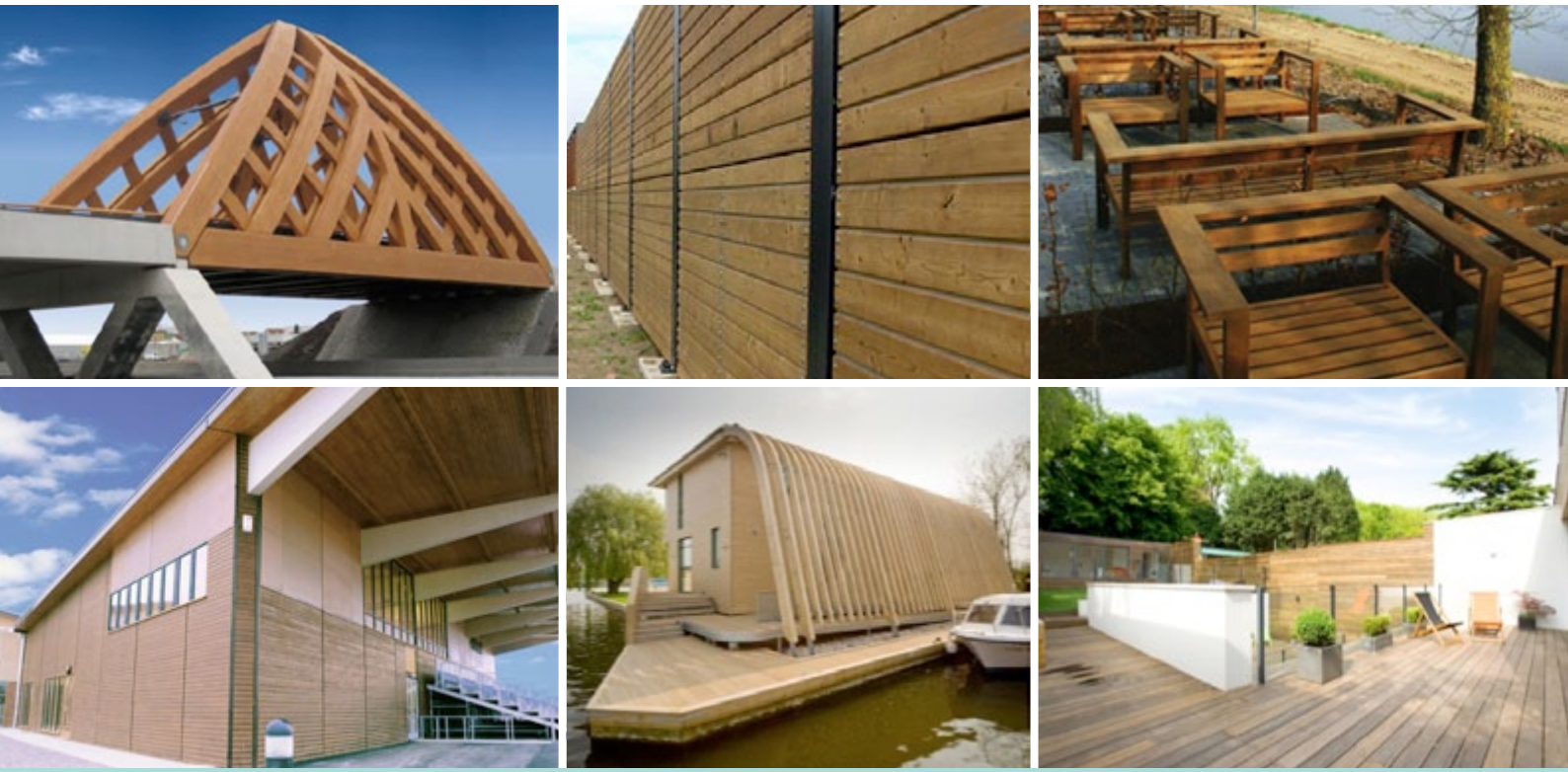
WPA
Wood Protection Association



Modified Wood Specification Manual

Guidance on the properties, performance and specification of modified wood products

1st edition October 2011

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About the Wood Protection Association (WPA)

The WPA is a not for profit technical and advisory organisation interested in the development and promotion of wood protection technology to support the use of wood as a cost effective, sustainable and low environmental impact construction material.

The WPA acts as a technical advisor to British and European Standards setters on wood preservation, modified wood and the fire protection of wood. On the Regulations governing wood protection, the WPA enjoys lead body status with agencies like the Health & Safety Executive, Environment Agency, Scottish Environmental Protection Agency, the Department for Environment, Food & Rural Affairs and the Highways Agency.

The roots of the WPA go back to the 1930's with the formation of the British Wood Preserving Association which became the British Wood Preserving & Damp-proofing Association in 1989 and subsequently the WPA in 2006.

As designers look increasingly to wood as a low carbon construction material the WPA is committed to providing guidance on the best ways to ensure wood is fit for the purpose intended. This Specification Manual gives detailed guidance about Modified Wood. The WPA also publishes Specification Manuals dealing with Wood Preservation (Publication ref: WPA/WPSM) and Flame Retardant Treatment (Publication ref: WPA/FRSM)

Front cover: (top row left to right)
Highway bridge - Accoya; Highway Sound Barrier - Plato Wood; Outdoor furniture - Keywood;
(bottom row left to right)
Boston Sports Stadium - Thermowood; Waterside home and boathouse - Accoya; Decking, cladding and fencing - Kebony.

Wood Protection Association

Clicking on highlighted text will take you to the appropriate place in the document or to a linked web site page if it begins with the prefix www.

ARCHITECTS HELPLINE
If you need help with a modified wood specification then e-mail the WPA info@wood-protection.org

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Introduction

The emergence of wood modification technologies and their commercial development provides designers, builders and users with another option when wood and wood-based products with enhanced properties, including durability and dimensional stability are required.

Modified wood is not easily compared with naturally durable or preservative-treated wood for the purposes of specification because performance testing may not be carried out in the same way.

This manual sets out a scheme for establishing performance of modified wood products, identifying suitable uses and any limitations to be taken in to account when specifying.

The *WPA Guide to Selection of Wood and Wood-based Products* compares the three material groups – **naturally durable, preservative treated** and **modified wood**.

Detailed specifications and guidance for preservative-treated timber is dealt with in another WPA manual - *Industrial Wood Preservation Specification and Practice* - that also incorporates advice on use of naturally durable timbers where appropriate. Protection against fire is covered in the Association's manual *Industrial Flame Retardant Treatment of Solid Timber and Panel Products*.

1. Scope

This manual sets out a scheme for establishing performance of modified wood products, identifying suitable uses and any factors to be taken in to account when specifying modified wood.

The suitability of other wood materials, notably preservative treated wood and naturally durable wood, is not considered in this document. Information on these materials is found in the WPA manual *Industrial Wood Preservation Specification and Practice* and the *WPA Guide to Selection of Wood and Wood-based Products*.

The processes used to produce modified wood products vary widely but a common assessment scheme is nevertheless desirable to allow product comparisons against a benchmark. This manual is based on a scheme that sets out in separate guidance for producers and suppliers the tests and performance data upon which product assessments should be made.

The characteristics of products supplied by members of the WPA are listed based on declared test data. Such products appear in this manual in section 8.

