

## Round timber in construction: Notes for structural design

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Report prepared for the Forestry Commission 2003 and published with their permission 2004 by TRADA Technology Ltd.

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## Round timber in construction: Notes for structural design

The use of round timber for structural applications can provide designers with attractive features in sympathy with local surrounding in a range of applications from housing and agricultural buildings to major engineering structures such as bridges. However Structural Engineers designing round timber elements are often faced with limited information with which to support design evaluations and connection detailing.

This sheet has been prepared on a “product specification” model and gives a technical and normative background to the design of round timber structures. It brings together basic terminology, grading and species selection advice together with suggested simplified design approaches and key references for further detailed information.

Note: Full details of standards and other items are given in the References section.

### Basic terminology

*From BS EN 844-2: 1997:*

Log: cross-cut portion of round-timber.

Round timber: felled tree cross-cut at the top, with all branches removed, that may or may not have been further cross-cut, generally excluding firewood. Note: ‘Round timber’ or ‘pole’ commonly denotes machine debarked tapered timbers of round cross section.

‘Machine rounded timber’ denotes mechanically shaped cylindrical round timbers.

### Processing

Typical machining and treatment operations are:

- Branch removal, cross cutting
- Mechanical debarking
- Machine rounding
- Cutting to length
- Visual sorting
- Preservative treatment if specified
- Drying, conditioning
- Quality / strength grading

## Sizes

Typical dimensions in use:

- Diameter: 80mm to 200mm
- Length: up to 6 meters

### Measurement of sizes and tolerances to prEN 14544 and prEN 1309-2:

The reference moisture content for the purpose of prEN14544 is 20%. The recommended limit for deviations in the nominal diameter measured at midspan under bark is 0/+20mm.

### Permitted deviations from target sizes

The permitted deviation is the difference between actual size and target size, taking into account difference in size due to moisture content. The target size is the size desired at a specific moisture content, after a production process and to which permitted deviations are related.

No National nor European standard specifies target sizes and permitted deviations for structural round timbers. Tolerances (sum of permitted deviations) should therefore be agreed by contract between client and supplier.

## Measurement of features

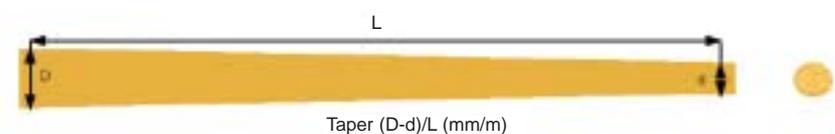
### Measurement of features and tolerances to prEN 14544 and BS EN 1310:

Knots, fissures, sweep, ovality, taper, spiral grain, rate of growth and proportion of sapwood must remain within appropriate limits. Fungal

*Machine rounded timber  
(cylindrical shape)*



*Round timber or pole  
(machine debarked). Note:  
The diagram exaggerates  
taper*



damage is not permitted. The diagrams below illustrate sweep and taper of machine rounded timbers and poles respectively.

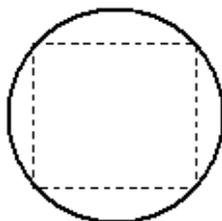
## Visual strength grading

No published National or European standards are yet available for visual strength grading for structural round timbers.

However EN 14544 (currently in preparation) will lay down the requirements for visual strength graded timber with round cross sections, with bark or debarked and cut to length but otherwise not machined.

Note: In practice a piece of timber of round cross section can be conservatively graded by grading the virtual largest square cross section it contains. Specialist grading advice should be obtained.

*Imaginary inner square section (conservative visual strength grading approach)*



## Marking

According to EN 14544 (currently in preparation), each piece of graded timber will be marked with the following information:

- identification of producer
- grading standard and grade.

Under the Construction Product Directive, structural round timber will be affixed a CE marking. CE marking will show that round timbers address the regulatory requirements within a system of harmonised technical specification, harmonised European Standards (hENs) or European Technical Approval (ETAs). This is detailed in annex ZA of EN 14544 currently in preparation.

Although marking of structural grade round timbers and poles is not current practice, specialist grading advice should be obtained for the selection of round timbers and poles to be used structurally.

## Mechanical properties

No tabulated grade stresses are available for structural round timbers to BS 5268-2 or tabulated characteristic values of mechanical properties to European standards.

In practice structural design calculations can be conservatively carried out using design stresses assigned by strength grading as described in 'Visual Strength Grading' above, together with an appropriate form factor (modification factor).

The designer should also consider whether a Design Assisted by Testing approach could be appropriate. Where structural design by calculation is impractical, and verification solely by testing is expensive, advantage can be gained from the application of a design assisted by testing approach. A mathematical design model is 'calibrated' using a selected testing approach, giving accurate design values supported by a cost effective test programme. Methodologies are specified in BS 5268-2: 2002 and BS EN 1990: 2002.

