Key points

- *Timber is an inherently durable material but in certain circumstances it can become a potential food source for a variety of wood decay fungi, wood boring insects and marine organisms.*
- *Timbers differ in their resistance to biological attack from these organisms and this level of resistance is known as the 'durability' of the timber. The outer sapwood of all timber species is non-durable.*
- *Moisture content more than 20% are usually required for fungal attack to occur.*
- *Timber can however be subject to insect infestation at lower moisture contents than 20%.*
- *Good construction detailing can help protect timber components and extend their service life; conversely poor detailing, workmanship, maintenance and storage and the use of incorrect materials can reduce the service life of a timber component.*
- *The use of correctly applied wood preservative treatments can greatly enhance and prolong the service life of susceptible timbers used in a high risk environment.*
- *Most preservative treatments provide an envelope of protection around the timber. The deeper the depth of penetration of the treatment into the timber the greater the degree of protection provided.*
- *The degree of protection is also enhanced by increasing the amount of preservative that is retained inside the timber following the treatment process – this is known as the 'retention' level.*
- *After treatment timber should be cut or drilled as little as possible and any exposed surfaces should be liberally brush treated with a suitable preservative.*
- *The preservative manufacturer should be contacted to confirm the compatibility of the treatment with metal components such as nails, staples, screws, wire, metal brackets, straps and hangers.*
- *If a water based treatment has been used the timber may need time to dry down to a suitable moisture content.*
- *The range of values for the natural durability of timbers is based on field tests on the heartwood of the timbers in ground contact over a number of years. The natural durability of some commonly used timbers has been discovered to be less than that originally thought.*
- *Heat treatment can be used to improve the durability of timber.*
- *Heat treated timbers may be machined after treatment.*
- *Heat treatment for durability improvement should not be confused with the much milder heat treatment for phytosanitary and bio-security purposes.*

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Timber preservative treatment and durability – solid timber – a background

Bill Robinson and Bob Davis

Introduction

This information sheet gives some general background to the preservative treatment of timber used in buildings and in particular structural timber. It mainly addresses preservatives that have been tested to EN 599-1 "Durability of wood and wood-based products – Performance of preservatives as determined by biological tests – Part 1: Specification according to hazard class"; these are the common treatments that apply to the use of timber in buildings. The overall purpose of this information sheet is to help ensure that manufacturers, specifiers, designers, builders and users understand what some of the basic requirements are for treatment; additional information sheets are planned including one for the higher use classes (mainly related to fencing). This information sheet is primarily aimed at those who have some basic knowledge of timber and to some extent timber treatment.

The Wood Protection Association (WPA) represents the wider treatment industry and its manual on wood preservation has been a valuable source of information on treatment for a considerable period of time. BS 8417:2011+A1:2014 "Preservation of wood - Code of practice" is also a good reference document and provides similar information as the WPA manual; the information essentially being the same.

The need for timber preservative treatment depends on the natural durability of the timber and its specific end use which is reflected in what use class it will fall into. Other factors to be considered are the cost of the treatment (which is usually low) and the benefits of treatment in terms of the consequence and cost of failure and perhaps of extending the components service life.

The older term 'hazard class' has largely been replaced by the term 'use class', use classes are specified in EN 335: 2013 "Durability of wood and wood-based products - Use classes: definitions, application to solid wood and wood-based products". Depending on the natural durability of the timber and the use class that it falls into, the timber may have a natural durability for its intended end use and may not need treatment.

In general, timber inside buildings will fall into use classes 1 and 2. Timbers exposed to the weather are in use class 3 e.g. external joinery, cladding and decking. Use class 4 relates to timbers in direct contact with the soil or with fresh water while use class 5 relates to timber in salt water.

The natural durability of a number of timber species is given in EN 350:2016 “Durability of wood and wood-based products - Testing and classification of the durability to biological agents of wood and wood-based materials”; natural durability is also influenced by the origin of the timber i.e. where it was grown.

In terms of relating treatment to the end use of the timber (use class), among the most useful documents are the WPA manual and BS 8417. BS 8417 like EN 335 has two sub-divisions in use class 3 but it also has service factors (which are not in EN 335); these are useful in helping a specifier decide on the need for preservative treatment. BS 8417 also specifies the requirements for preservative treatment for a range of different preservatives, including those not normally used in buildings.

Most preservative treatments provide an envelope of protection which may vary from a few millimetres to full sapwood penetration. After treatment care has to be taken to ensure the treatment is not compromised by e.g. planing, cutting or drilling.

Definition of Use Classes – EN 335

This standard gives information on biological agents (fungi and insects) and defines use classes related to the exposure level of the timber and biological agents:

- Use class 1 (UC 1) - situations where the wood or wood-based product is inside a construction and not exposed to the weather and wetting. Insect attack might be possible.