2. Definitions

For the purposes of this Manual the following terms and definitions apply. A general description of wood modification processes is given in Annex 1.

2.1 Wood modification

Wood modification involves the action of a chemical, biological, physical agent or reaction upon the material, resulting in a desired property enhancement during the service life of the modified wood. If the modification is intended for or confers claimed improved resistance to biological attack, then the mode of action should, as far as can be determined, be non-biocidal.

2.2 Modified wood

Wood or wood-based products whose properties have been altered by a wood modification process. For the purposes of this manual modified wood shall be wood that has been modified across the entire cross section of the component. Components that have been subject to "envelope treatments" or have untreated zones (e.g. heartwood) are not within the scope of this manual.

Modified wood in action

Boston Sports Stadium, Boston, Lincolnshire
Thermowood, heat treated softwood finished with translucent stain provides a cost effective external and durable external cladding.

Photo courtesy: Finnforest

3. Suitability characteristics of wood products

For many end uses of wood, particularly where there is a risk of wood becoming wet, durability (resistance to biological attack) is seen as the key characteristic of determining its suitability for use. Most wood modification processes improve wood durability. However, improving durability is commonly not the sole effect of wood modification, and may not even be the purpose at all.

Although a range of wood properties may be affected (positively or adversely) by the modification process, for the purposes of this manual the suitability of modified wood for a given end use has been based on four main criteria: durability to wood-destroying organisms (fungi and insects); bending strength; stability in the face of changing humidity; hardness.

- **Durability:** Service environments have been categorised into a series of Use Classes in BS EN 335-1. Five classes are defined which describe the different service situations on the basis of the biological hazard likely at the in-service moisture conditions which may prevail. (Table 1). In this manual the durability of a given modification type in a particular end use has been recorded in terms of 'desired service life'. This phrase is fully defined in section 5.1.3.
- **Stability:** Dimensional change under the influence of high humidity.
- **Strength:** A measure of the ability of wood to resist outside forces, such as compression, tension and shear. Different aspects of strength may be more relevant than others for particular end uses.
- **Hardness:** The resistance of wood to indentation.

These performance criteria are further explored in section 5.

4. End use categories

To aid specification of modified wood based on wood property improvements, seven end use categories (M1 to M7) follow which consider the appropriateness of the various wood modification types available.

In tables M1 to M7, where a property improvement is required for modified wood to be considered appropriate this is recorded. Where a property improvement is not necessarily a requirement, but could contribute to improved performance of the component, this is recorded as 'desirable'. It should be noted that these tables are generic in nature, and that the relative importance of various property improvements, whether included in tables M1 to M7 or not, will vary. Any specific requirements can be considered in comparison with the information given for each modification type in section 8.

Tables M1 to M7 give the desired service life of a recommended wood modification in the appropriate Use Class. This desired service life only takes into account the durability of the modified wood to decay fungi and insects. It does not take into account the expected/ desired functional life of the component as governed by other wood properties.

Tables M1 to M7 consider changes to strength, stability and hardness of wood when modified in terms of whether the property is considered superior (+), inferior (-) or unchanged (0) in comparison to unmodified wood. These tables are intended only to be indicative, and do not record the extent of any change in property. This information is given in section 8.

Modified wood in action

"The Haven", Horning, Norfolk
Accoya, acetylated wood was chosen for the cladding, decking and curved glue-laminated beams for this flood resistant waterside home and boathouse in the Norfolk Broads. Cladding was factory finished with translucent stain.

Photo courtesy: Titan Wood

Modified wood
WPA use categories

- M1 CLADDING
- M2 DECKING
- M3 EXTERNAL JOINERY
- M4 FENCING
- M5 FLOORING AND OTHER NON-STRUCTURAL INTERIOR USES
- M6 FURNITURE

M1 CLADDING

END USE CATEGORY M1 Cladding

Scope

This category covers external cladding, including battens for cladding, for buildings in the UK.

Hazards

Cladding components are exposed to the weather and are therefore in Use Class 3. They may be protected from the weather by a coating but the risk of becoming wet in service remains and all wood in these situations should have adequate natural or conferred durability against decay fungi.

Table M1 Selection of materials suitable for cladding

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS			
			Durability UC3	Strength	Stability	Hardness
Cladding	Cladding on buildings[1]	3	Required		Desirable[2]	
Battens	Battens to which cladding is fixed	3	Required			
RECOMMENDED MODIFIED WOOD[3]			Durability (Desired service life)[4] UC3	Strength	Stability	Hardness
Accoya			60	0	+	+
Kebony SYP			60	+	+	+
Keywood			60	0	+	+
Plato Wood Spruce			60	-	+	0
Plato Wood Frake			60	-	+	0
ThermoWood, Thermo-D (Spruce, Pine)			60	-	+	0
ThermoWood, Thermo-S (Spruce, Pine)			30	0	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

Notes to Table M1

Note 1. UK Building regulations require cladding to have enhanced reaction-to-fire rating in some situations. Check individual product information in section 8 for suitability where this is required. The WPA manual Industrial Flame Retardant Treatment of Solid Timber and Panel Products has guidance on the selection and specification of flame retardant treatment.

Note 2. Enhanced dimensional stability can extend coating life and is particularly desirable where extended coating life is required.

Note 3. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 4. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1.

Modified wood in action

NHS Carlisle – specialist unit

Plato Wood Frake, heat treated sustainable hardwood cladding features on the external surfaces of this specialist unit at Carlisle NHS hospital. Hard wearing, knot free and durable weathers evenly to sliver grey when uncoated.

Photo courtesy: Howarth Timber

M2 DECKS AND ASSOCIATED STRUCTURES

END USE CATEGORY M2 Decks and associated structures

Scope

This category covers decks in the UK. It does not describe the design or construction of decks; for these aspects the WPA recommends the various technical publications available from the Timber Decking Association www.tda.org.uk.

Examples of items covered by this category are:

Deck support framework including posts and other components in ground contact

Deck boards out of contact with the ground

Parapets/safety rails and other on-deck features.

Hazards

Deck components not in ground contact are exposed to the weather and are therefore in Use Class 3. They may be protected from the weather by a coating but the risk of becoming wet in service remains and all wood in these situations should have adequate durability against decay fungi.

Deck components in ground contact are in Use Class 4. However, to impart a high degree of confidence in structural performance all deck support structures should have durability sufficient to protect wood in Use Class 4.

Table M2 Selection of materials suitable for decks

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS				
			Durability UC3	Durability UC4	Strength	Stability	Hardness
Decking	Deck panels, deck boards, security rails and other on-deck features	3	Required		Desirable	Desirable	
Deck support framework including posts and other components in and out of ground contact[1]	Posts, beams, joists, elevated deck support **components**	4		Required	Desirable		
RECOMMENDED MODIFIED WOOD[2]			Durability (Desired service life)[3] UC3	UC4	Strength	Stability	Hardness
Accoya			60	60	0	+	+
Kebony SYP			30	15	+	+	+
Keywood			60	30	0	+	+
Plato Wood Spruce			60	15	-	+	0
ThermoWood, Thermo-D (Spruce, Pine)			60	15	-	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

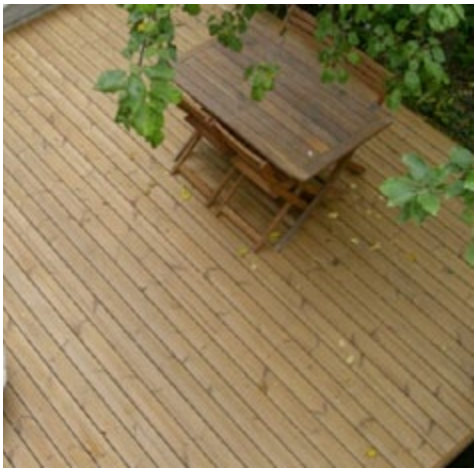
Notes to Table M2

Note 1. Deck support structures may include components used both in and out of ground contact. To impart a high degree of confidence in structural performance all deck support structures should have natural or conferred durability to Use Class 4 standard.