BS EN 408: 1995 specifies test methods for determining mechanical properties of structural timber and glued laminated timber. The test methods apply to circular shapes of substantially constant cross-section (machine rounded timber).

Procedures given in BS EN 384: 1995 may be used to derive characteristic design values for use with Eurocode 5. These characteristic values may then be modified to provide stresses and moduli appropriate for use with BS 5268-2 design procedures. Expert advice should be sought when preparing a test programme and interpreting test data.

EN 14251 (currently in preparation) will specify test methods for determining mechanical properties of structural round timber.

Note: The mechanical removal of bark reduces the strength of poles in comparison with manual debarking which limits damage to the natural structural arrangements of the wood fibres eg swelling around knots. Logically, therefore, machine rounding also affects strength, for example bending strength for mechanically shaved poles may be reduced by 25% compared with manual debarking. (Follett, P. Jayanetti, L).

## Specification

### Conditioning, Moisture Content (MC) in service conditions

To reduce dimensional movement and control creep under load, the moisture content of timber when installed should be close to that likely to be attained in service. Appropriate design values should be selected to reflect the timber moisture content and intended Service Class environment

After felling, round timbers and logs have a high moisture content and, apart from external uses, should be dried before grading and installation to match as closely as possible the recommended moisture content in service. BS EN 335 defines five hazard classes which represent the different service situations to which wood and wood-based products can be exposed. The table below relates Service Classes for timbers to BS 5268-2 to Hazard Classes to BS EN 335-1 :

Service class to BS 5268-2: 2002	Examples of end use in building	Average MC likely to be attained in service conditions	Hazard classes to BS EN 335-1: 1992
3	External uses, fully exposed.	20 or more	3 to 5
2	Covered and generally unheated	18	2
2	Covered and generally heated	15	2
1	Internal uses in continuously heated building	12	1

## Natural durability and conferred durability (via preservative treatment) of wood

The natural durability (to biological attack) of wood depends to a large extent upon species and whether it is heartwood or sapwood. The natural durability classification of timber refers to heartwood only.

The service life of timber in out-of-ground contact situations depends on both its durability class and its treatability class. Guidance is given in BS EN 350-2: 1994 (see References).

The natural durability of timber may be improved by preservative treatment. The methods of treatment that may be used depend upon:

- species
- the presence of heartwood or sapwood
- the preservative product used and the penetration (relating to permeability of timber) and retention values selected from BS EN 351-1 (see References)
- the intended use in the construction
- recyclability, re-use and waste disposal aspects.

For the natural durability of wood see BS EN 350-2: 1994.

For the penetration and retention combinations available, see BS EN 351: 1996.

For the performance of wood preservatives, see BS EN 599: 1997.

For guidance on the durability requirements for wood to be used in hazard classes, see BS EN 460: 1994.

BS 8417 gives recommendations for specifying timber treated with preservatives in accordance with current European Standards. These describe the results of treatment to be achieved, in terms of penetration of preservative and retention in the analytical zone.

BS 5268-5 and BS 5589 are now obsolescent. They concern the use of wood preservatives covered by BS 144, BS 4072 and BS 5707. In BS 5268-5 and BS 5589 treatment processes are described in terms of preparation of the timber for treatment and the precise treatment process to achieve a specific performance in particular service environments.

## Environmental aspects

This section applies to timber as a building material in general.

### Environmental impact assessment

No UK National or European standards specifically address environmental impact construction materials. However general methodology for life cycle impact assessment is given in EN ISO 14042 and EN ISO 14043.

A collaborative European research project FAIR CT 95-0726 - Life-Sys Wood reports assessments of environmental impact of selected timber based building materials, assemblies and structures.

The UK National initiative DTI Fast Track project FT7-BHP0 - Assessing environmental impact of innovative Glulam timber construction reports the experience of undertaking an embodied energy environmental impact assessment of a significant Glulam structure.

## Ecolabelling

No UK national or European standards specifically address ecolabelling of construction materials. However ecolabelling is dealt with generically in EN ISO 14020, EN 14021 and EN ISO 14024 (see References).

## Sustainable forestry and chain of custody certification

The main aspects of sustainable forestry and chain of custody certification are:

- Sustainable forestry standards – e.g. the UK Woodland Assurance Standard (UKWAS)
- Sustainable forest management certification schemes – e.g. the Forest Stewardship Council, FSC and the Programme for the Endorsement of Forest Certification, PEFC
- Chain of custody of fibres and wood for all processing companies along the wood chain and the trading companies - e.g. FSC; PEFC
- Wood based products labelling - e.g. FSC; PEFC.