  In this environment the moisture content of solid wood is such that the risk of attack by surface moulds or by staining or wood-destroying fungi is insignificant (that is the wood shall have a moisture content of a maximum of 20% in any part of the component for practically the whole of its service life).

  Examples include internal joinery, dry roofs and internal floor timbers;

- Use class 2 (UC 2) - situations where the wood or wood-based product is under cover and not exposed to the weather (especially rain) but where occasional, but not persistent wetting may occur.

  For timbers whose use includes a decorative function; disfigurement can also occur as a result of the growth of surface moulds and staining fungi in use class 2 and above.

  In this environment the moisture content of solid wood occasionally exceeds 20%, either in the whole or only in part of the component and thus allows attack by wood-destroying fungi.

  Examples include roof timbers where there is a risk of wetting, timber frame external wall panels and ground floor joists;

- Use class 3 (UC 3) - situations where the wood or wood-based product is above ground and is exposed to the weather.

  There are two sub-classes in this use class:

  - Use class 3.1 (UC 3.1) – where the wood or wood based product will not remain wet for long periods; water will not accumulate;

  - Use class 3.2 (UC 3.2) – where the wood or wood based product will remain wet for long periods and water may accumulate.

  In this environment the moisture content of solid wood can be expected to be frequently above 20%, and thus it will often be liable to attack by wood-destroying fungi.

  Examples include external joinery, decking boards and joists, cladding and fencing rails;

- Use class 4 (UC 4) - situations where the wood or wood-based product is in direct contact with the ground or fresh water.

  In this environment the moisture content of solid wood can be expected to exceed 20% permanently and is liable to attack by wood-destroying fungi. The above-ground (or above-water) portion of certain components, for example fence posts, may be attacked by wood-boring beetles.

  Examples include fence posts, decking posts, poles, sleepers and fencing rails;

- Use class 5 (UC 5) - situations where the wood or wood-based product is permanently or regularly sub-merged in salt or brackish water.

  In this environment the moisture content of solid wood can be expected to exceed 20% permanently. Attack by invertebrate marine organisms is the principal hazard, particularly in the warmer waters where organisms such as Limnoria spp., Teredo spp. and Pholads can cause significant damage. The above water portion of certain components, for example harbour piles, can be exposed to wood-boring insects, including termites.

EN 335 also has additional information on some types of fungi and wood destroying insects.

Service classes

The main timber design standard I.S. EN 1995-1-1 refers to 'service classes' which are based essentially on the moisture content of timber related to the relative humidity. Service class 1 approximates to Use class 1, service class 2 also approximates to Use class 1 or (if there could be occasional wetting of the timber) to Use class 2; service class 3 approximates to Use class 2 or Use class 3 or higher if the timber if used externally.

Natural durability of timber

The term natural durability relates to the heartwood of the timber and the specified performance relates to the timber being in ground contact (use class 4); all sapwood should be regarded as non-durable or perishable. However, for some species (softwoods especially) the natural durability of heartwood is now considered to be the same as sapwood i.e. non-durable.

The natural durability of various timber species is given in EN 350:2016 "Durability of wood and wood based products - Natural durability of solid wood - Guide to natural durability and treatability of selected wood species of importance in Europe"; the standard also gives information on timber treatability.

There are five timber durability classes for resistance to fungal decay; DC 1 (DC stands for durability class) being very durable and DC 5 being not durable; intermediate classes refer to durable, moderately durable and slightly durable. There are also durability classes for insect attack (such as longhorn beetle and the common furniture beetle); termites and marine borers. These classes are summarised in the table below.

Durability classes of timber

Description	Fungi	Wood-boring beetles	Termites	Marine organisms
Very durable	DC1			
Durable	DC2	DC D	DC D	DC D
Moderately durable	DC3		DC M	DC M
Slightly durable	DC4			
Not durable	DC5	DC S	DC S	DC S

Some examples of common timbers and their usual fungal durability classes are Burmese teak (*Tectona grandis*) DC1, European white oak (*Quercus robur*) DC2, Western red cedar (*Thuja plicata*) DC3 and DC4 depending on source, with most spruces (*Picea*) falling into DC5.

Timber treatability has four classes; 1 being easy to treat and 4 being extremely difficult to treat; intermediate classes are moderately easy and difficult. Timber with an unusually high degree of variability is marked by a 'v' while 'n/a' denotes insufficient data. In general heartwood is always difficult to treat; EN 350 gives information where known on the treatability for sapwood and heartwood. Treatability is usually of little concern to specifiers and users.