Note 2. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 3. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1.

Modified wood in action



Decks and boardwalks

Thermowood, heat treated pine, provides a durable surface for external domestic and commercial decks and boardwalks.

Photo courtesy: Thermowood Association

M3 EXTERNAL JOINERY

END USE CATEGORY M3 External Joinery (non-load bearing) not in contact with the ground

Scope

This category covers the requirements for external joinery and external fittings (excluding cladding) in buildings in the United Kingdom. Considerations related to practicality of use in joinery operations are not considered in this section and should be discussed with the Joinery Company.

Examples of items covered are:

Window frames, casements and sashes, conservatory frames, surrounds for non-wooden windows, doors, door frames and porches, and external fittings, e.g. soffits, facias and barge boards.

Hazards

External joinery is exposed to the weather and is therefore in Use Class 3. It may be protected from the weather by a coating or by design features such as overhanging eaves but the risk of becoming wet in service remains and all wood in these situations should have adequate durability against decay fungi.

The risk in service wetting creates a second level of hazard for those external joinery applications from the above list requiring low coating maintenance and tight dimensional tolerance to provide good function, for example windows. Dimensional stability is desirable for these applications.

Table M3 Selection of materials suitable for external joinery

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS			
			Durability UC3	Strength	Stability	Hardness
External joinery	Window frames, casements and sashes conservatory frames	3	Required		Desirable[1]	
Other external fittings	Soffits, facias and barge boards	3	Required		Desirable[1]	
RECOMMENDED MODIFIED WOOD[2]			Durability (Desired service life)[3] UC3	Strength	Stability	Hardness
Accoya			60	0	+	+
Kebony SYP			60	+	-	+
Keywood			60	0	+	+
Plato Wood Spruce			60	-	+	0
Plato Wood Frake			30	-	+	0
ThermoWood, Thermo-D (Spruce, Pine)			60	-	+	0
ThermoWood, Thermo-S (Spruce, Pine)			30	0	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

Notes to Table M3

Note 1. Dimensional stability is particularly desirable where wood is coated.

Note 2. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 3. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1.

Modified wood in action

Joinery manufacture

Dimensionally stable modified wood provides the ideal substitute for factory finished external joinery

Photo courtesy: Titan Wood

M4 FENCING

END USE CATEGORY M4 Fencing

Scope

This category covers fencing in the UK.

It does not describe the design or construction of wood fencing and attention is drawn to BS 1722 that covers these aspects for different types of fences using wood components.

Examples of items covered by this category are:

- **Fencing posts and struts**
- **Gravel boards**
- **Rails**
- **Gates, gate posts**
- **Boarding and slats**
- **Droppers**
- **Post caps**
- **Dowels**
- **Sound barriers**

Hazards

Fence components not in ground contact are exposed to the weather and are therefore in Use Class 3. They may be protected from the weather by a coating but the risk of becoming wet in service remains and all wood and wood-based materials in these situations should have adequate natural or conferred durability against decay fungi.

Fence components in ground contact are in Use Class 4

Table M4 Selection of materials suitable for fencing

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS				
			Durability UC3	Durability UC4	Strength	Stability	Hardness
Fence components not in contact with the ground	Fence rails, gates, boarding and slats, post caps, dowels	3	Required		Desirable	Desirable[1]	
Fence components in ground contact	Fence posts, gate posts, struts, gravel boards, droppers	4		Required	Desirable		
RECOMMENDED MODIFIED WOOD[2]			Durability (Desired service life)[3] UC3	Durability (Desired service life)[3] UC4	Strength	Stability	Hardness
Accoya			60	30	0	+	+
Kebony SYP			30	15	+	+	+
Keywood			60	30	0	+	+
Plato Wood Spruce			60	Check[4]	-	+	0
ThermoWood, Thermo-D (Spruce, Pine)			60	Check[4]	-	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

Notes to Table M4

Note 1. Dimensional stability is particularly desirable where wood is coated.

Note 2. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 3. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1.

Note 4. Check with the manufacturer for latest advice on use in UC4

Modified Wood in action

Highway Sound Barriers

Plato Wood, heat treated softwood, highway sound barrier.

Photo courtesy: Plato Wood

M5 FLOORING AND OTHER NON-STRUCTURAL INTERIOR USES

END USE CATEGORY M5 Flooring and other non-structural interior uses

Scope

This category covers the requirements for non-structural wood and wood-based materials in buildings in the United Kingdom.

Examples of items covered are:

Flooring :Domestic floors
:Specialist floors (e.g. ballrooms)
:Commercial and public building floors (e.g. offices and hotels)
:Industrial floors
:Extreme condition floors (e.g. inside swimming pool decks)

Mouldings :Architraves and other interior joinery

Hazards

Interior wood in buildings should normally remain dry throughout the life of a building (Use Class 1) and is not, therefore, at risk from fungal decay. This depends on good design and maintenance of the building envelope and is assumed, except for certain specialised uses, for this end use specification.

Unmodified wood containing sapwood, regardless of the durability of its heartwood, can be attacked by wood boring insects, as is wood where there is no clear distinction between heartwood and sapwood. Modified wood may be resistant to insect attack and individual product details will indicate if insect resistance is claimed. Non-structural interior wood is not considered to be at significant risk of attack by wood-boring beetles in the UK but specifiers should be aware of the risk and decide if protection is required. The table assumes an insect resistance requirement.

Table M5 Selection of materials suitable for non-structural interior uses

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS				
			Durability UC1	Durability UC2	Strength	Stability	Hardness
Floors[1]	Domestic	1	Required[2]				Desirable
	Specialist floors (e.g. Ballrooms)	1	Required[2]			Desirable	Required[3]
	Commercial and public building floors	1	Required[2]			Desirable	Required[3]
	Industrial floors	2		Required		Desirable	Required[3]
	Extreme condition floors (e.g. swimming pool deck)	2		Required		Desirable	Desirable
Mouldings	Architraves and other interior joinery	1	Required[2]				
RECOMMENDED MODIFIED WOOD[3]			Durability (Desired service life)[5] UC1	UC2	Strength	Stability	Hardness
Accoya			60	60	0	+	+
Kebony SYP			60	60[6]	+	+	+
Keywood			60	60	0	+	+
ThermoWood, Thermo-D (Spruce, Pine)			60	60	-	+	0
ThermoWood, Thermo-S (Spruce, Pine)			60	60	0	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

Notes to Table M5

Note 1. UK Building regulations require floors to have a fire resistance rating in some situations. This can only be confirmed in full scale floor structure testing and cannot be predetermined by the properties of wood-based products in reaction-to-fire testing.

