs of panels, especially in areas such as soffits where cavities must be adequately ventilated to allow dispersal of moisture.

Failure to leave expansion gaps around the edges of panels can lead to buckling (3mm gap on each edge is generally considered adequate).

Provide clearance at panel joints for water to drain freely. Mastic joints between panels are unlikely to be satisfactory due to the cumulative movement across the width or length of the panel being concentrated in the area of the joint. Exposed or concealed joints may be used but should, in each case, provide a gap for expansion and drainage. The gap should be wide enough to facilitate re-treatment of the panel edges when redecorating.

Similar considerations apply when detailing the junctions between wood-based panels and masonry. Leave adequate clearance at the junction to allow for panel expansion, drainage and prevention of capillary absorption of water from the porous masonry, and to allow periodic reinforcement of the edge sealing. The bottom edges of the panels should stand well clear of any flashings or sills for similar reasons.

Specify non-concealed fixings that are non-ferrous, or of a suitable grade of stainless steel, to prevent unsightly iron-staining. Pay particular attention to this when using translucent finishes, since any staining due to moisture or corrosion products is readily visible against a relatively uniform background.

Maintenance

Appropriate specification is the main consideration when using wood-based panels in exterior applications. Maintenance is then restricted to the renewal of surface coatings, the repair of edge sealing, the replacement of sealants and possibly remedial action on fixings.

Regular maintenance will help prolong the service life of wood-based panels when used in exterior applications. Follow the guidance from both the coating and the panel manufacturer in respect of the maintenance intervals and methods for re-coating. The maintenance interval will also depend on the level of exposure and elevation. For example, wear and erosion of the coating is more apparent on south- and west-facing elevations. As for solid wood, where coating failure leads to weathering of the wood/wood particles, successful recoating will require the surface of the panel to be sanded to provide a suitable key for coating adhesion.

For that reason it is essential that recommended maintenance intervals be observed.

Panels with factory-applied, phenolic-resin film or GRP type coatings can also be repaired with patching compounds and many panel manufacturers provide data sheets for these procedures.

CE and UKCA marking

Under the Construction Products Regulation (CPR), which came into effect in 2013 throughout the EU, the panel manufacturer is required to comply with the requirements of BS EN 13986 and to CE mark accordingly where a panel product falls within the scope of BS EN 13986 and is intended for use in construction. The manufacturer must produce a Declaration of Performance (DoP) for the product, stating the performance claimed in respect of various properties and ensure that the CE marking information is aligned with the DoP. The DoP must be freely available, for instance on the manufacturer's website. The whole supply chain has a responsibility to ensure the CE marking information accompanies the product to its final destination.

With the UK having left the EU, the requirements of the CPR have been transferred into UK law so the obligation on panel manufacturers to comply with BS EN 13986 will continue for products placed on the UK market. During 2021, products that comply may be CE marked as before or marked with the new UKCA (conformity assessment) mark, but from 2022 only the UKCA mark will be accepted. In the longer term, the requirements for UKCA marking may deviate from those for CE marking. Differing requirements will apply to products being placed on the market in Northern Ireland.

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About TRADA

The Timber Research and Development Association (TRADA) is an internationally recognised centre of excellence on the specification and use of timber and wood products.

TRADA is a company limited by guarantee and not-for-profit membership-based organisation. TRADA's origins go back over 80 years and its name is synonymous with independence and authority. Its position in the industry is unique with a diverse membership encompassing companies and individuals from around the world and across the entire wood supply chain, from producers, merchants and manufacturers, to architects, engineers and end users.

Our aim

To provide members with the highest quality information on timber and wood products to enable them to maximise the benefits that timber can provide.

What we do

We seek to achieve this aim through active and on-going programmes of information and research. Information is provided through our website, an extensive collection of printed materials and our training courses.

Research is largely driven by the desire to update and improve our information so that it continues to meet our members' needs in the future.

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