Heat treatment

Heat treatment is a relatively new process and will usually improve a timber by two durability classes. Heat treated timbers may be machined after treatment without the durability being significantly compromised.

Heat treatment for durability improvement should not be confused with the much milder heat treatment for phytosanitary and bio-security purposes.

More information on heat treatment can be found in the COFORD Connects Note "Heat treatment of softwoods to improve stability and durability", number 44 under Wood Processing and Product Development (web address: www.coford.ie/publications/cofordconnects/).

Preservative treatment systems

Timber is treated according to its intended end use; end uses are related to use classes which are defined in EN 335. The WPA manual and BS 8417 relate end use to use class and treatment recommendations.

- Low pressure/double vacuum = Use classes 1, 2, 3.1.
- High pressure = Use Classes 1 – 5.

Where protection is required against both fungal decay and insect attack the preservative treatment must contain both fungicides and insecticides.

Timbers destined for use class 3.1 and treated with a low pressure system need to be protected by a surface coating in accordance with manufacturer's instructions

Specifying treatment

For the specifier the main consideration will be whether or not timber should be treated. The specifier will have to assess if the timber is at risk – if it is then for many softwood species (and some hardwoods) the timber will need to be treated especially as it is difficult to ensure that the timber consists only of heartwood (most softwood components have some sapwood). Even if the softwood timber is heartwood in many cases there would be no guarantee it would provide adequate resistance to fungal or insect attack.

The Wood Protection Association (WPA) is a good guide on the treatment of wood-based boards and engineered wood panels as well as solid timber. BS 8417 applies only to solid timber.

In considering the need for treatment the costs of timber failure and remedial action should be considered, treatment is usually relatively inexpensive and can extend the life of a component. Some standards specify components that have to be treated (e.g. I.S. 440 "Timber Frame Construction, Dwellings and Other Buildings"); other components are treated according to common practice e.g. ground floor joists. A number of local authorities specify timber treatment as a general requirement for all timbers.

Treatment can be specified by use class and desired service life; in the absence of a stated desired service life a desired service life of 60 years would normally be assumed for Use class 1 & 2 if treated with a wood preservative manufactured in accordance with EN599 and BS 8417.

BS 8417:2011+A1:2014 "Preservation of wood- Code of practice"

This standard helps to decide whether to treat timber or not. It further divides each use class into another four sub-sections (A, B, C and D) based on service factors and depending on how the specifier considers the risk level of the timber; the four sub-sections are:

A Treatment unnecessary (negligible risk of failure);

B Treatment optional (low failure risk, remedial action is easy, treatment would be an insurance against repair costs);

C Treatment desirable (high failure risk, remedial costs difficult and/or expensive);

D Treatment essential (very high failure risk, possible serious danger to persons or structure).

The relevant table in BS 8417 for the more common preservatives (those that comply with EN 599-1) for buildings timbers is Table 4.

Some common classifications are:

- Timber frame walls are usually considered to be Use Class 2 sub-section C or D and are normally treated;
- Sole plates above DPC level (damp proof course) are assigned to Use Class 2 sub-section D (the D signifies that the timber would be difficult and expensive to replace and therefore treatment is considered essential). BS 8417 specifies a higher level of treatment specifically for sole plates;
- Ground floor joists and associated timbers are usually assigned to use class 2D and are normally treated;
- External joinery is usually considered to be Use Class 3 sub-section C or D; they are at risk and expensive to replace;
- Roof timbers (dry) are usually considered to be Use Class 1 sub-section B or D but if there is a risk of wetting then Use Class 2 sub-section C would be appropriate. Dry roofs are sometimes classified as Use Class 2 sub-section C for treatment purposes as an assurance against future remedial action.

BS 8417 is considered to be a 'UK national interpretative document' to EN 599-1 and EN 351-1 and provides complementary information to those standards. Ireland does not currently have an equivalent document but it is likely that BS 8417 will effectively act as the national interpretative document.

EN 14081-1

EN 14081-1 "Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements" is the governing harmonised standard for strength grading timber and specifies durability as an essential characteristic in regard to CE marking and by extension to the Declaration of Performance (DoP). The Declaration of Performance (DoP) should have the same declared performances as the CE mark; the DoP has to be drawn up before a CE mark can be applied and the DoP is a requirement of the Construction Products Regulation (CPR) not EN 14081-1.

If the timber is not treated the durability may be declared through the natural durability of the timber (the Use class is often given as well), if the timber is treated then the durability will normally be declared through the Use class. A manufacturer has the option of declaring NPD (no performance determined) for an essential characteristic including durability. If the timber is treated NPD is unlikely to be declared against durability unless treatment was carried out by a different company responsible for the timber grading.