Note 2. This table assumes an insect resistance requirement

Note 3. Material properties in section 8 need to be consulted to ensure they match the end use requirement.

Note 4. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 5. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1

Note 6. Not suitable for extreme condition floors (e.g. swimming pool decks)

M6 FURNITURE

END USE CATEGORY M6 Furniture

Scope

This category covers furniture for use either indoors or outside in the United Kingdom.

Hazards

Indoor furniture is expected to remain dry throughout its service life and is not, therefore, at risk from fungal decay (Use Class 1). Furniture is not considered to be at significant risk of attack by wood-boring beetles in the UK and the table assumes no insect resistance requirement.

Outdoor furniture may become and remain wet for short periods and so is considered to be in Use Class 3. If supports are set into concrete or the ground they will be in Use Class 4. All wood and wood-based materials in these situations should have adequate durability against decay fungi.

Table M6 Selection of materials suitable for furniture

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS					
			Durability			Strength	Stability	Hardness
			UC1	UC3	UC4			
Furniture	Indoor	1	Note 1					
	Outdoor (not set in ground)	3		Required			Desirable[2]	
	Outdoor (components set in ground)	4			Required			
RECOMMENDED MODIFIED WOOD[3]			Durability (Desired service life)[4]			Strength	Stability	Hardness
			UC1	UC3	UC4			
Accoya			Note 1	60	30	0	+	+
Kebony SYP			Note 1	60	N/A	+	+	+
Keywood			Note 1	60	30	0	+	0
Plato Wood Spruce			Note 1	60	Check[5]	-	+	0
Palto Wood Frake			Note 1	30	N/A	-	+	0
ThermoWood, Thermo-D (Spruce, Pine)			Note 1	60	Check[5]	-	+	0
ThermoWood, Thermo-S (Spruce, Pine)			Note 1	30	N/A	0	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

Notes to Table M6

Note 1. No durability requirement for this use.

Note 2. Dimensional stability is particularly desirable where wood is coated and tight jointing tolerance is required.

Note 3. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 4. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1.

Note 5. Check with the manufacturer for latest advice on use in UC4

Modified Wood in action

Outdoor furniture manufactured from Keywood

Photo courtesy: Thermowood Association

M7 STRUCTURES IN WATER

END USE CATEGORY M7 Structures in water

Scope

This category covers structures in water, both in fresh water and in the sea.

Hazards

Wood components in fresh water are in Use Class 4 and require the same degree of natural or conferred durability as, for example, fence posts in the ground.

Wood components in seawater are in Use Class 5 and are subject to fungal decay and erosion and burrowing by marine borers such as Limnoria (gribble) and Teredo (shipworm).

Table M7 Selection of materials suitable for use in water

DESCRIPTION	SUBTYPES	USE CLASS	MODIFIED WOOD CHARACTERISTICS				
			Durability		Strength	Stability	Hardness
			UC4	UC5			
Wood in fresh water	River bank supports, bridge supports, wharves, marina	4	Required		Desirable		
Wood in sea water	Wharves, marinas, harbours	5		Required	Desirable		
RECOMMENDED MODIFIED WOOD[1]			Durability (Desired service life)[2]		Strength	Stability	Hardness
			UC4	UC5			
Accoya			60	N/A	0	+	+
Kebony SYP			15	N/A	+	+	+
Keywood			30	N/A	0	+	+
Plato Wood Spruce			Check[3]	N/A	-	+	0
ThermoWood, Thermo-D (Spruce, Pine)			N/A	N/A	-	+	0
ThermoWood, Thermo-S (Spruce, Pine)			N/A	N/A	0	+	0

Property characteristics: 0 = unchanged + = superior property - = inferior property

Notes to Table M7

Note 1. The properties of different modified woods vary. Consult section 8 for details of specific properties.

Note 2. Desired service life for the given use refers to biological durability only and is determined in accordance with section 6.1.

Note 3. Check with the manufacturer for latest advice on use in UC4

Modified wood in action

Retaining wall and piling

Photos courtesy: Platowood

5. The performance of modified wood

Wood modification processes may change a number of characteristics (either enhancing or reducing them) and, in assessing the suitability of modified wood for a particular use, designers need to know if the process does have an effect and, if so, to what extent does it affect design considerations.

5.1 Durability - resistance to wood-destroying organisms

Specification of wood preservative treatment and naturally durable wood in the UK is made through a system of Use Classes and desired service lives.

The appropriateness of a wood preservative for a given end use is measured through a series of tests as detailed in BS EN 599-1.

The natural durability of a timber species against fungal attack is classified in terms of a durability class. This durability class relates to the resistance of the heartwood of the species and is based on ground contact field testing and/or long term practical experience.

It should be noted that due to the time it can take to establish a durability class from a ground contact field trial, it is possible to obtain a 'provisional' durability class based on laboratory fungal decay tests that is valid until results from the field test become available. Insect testing is also undertaken to establish a separate durability class specific to insect attack.

Details of this testing is given in BS EN 350-1 and a list of durability classes for well known species important in Europe is given in BS EN 350-2 . The Durability classes are set out in Table 1.

Table 1: BSEN350:2 Durability classes

HEARTWOOD DURABILITY CLASS[1]	TYPICAL SPECIES
Class 1: Very durable	Jaraha, Iroko, Yellow Balau
Class 2: Durable	European Oak, Western Red Cedar
Class 3: Moderately durable	Douglas fir, Larch[2]
Class 4: Slightly durable	European Larch, European Redwood
Class 5: Not durable	Radiata Pine, Sitka Spruce

Note 1: The sapwood of all species is classed as non-durable

Note 2: European larch is rated 3-4. Class 3 is generally taken to apply only to natural forest sources of Siberian larch.

For modified wood products, the mechanism by which the durability is enhanced differs from that for preservative treated wood and for naturally durable wood, and in some cases is not completely understood. For many modified woods it is not possible to test the modification as if it were a preservative, and the durability of modified wood is therefore best considered in terms of a 'durability class' similar to the classes used for natural durability. In other words, as if the modified wood was a new timber species. For example, wood modification can increase resistance to fungal decay of a species from the least durable class (Class 5) to the same durability as species with a Class 2 (Durable) and Class 1 (Very durable) rating.

However, the system by which natural durability against fungi is measured in ground contact is not universally applicable to wood modification as some modified woods may perform well out of ground contact but poorly in ground contact. This is considered in section 5.1.2.

From the Use Class (5.1.1) and the durability class (5.1.2), a desired service life (5.1.3) can be established.

An important factor that has not been directly addressed in this manual is the consequence of failure. Where the consequence of failure of a wooden component is high, for example due to a risk to human safety or a high economic cost of replacement, the specifier may wish to chose wood with a higher durability than might otherwise be considered.

Modified wood in action

Moses Bridge

Accoya sheet piling used to create this discrete waterway crossing in the renovation of the historic Fort de Roovers, Holland.

Photo courtesy: Accsys Technologies

5.1.1 Use Classes

The different service situations in which wood can be used have been categorised into a series of Use Classes. Five such classes, which describe the different service situations on the basis of the biological hazard likely at the in-service moisture conditions that may prevail, are defined in BS EN 335-1. Table 2 summarises the Use Class system. Examples of typical service situations are given.

Table 2. BSEN335:1 Use Class and typical service situations

Use Class	SERVICE SITUATION	PRINCIPAL BIOLOGICAL AGENCY	TYPICAL SERVICE SITUATION	EXAMPLES
1[1]	Above ground, covered Permanently dry.	Insects	Internal, with no risk of wetting.	All timbers in normal pitched roofs except tiling battens and valley gutter members Floor boards, architraves, internal joinery, skirtings. All timbers in upper floors not built into solid external walls[1].
2	Above ground, covered (i.e. by a roof or other building component). Occasional risk of wetting.	Fungi / Insects	Internal, with risk of occasional wetting.	Tiling battens, frame timbers in timber frame houses[2], timber in pitched roofs with high condensation risk, timbers in flat roofs, ground floor joists[2], sole plates (above dpc), timber joists in upper floors built into external walls[2].
3	3 (coated) Above ground, protected, e.g. by a coating. Exposed to frequent wetting. If wood becomes wet, drying out may be delayed by a coating. 3 (uncoated) Above ground, not protected. Exposed to frequent wetting.	Fungi[3] Fungi[3]	External, above damp proof course (dpc) coated[3]. External, above damp proof course (dpc) uncoated[3]	External joinery including roof soffits and fascias, barge boards, etc., cladding, valley gutter timbers [2], external structural load bearing timbers Cladding, fence rails, gates, fence boards, agricultural timbers not in soil / manure contact and garden decking timbers that are not in contact with the ground.
4[4]	In contact with ground or fresh water. Permanently exposed to wetting.	Fungi[3]	Timbers in permanent contact with the ground or below dpc. Timbers in permanent contact with fresh water Cooling tower packing Timbers exposed to the particularly hazardous environment of cooling towers.	Fence posts, gravel boards, agricultural timbers in soil / manure content, poles, sleepers, playground equipment, motorway & highway fencing and garden decking timbers that are in contact with the ground. Lock gates and revetments. Cooling tower packing (fresh water).
5	Permanently exposed to wetting by salt water	Marine borers, Fungi	All components in permanent contact with sea water.	Marine piling, piers and jetties, dock gates, sea defences, ships hulls, and cooling tower packing (sea water)

Notes to Table 1

1. Wood and wood-based products for use in Use Class 1 do not normally require enhanced durability unless the risk of insect attack is considered to be important.
2. These timbers are assigned to a "higher" Use Class than suggested by their location in the structure, owing to the potential consequences of failure based on experience within the UK.
3. BS EN 335-2 includes insects as a risk factor in Use Classes 3 and 4 but this is not, under present conditions, recognised as a significant risk for timbers in these situations in the UK.
4: BS EN 335-2 has two sub-classes in Use Class 4 but the difference in biological hazard is not recognised as sufficiently different for timbers in these situations in the UK and recommended preservative treatments in BS 8417 and this manual are based on a single Use Class for timber in ground or water contact.

The allocation of a component to a particular Use Class assumes good design and maintenance of the construction. It should be recognised that if conditions arise during the service life of the component which result in unexpected wetting of the timber, for example as a result of design faults, condensation, failure of other materials, poor workmanship or lack of maintenance, the Use Class assigned to the component can change and therefore the recommendations for enhanced durability can change.

Column 5 of Table 2 allocates a representative range of components to the Use Class that they usually occupy in the UK. If a component being considered is not listed, the specifier should either allocate it to the appropriate Use Class based on the examples given, or contact the WPA for advice info@wood-protection.org or via the website enquiry service at www.wood-protection.org

5.1.2 Measurement of durability class

The durability classes of a modified wood for fungi, insects (beetles) and marine borers shall be measured in accordance with BS EN 350-1 as if the modified wood were the heartwood of a naturally durable timber. Where durability classes are used, the wood must be modified across the full cross section of the wood. Some aspects of the sampling procedures given in BS EN 350-1 will not be applicable to modified wood, but sampling procedures should be followed as closely as possible.

For durability to fungi, if the modified wood is not to be used in UC4, the laboratory procedure determining the provisional natural durability classification can be used to determine durability class. However, information must be given on the Use Classes in which the modified wood may be used.

Where a durability class is provisional in BS EN 350-1, this must be recorded in the Modified Wood Products listed in section 8 of this manual. Where this provisional class is assigned to a product used for ground contact applications, the ground contact field test required in BS EN 350-1 must be ongoing, and the manufacturer must update recommendations as information from the field test becomes available.

The basis on which these durability classes are established is not fully quantified and inevitably at this stage confidence in performance may not be unequivocal.

Nevertheless for the modified wood products listed in this manual, the manufacturers are able to declare, principally on the basis of laboratory and/or field testing with early service experience, the suitability of their products for each Use Class.

5.1.3 Desired service life

The specification of a wood preservative for an end use in the UK has for many years involved a target or 'desired' service life. The current versions of BS 8417 and of the WPA manual Industrial Wood Preservation Specification and Practice also provide a system of establishing desired service lives for naturally durable timber. In these documents, recommendations are given where appropriate for desired service lives of 15, 30 and 60 years.

This system has been adopted in this manual for modified wood. Table 3 contains identical information to that for naturally durable timber that appears in BS 8417 and the WPA manual Industrial Wood Preservation Specification and Practice. In these cases the natural durability rating is taken from BS EN 350-2, which states that the ratings are "based upon information drawn from various sources, including historical records, practical experience, laboratory tests and other data". For all species the durability rating for fungal attack includes data from ground contact field trials with timber stakes. Thus it should be understood that the link between durability rating and service life is, for naturally durable solid timber, a rather robust one reflecting long experience with each species.

For modified wood, durability data may have been derived from laboratory tests, perhaps supplemented with field trial or even service experience. The durability class for modified wood may also not be applicable across all Use Classes in Table 3 as it is for naturally durable wood. As such, the desired service lives given in Table 3 should be used with caution when assigned to modified wood.

It is essential to appreciate that the prediction of service life is not precise; these desired service lives are not guarantees of performance but indications of the expectation against which the recommendations for timber treatment are drawn up, assuming good design and normal conditions of use.

As they relate solely to the resistance of the timber to biodeterioration, it is essential to bear in mind that other factors, such as mechanical damage or failure of other elements of the construction, could limit the life of the complete commodity. The service lives in Table 3 have not been established by direct service evidence and therefore could be subject to revision as more experience is gained.

Table 3. Durability recommendations for wood components (BS8417)

COMPONENT	USE CLASS	DURABILITY CLASS (against decay fungi) DESIRED SERVICE LIFE (years)		
		15	30	60
Roof timbers (risk of wetting)	2	4	3	2
External walls/ground floor joists	2	4	3	2
Sole plates above damp-proof course (DPC)	2	3	2	2
External joinery	3 coated	4	3	2
Fence rails, garden decking	3 not coated	3	2	1
Sleepers in free-draining ballast	3 not coated	2	1	1
Fence posts	4	2	1	1
Poles	4	2	1	1
Sleepers in soil contact	4	2	1	1
Timber in fresh water	4	2	1	1
Cooling tower packing (fresh water)	4	2	1	No recommendation

5.2 Strength

Strength is a measure of how resistant wood is to outside forces – compression, tension and shear – that could result in its failure. The ability of a component to withstand the loads placed upon may be a function of a specific component and specifiers should satisfy themselves that the strength of a particular modified wood material is relevant for the anticipated end use. Different aspects of strength may be more relevant than others for certain end uses.