When timber is treated and the performance declared in the DoP and CE mark then the information set out in EN 15228 (under marking) should be provided by the treater.

Even if no performance on durability is given in the DoP or CE mark (i.e. NPD is declared), the information required by EN 15228 (under marking) is still required to be provided by EN 14081-1 although it would probably not be considered as part of the DoP or CE mark.

Comment

EN 15228 is not a harmonised standard and this means that factory production control or its monitoring by a third party may not be at the same level as that required by a harmonised standard.

If strength grading and treatment is carried out by the same company then a DoP and CE mark can be provided without difficulty. If a company buys in graded timber (which should come with a DoP and CE mark) and then treats the timber the treatment will change the declared performance of durability in the original DoP and CE mark. In this case the information required by EN 15228 (commonly referred to as a treatment certificate) becomes more important as the CE mark and DoP durability declarations are in theory incorrect. However, the treatment certificate if compliant with EN 15228 is likely to be accepted by most regulatory bodies and certifiers.

Ultimately the original specifier (e.g. project architect) will have to decide on whether treatment is necessary or not. The same person or a designated expert will also have to inspect the DoP to see if the durability requirements for the specific use of the timber have been met.

Treatment certificates provided by treaters can lack detail and sometimes are not in compliance with EN 15228. Many treatment certificates can only be taken as a declaration by the treater that the timber has been treated; if the timber is not treated or treated incorrectly then problems will only show up some time in the future.

In Ireland few treaters are in a quality assurance scheme overseen by a suitable third party; i.e. there are no independent checks on timber treatment. In the absence of a quality scheme monitored by an independent third party and particularly if there is any doubt about treatment then consideration should be given to the testing of timber samples for the presence of preservatives (qualitative testing) and if necessary the testing of timber for the correct retention level of the treatment (quantitative testing); the requirements for such testing could be included in a specification to enact as necessary.

Reference standards

The main standards referred to in this information sheet are:

- EN 335: 2013 “Durability of wood and wood-based products - Use classes: definitions, application to solid wood and wood-based products”;
- EN 350:2016 “Durability of wood and wood based products - Natural durability of solid wood - Guide to natural durability and treatability of selected wood species of importance in Europe”;
- EN 599-1 “Durability of wood and wood-based products – Performance of preservatives as determined by biological tests – Part 1: Specification according to hazard class”;
- EN 14081-1 “Timber structures - Strength graded structural timber with rectangular cross section - Part 1: General requirements”;
- BS 8417:2011+A1:2014 “Preservation of wood- Code of practice”.

Biological terms

Fungi

Blue stain fungi and Mould fungi (these do not cause significant alteration of the mechanical properties of wood).

Basidiomycete fungi are responsible for brown rot and white rot.

Wet rot is a generic term used to define a variety of fungi species (the most common species is *Coniophera puteana*); removal of the source of water usually cures the problem as wet rot cannot spread in dry timber. Wet rot can however cause extensive damage and will continue to spread if left untreated.

Dry rot refers to *Serpula lacrymans*, it can cause extensive damage and can be difficult to treat as the fungal strands can spread in all directions, even through bricks and mortar. The strands can transport moisture from damp areas where it is established, allowing the fungus to spread onto dry unventilated areas of wood. Dry rot can also spread by spores of the fungus being transported throughout a building by air currents. These spores then present a risk should they come into contact with timber at other locations in the building. Therefore solving the original source of water ingress may not stop dry rot; usually the affected timber has to be removed and some treatment of the building fabric undertaken.

Insects which infest wood

Beetles (*Coleoptera*) cause damage by the larvae or grub stage of the insects boring tunnels inside the timber while they are maturing. Insect holes appearing on the surface of the timber are exit or flight holes formed when the insect larvae have become adult beetles and have left the wood to commence a new life cycle. These species include:

- Common furniture beetle / Woodworm (*Anobium punctatum*);
- Powder post beetle (*Lyctus brunneus*);
- Wood boring weevil (*Pentarthrum huttoni*);
- Wood wasp (*Sirex* species);
- Pinhole borer / Ambrosia beetle (*Scolytidae* species);
- Forest longhorn beetle (*Cerambycidae* species);
- House longhorn beetle (*Hylotrupes bajulus*).

Many other wood-destroying beetles exist which are either of lesser or only regional importance, examples of which are *Hesperophanes* spp, *Xestobium rufovillosum*, *Nicobium* spp. and *Lyctus* species other than *Lyctus brunneus*.

Termites (*Isoptera*) cause serious damage to timbers in the tropics and sub-tropics by completely consuming unprotected timber. Only two species are currently known to exist in southern Europe but these do not extend further northward in Europe than Paris or Hamburg due to climatic conditions.