5.3 Stability

Stability is this manual relates to any change in dimensions, swelling/shrinkage that occurs when a moisture containing material like wood is exposed to changes of humidity and temperature. Most modified woods have improved resistance to movement of between 60% and 90% in both radial and tangential directions. Section 8 of this manual gives specific stability rates for each type of modified wood compared with unmodified wood of the same species.

5.4 Hardness

Hardness is the ability of wood to withstand physical damage, denting and abrasion/wear and tear. The hardness rating of a species is also a good indicator of the ease by which it can be cut or worked with hand tools.

Hardness is measured by the Janka (or equivalent) test. This test measures the force required to embed a steel ball into wood to half its diameter.

The hardness ratings for modified wood given in section 8 of this manual are compared with unmodified wood.

6. Coatings for modified wood

Coatings may be applied to modified woods in a similar way as other wood, using both factory and manual techniques. The long term performance of a coating and its maintenance requirements are important factors in specifying which substrate to use. Experience has shown that the more dimensionally stable a material is the more likely that the frequency and cost of maintenance is reduced. The full factory application of a coating often comes with an extended warranty and the enhanced stability of modified wood is proving increasingly popular for joinery and external trim.

Section 8 of this manual includes information on the application and performance of coatings with the individual types of modified woods listed.

Section 8 also includes information on coatings for modified woods supplied by members of the WPA

7. Factory Production Control

Because the properties of modified wood are very dependent on the wood modification process used, all products listed in this manual must be produced using a Factory Production Control system (FPC), with third party accreditation, specific to each individual product and process.

FPC must include all critical process parameters that confer the claimed properties of the named individual modified wood product.

A quality management system complying with BS EN ISO 9001 or equivalent with third party accreditation must be in operation. In the UK, certification bodies must be UKAS accredited. For production outside the UK, a UKAS accredited body may be used or an equivalent subject to acceptance by the WPA.

Modified wood in action

Furniture

Outdoor furniture manufactured from Keywood.

Photo courtesy: Arch Timber Protection

8 Modified wood products

8.1 ACCOYA

Product description.

The Accoya® process is effective through the entire cross section of modified timber. Research into the process dates back to 1928 and so the enhanced performance properties conferred on Accoya are proven through long term field trials and well known

The process comprises the reaction of solid sawn sections of wood with acetic anhydride under conditions of high temperature and pressure. The increased acetyl content blocks moisture absorption by the wood fibres.

Significant improvements of durability (resistance to fungal decay), stability and coating performance result from this stabilisation of wood fibres and exclusion of moisture from the wood cells. Additionally hardness is improved. Ease of machining, strength, on-site workability, adhesion is similar to unmodified wood.

Although the process works on a range of softwoods and hardwoods, the Accoya® is produced using FSC radiata pine. Typical applications are Cladding, decking, joinery and fresh water contact situations.

Accoya® cladding is available in a range of appearance grades.

The Accoya brand and technology is owned by Accsys Technologies Plc who verify that the information given below is accurate and based on laboratory, field experience and independent assessment where applicable

Durability

CRITERION	DURABILITY CLASS	QUALIFYING REMARKS
Fungi	1	Laboratory and field stake trials
Insects (beetles)		
Marine	N/A	

Physical characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Stability	+	Radial swelling between 60 and 90% rh = 0.4% Tangential swelling between 60 and 90% rh = 0.7%
Strength	+	Bending Strength 80 N/mm^2
Hardness	+	Janka Hardness 3950 N

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Other characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Metal fixings and fastenings	-	Accoya pH is similar to oak, Stainless metalwork is recommended
Gluing	0	Accoya can be glued using standard practice. Polyurethane, EPI and PRF resins show the best exterior performance.
Surface coatings	+	Field testing at TRADA & SHR demonstrate superior performance to unmodified wood
Flammability of modified wood product	0	Where necessary Accoya can be treated with WPA FR Type LR to achieve reaction to fire classification Euroclass B.
Conditions for post-production machining	0	Accoya timber is modified through the entire cross section. Machining does not compromise performance. Machining is with normal wood tooling.
Post-production and on-site handling	0	Accoya timber and finished Accoya product is handled as any other timber in production. Finished products should be properly stored on site and kept in general good condition

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Modified wood in action

Waterside house, Norfolk

Cladding anbd decking and glulam beams in Accoya.

Photo courtesy: Accsys Technologies

End of life

GUIDANCE ON DISPOSAL OF WASTE PRODUCT.
Accoya® wood waste can be handled in the same way as untreated wood. Accoya® is non-toxic and does not require any special disposal considerations. Given its long life, multiple applications and non-toxicity, Accoya® is suited to re-use and recycling. Sawdust and shavings are not recommended for use as animal bedding.

Quality assurance

ISO 9000 registration	Scope: Performance, Application and Use Certificate number: Certified body:
Other third party QA system	Scope: Assessment of uniformity and reproducibility of production process, QA protocols and wood properties according to National Assessment Directive BRL 0605 Certificate number: 33058 Certified body: SKH (www.skh.org)
Independent product assessments:	Organisation: VFF (Germany) Conclusion: Accoya® wood is suitable for in use of German RAL certified joinery (VFF Merkblatt HO.06-4)
Independent product assessments:	Organisation: WDMA (USA) Conclusion: Accoya® wood has been approved material for Hallmark Certified producers.
Independent product assessments:	Organisation: MDBC Conclusion: Accoya® wood has been accredited for a Cradle to Cradle Gold certificate.
Independent product assessments:	Organisation: Singapore Environment Council Conclusion: Accoya® wood has been accredited for the Singapore Green label.
Other certifications FSC	Scope: FSC Chain of Custody, including FSC controlled wood Certificate number: CU-COC-807363
Other certifications PEFC	Scope: PEFC Chain of Custody Certificate number: CU-PEFC-807363 Certified body: Control Union (NL)

8.2 KEBONY SYP

Product description.

Wood materials are impregnated with a water based furfuryl alcohol solution, in a full cell impregnation procedure. After impregnation the furfuryl alcohol is polymerised inside the wood cell walls by heating the material to between 70 and 120 °C, thus giving the treated wood a permanently changed and more rigid cell wall structure.

The Kebony SYP wood obtained by this process has a dark brown colour from the formed polymer, and is harder, denser and more durable than the untreated wood. The enhanced dimensional stability will also extend the lifetime of surface coatings compared to untreated wood.

Durability

CRITERION	DURABILITY CLASS	QUALIFYING REMARKS
Fungi	2	Evaluated according to EN 350-1
Insects (beetles)	N/A	Product tests shows increased resistance, but are not tested according to EN 350-1 for determination of Durability Class
Marine	M	Evaluated according to EN 350-1

Physical characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Stability	+	Swelling from dry to 95% RH Radial: 2.2 .. 4.4 % Tangential: 3,3 .. 4,3 % Longitudinal: 0.2 %
Strength	+	MOR: 95 MPa. (62,5...122 MPa) MOE 14.700 MPa. (10.600...18.790 MPa)
Hardness	+	Hardness Brinell 4.1 (2,9 ... 5,3)

Other characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Metal fixings and fastenings	0	Withdrawal strength in radial direction: 233±40 N/mm for 3,5 mm screw 259±26 N/mm for 4,2 mm screw Values are 17 and 34 % above values for untreated wood. Stainless steel are recommended to avoid stain in wet environment
Gluing	0	Kebony can be glued similar to ordinary wood. Best results are obtained with, Polyurethane, EPI and PRF resins.
Surface coatings	0	Kebony can be coated with standard wood coatings. Best results are obtained with acrylic based products.
Flammability of modified wood product	0	Euroclass D, according to EN13501-1
Conditions for post-production machining	0	Conditions for post-production machining Kebony SYP is treated throughout the cross section and can be machined and moulded as other hardwoods.
Post-production and on-site handling	0	Handled according to best practice to ensure stability and preferred moisture content depending on further use.

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Private development, Highbury, London
Decking and cladding in Kebony.

Photos courtesy: Bliss

End of life

GUIDANCE ON DISPOSAL OF WASTE PRODUCT.
Kebony SYP does not contain any toxins or heavy metals that can harm the environment. The product can be disposed by landfill or incineration.

Quality assurance

ISO 9000 registration	Scope: Performance, Application and Use Certificate number: Certified body:
Other third party QA system SINTEF Technical Approval (TG) is a national approval system for building materials, components and construction systems, managed by SINTEF Certification. The purpose of an approval is to certify that a building product has been found fit for its intended use, when applied as stated in the approval.	Scope: Decking, cladding and roofing of KEBONY pine (Kebony based on Scots pine) Certificate number: NTG-2493 Certified body: SINTEF
Independent assessments: N/A	Organisation: Conclusion:

8.3 KEYWOOD

Product description.

KEYWOOD is sustainably sourced Radiata pine that has been modified with a unique, biomass based resin to significantly improve its biological durability and physical properties.

The transformation is carried out through a process known as resinification, during which the resin is irreversibly cured at high temperature. This takes place within the wood cell wall, allowing better stabilisation of the wood structure. The process is carefully controlled to give a consistent product.

The process imparts a warm, natural brown colour throughout the timber and produces a durable, versatile and sustainable material that is ideal for cladding, decking, joinery, flooring and furniture projects.

KEYWOOD may be used with or without a coating and is available in a range of sizes and profiles to meet specific requirements.

THE KEYWOOD brand is owned by Arch Timber Protection, specialists in the protection of timber.

Durability

CRITERION	DURABILITY CLASS	QUALIFYING REMARKS
Fungi	1	Relevant to Use Classes 1 to 4. Based on laboratory tests with ground contact field tests ongoing.
Insects (beetles)		No information currently available for durability against insects
Marine		No information currently available for durability against marine organism

Physical characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Stability	+	Swelling from oven dry to saturated: radial 2-3% tangential 4-6% (most severe test: equivalent to 0 to 100% RH)
Strength	0	MOR: 95 MPa. (62,5...122 MPa) MOE 14.700 MPa. (10.600...18.790 MPa)
Hardness	+	Hardness Brinell 4.1 (2,9 ... 5,3)

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Other characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Metal fixings and fastenings	0	Stainless steel fixings are recommended where possible
Gluing	0	Suitable for use with standard glues, including MUF, EPI and PvAC
Surface coatings	0	Coatings are not required. Many coating products are available on the market and whilst testing has shown a broad range of these to be compatible with Keywood, it is not possible to test them all.
Flammability of modified wood product	0	Same fire classification as untreated wood. Can be improved using a fire retardant treatment
Conditions for post-production machining	0	Keywood is modified through the whole cross-section. Machining does not compromise performance. Knives suitable for tropical hardwoods are preferred.
Post-production and on-site handling	0	Keywood should be handled as for any other type of timber, and kept in proper storage facilities.

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Modified wood in action

Holiday Lodge, Holland
Cladding and structural support in Keywood, Radiata Pine impregnated with bio resins and heat treated.

End of life

GUIDANCE ON DISPOSAL OF WASTE PRODUCT.
Material can be disposed of in the same way as untreated timber

Quality assurance

ISO 9000 registration	Scope: Registration currently being sought Certificate number: Certified body:
Other third party QA system	Scope: N/A Certificate number: Certified body:

8.4 PLATO WOOD

Product description.

Plato's unique two stage thermal process dramatically improves the performance of abundant wood in an environmentally responsible way. No chemicals are involved throughout the process, where a careful combination of temperature and pressure significantly upgrades the stability and natural durability of timbers such as knotty Norway Spruce or exotic Frake, while retaining important mechanical properties.

The result is a more robust finished product, which combines optimal levels of both Durability and Stability into a wider product range, with more choices in section sizes (up to 100mm thick) and less brittleness than other thermo modification technologies.

This makes Plato®wood the perfect choice for projects seeking a greater environmental performance over a long worry-free service life. Projects in its wide range of applications include cladding, rainscreens, decking, fencing and even ground and fresh water landscaping.

Durability

CRITERION	DURABILITY CLASS	QUALIFYING REMARKS
Fungi	2 3 3	Plato Wood Norway Spruce Plato Wood Frake Plato Wood Poplar
Insects (beetles	0	Plato Wood does not guarantee against insects.
Marine	N/A	

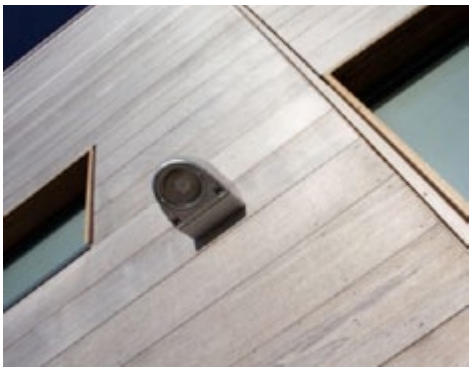
Physical characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Stability	+	Plato Wood has excellent dimensional stability. Swelling from oven dry to saturated: Norway spruce: 2.1% rad, 3.8% tang Frake: 2.6% rad, 3.3% tang Poplar: 2.1% rad, 4.1% tang
Strength	-	Bending strength of defect free specimens: Norway spruce: 79 +/- 19 N/mm2 Frake: 71 +/- 16 N/mm2 Poplar: 79 +/- 19 N/mm2 MOE of defect free specimens: Norway spruce: 10514 +/- 2665 N/mm2 Frake: 11527 +/- 1236 N/mm2 Poplar: 10514 +/- 2665 N/mm2
Hardness	0	Janka test Norway spruce: Radial @ 1990 +/- 354 N Tangential @ 1905 +/- 280 N Perpendicular @ 3440 +/- 463 Janka test Poplar: Radial:1905 +/- 38 N Tangential: 1990 +/- 119 N Perpendicular: 3444 +/- 371 N

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Modified wood in action

M&S Distribution Centre, Bradford
Externally clad with Plato Wood heat treated softwood.
Photos courtesy: Howarth Timber



NHS Carlisle - specialist unit
Plato Wood Frake hardwood cladding.

Other characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Metal fixings and fastenings	-	Stainless steel metalwork is recommended
Gluing	0	Plato Wood can be glued using standard practice however low water content based adhesives are advised.
Surface coatings	+	Plato Wood offers an ideal substrate for various decorative finishes. The improved stability and negligible resin content enhances the performance of any surface coatings.
Flammability of modified wood product	0	The flammability of Plato Wood is the same as untreated timber however has the advantage of lower smoke emissions. Where necessary Plato Wood can be treated with WPA FR Type LR to achieve reaction to fire classification Euro Class 'B'.
Conditions for post-production machining	0	Plato Wood is modified through the entire cross section therefore machining does not compromise the products performance. Plato Wood dust is finer than untreated timber so an efficient dust extraction should be used.
Post-production and on-site handling	0	Care should be taken when handling and in storage to minimise potential damage.

End of life

GUIDANCE ON DISPOSAL OF WASTE PRODUCT.
PlatoWood is a natural wood product without any chemicals additives. At the end of its service life Plato Wood waste can be handled as with any other untreated wood waste. The material is bio-degradable and can be disposed of at the end of its service life by either burning or placing into the normal waste system.

Quality assurance

ISO 9000 registration	Scope: Certificate number: Certified body:
Other third party QA system	Scope: Certificate number: Certified body:
Other QA system CE	Scope: EN 14915 Solid wood panelling and cladding Certificate number: Certified body: Manufacturer's declaration

8.5 THERMOWOOD®

Product description.
ThermoWood is a registered trademark owned by International ThermoWood Association.

The manufacturing process of ThermoWood is based on the use of high temperature and steam. No chemicals are used in the process. The process improves dimensional stability and biological durability of wood. Another improvement is in the insulation properties of the final material, the process leads to a reduction in thermal conductivity. Due to the high treatment temperatures the resin is removed from the wood. The modification process can be divided into three phases: 1. Temperature increase and kiln drying, 2. Intensive heat treatment and 3. Cooling and moisture conditioning.

The product classes are Thermo-D ("Durability", 212 °C) and Thermo-S ("Stability", 190°C). Because of improved durability property against decay, the ThermoWood products are well suited to applications involving demanding weather conditions. The finewood-style look and dimensional stability make the products suitable for interior decoration.

Further information: www.thermowood.fi

Durability

CRITERION	DURABILITY CLASS	QUALIFYING REMARKS
Fungi	3 2	Thermo-S (Spruce, Pine) Thermo-D (Spruce, Pine)
Insects (beetles	+/0	ThermoWood process gives good protection against longhorn beetles. Concerning termites, the test results indicate that the ThermoWood is unable to resist them. Local tests are recommended since termite types vary from one region to another.
Marine (UC5)	N/A	N/A

Physical characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Stability	+	The ThermoWood process reduces swelling and shrinkage remarkable when compared to untreated timber.
Strength	0 -	Thermo-S (Spruce, Pine) Thermo-D (Spruce, Pine)
Hardness	0	

Note 1: Effect classification: '+' = positive effect/improvement compared with unmodified wood; '0' = no change from unmodified wood; '-' = adverse effect compared with unmodified wood.

Modified wood in action

Boston Sports Stadium, Boston, Lincolnshire
Thermowood, heat treated softwood finished with translucent stain provides a cost effective external and durable external cladding.

Thermowood decking
Photo courtesy: Finnforest

Other characteristics

CRITERION	EFFECT[1]	QUALIFYING REMARKS
Metal fixings and fastenings	-	ThermoWood is more acidic than untreated timber. Stainless steel metalwork is recommended where possible
Gluing	0	ThermoWood can be glued using standard practice however low water content based adhesives are advised.
Surface coatings	+	ThermoWood offers an ideal substrate for various decorative finishes. The improved stability and negligible resin content enhances the performance of any surface coatings.
Flammability of modified wood product	0	The flammability of ThermoWood is the same as untreated timber however has the advantage of lower smoke emissions. Where necessary ThermoWood can be treated with WPA FR Type LR to achieve reaction to fire classification Euro Class 'B'.
Conditions for post-production machining	0	ThermoWood is modified through the entire cross section therefore machining does not compromise the products performance. ThermoWood dust is finer than untreated timber and efficient dust extraction should be used.
Post-production and on-site handling	0	ThermoWood can be more brittle than untreated wood and care should be taken when handling and in storage to minimise potential damage.

End of life

GUIDANCE ON DISPOSAL OF WASTE PRODUCT.
ThermoWood is a natural wood product without any chemicals additives. At the end of its service life ThermoWood waste can be handled as with any other untreated wood waste. The material is bio-degradable and can be disposed of at the end of its service life by either burning or placing into the normal waste system.

Quality assurance

KOMO-certification	Scope: Product certificate; Performance, Application and Use Certificate number: Finnforest 32917/07, 32919/07 Stora Enso Wood Products Oy Ltd 32942/07 Oy Lunawood Ltd 32941/04 Oy SWM-Wood Ltd 32878/03 Certified body: SKH (KOMO-certification, www.skh.org)
FI-certification	Scope: Production quality control Certificate number: Ekosampo Oy 5047-1 HJT-Holz Oy 4719-01 Heatwood 5319-01 Finnforest 4691-01 Novawood Oy Lunawood Ltd 4693-01 Oy SWM-Wood Ltd 4694-02 Stora Enso Wood Products Oy Ltd 4692-02 Suomen Lämpöpuu Oy 4729-01 Certified body: INSPECTA OY (FI certification, www.inspecta.com)

9. References

BS EN 113:1997 Wood preservatives. Test method for determining the protective effectiveness against wood destroying basidiomycetes. Determination of the toxic values.

BS EN 350-1:1994 Durability of wood and wood-based products. Natural durability of solid wood. Guide to the principles of testing and classification of natural durability of wood.

BS EN 335-1:2006 Durabiltity of wood and wood-based products. Definitions of use classes. General.

BS EN 460:1994 Durability of wood and wood-based products. Natural durability of solid wood. Guide to the durability requirements for wood to be used in hazard classes.

DD ENV 807:2001 Wood preservatives. Determination of the effectiveness against soft rotting micro-fungi and other soil inhabiting micro-organisms.

EN 252:1989 Field test method for determining the relative protective effectiveness of a wood preservative in ground contact

Fincham, J. A history of naval architecture, Elibron Classics, 1851.

BRE Digest: Modified Wood Technology

TRDA Technology: Wood Information Sheet 63: Modified wood Products

Annex 1

A description of wood modification processes

The available modified wood technologies can be grouped into three main modifications:

- those that are induced by a physical process such as heating or heat and pressure, and
- those that are induced by a chemical process such as reaction with acetic anhydride.
- those that are induced by a combination of processes that may include physical, chemical or even biological processes.

A.1 Physical processes

Thermal modification is the only commercialised example of this type of process available in the UK.

Thermal modification of wood, unlike heat treatment for phytosanitation of wooden pallets, creates a permanent change in the polysaccharides of the wood. For thermal modification of timber it must be heated to a temperature in excess of 160 °C. Wood chars at high temperatures so the process of thermal modification is carried out in an environment in which oxygen is restricted or eliminated from the system. The means by which this is achieved is one of the core distinctions between the different processes that are used across Europe. The processes to exclude oxygen include: heat in nitrogen, heat green timber creating a steam veil to protect the wood, heat in oil.

A.2 Chemical processes

The chemical modification of wood induces a reaction between an introduced molecule and the wood polysaccharides creating bonds and a permanent change to the wood. There are a number of chemical modification processes; current commercial processes include acetylation and furfurylation.

A.3 Combination processes

Densification is the only commercially available example of any other modification technology in the UK. Solid wood is impregnated with plant polymer extract products in a water-borne solution that contains polymerisation catalysts. It is kiln dried and additives cause in-situ polymerisation which turns the timber into a dense hardwearing product.

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