## Machining - health and safety aspects

Recommendations regarding Health and Safety of wood machining operation are given by the Health and Safety Executive (HSE). Free literature can be viewed from “HSE Free Leaflets – Woodworking” web page at: <http://www.hse.gov.uk/pubns/woodindx.htm> .

## Waste management

As with any other waste resulting from manufacturing processes, wood waste is dealt with under the Integrated Pollution Control (IPC) regulations. IPC is a system established under Part I of the Environmental Protection Act 1990 to control pollution from industry. It applies to the most potentially polluting or technologically complex processes in England and Wales and is enforced by the Environment Agency. A parallel but separate system of IPC is used in Scotland and enforced by the Scottish Environment Protection Agency, SEPA. IPC is concerned with the release of polluting substances to air, land and water.

A new UK regime, Pollution Prevention and Control (PPC), will eventually replace the existing legislation and implement the European Commission Directive on integrated pollution prevention (IPPC, Integrated Pollution Prevention Control).

Treated timber generates special or hazardous waste. Wood waste is traditionally disposed off in landfill with some sent for combustion. It is

presently difficult to sort clean - ie untreated wood - waste from hazardous - i.e. treated wood - at source. This results in a small proportion only of wood waste being recycled and creates difficulties at the point of disposal with contaminants and the need to control emissions. Research work is currently being carried out at TRADA and elsewhere which aims to identify ways of sorting sources of wood waste to make better use of clean waste.

More information is available at  
<http://www.defra.gov.uk/environment/index.htm> (Department for Environment Food and Rural Affairs),  
[http://www.environment-agency.gov.uk/subjects/waste/?lang=\\_e](http://www.environment-agency.gov.uk/subjects/waste/?lang=_e) (Environment Agency),  
<http://www.wrap.org.uk> (The Waste and Resources Action Programme)  
and  
<http://www.recycle-it.org/news/index.asp> (Timber Recycling Information Centre).

## References

### Standards

- BS 1990-1: 1984: Woodpoles for overhead and telecommunication lines - Part 1. Specification for softwood poles
- BS EN 335: 1992: Hazard classes of wood and wood-based products against biological attack
- BS EN 350: 1994: Durability of wood and wood-based products - Natural durability of solid wood
- BS EN 351: 1996: Durability of wood and wood-based products - Preservative treated solid wood
- BS EN 384: 1995: Structural timber - Determination of characteristic values of mechanical properties and density
- BS EN 408: 1995: Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties
- 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
- BS EN 599: 1997: Durability of wood and wood-based products - performance of preventive wood preservatives as determined by biological tests
- BS EN 844-1: 1997: Round and sawn timber - Terminology - Part 1: General terms common to round timber and sawn timber
- BS EN 844-2: 1997: Round and sawn timber - Terminology - Part 2. General terms relating to round timbers
- BS EN 844-3: 1997: Round and sawn timber - Terminology - Part 3: General terms relating to sawn timber
- BS EN 1310: 1997: Round and sawn timber - Method of measurement of features

BS EN 1315-1: 1997: Dimensional classification - Part 1. Hardwood round timber

BS EN 1315-2: 1997: Dimensional classification - Part 1. Softwood round timber

BS EN 1316: 1997: Hardwood round timber - Qualitative classification

BS EN 12509: 2001: Timber poles for overhead lines - Determination of modulus of elasticity, bending strength, density and moisture content

BS 5268-2: 2002: Structural use of timber - Part 2. Code of practice for permissible stress design, materials and workmanship

BS EN 1990: 2002: Eurocode - Basis of structural design

prEN 1309-2: Round and sawn timber - Method of measurement of dimensions - Part 2. Round timbers (EN in preparation)

prEN 1927: Softwood round timber - Qualitative classification (EN in preparation)

prEN 14251: Structural round timber - Determination of the strength and stiffness parallel to the grain in bending and compression (EN in preparation)

prEN 14544: Timber structures - Strength graded structural timber with round cross-section - Requirements (EN in preparation)

prEN 1995-1-1: Eurocode 5 - Design of timber structures - Part 1-1- General rules - General rules and rules for buildings (EN in preparation)

EN ISO 14020:2001 Environmental labels and declarations - General principles

EN ISO 14021:2001 Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)

EN ISO 14024:2000 Environmental labels and declarations - Type I environmental labelling - Principles and procedures

EN ISO 14042:2000 Environmental management - Life cycle assessment - Life cycle impact assessment

EN ISO 14043:2000 Environmental management - Life cycle assessment - Life cycle interpretation

## Others

Bois de structures - Bois ronds structuraux. CTBA. November 2001.

Round small diameter timber for construction - Final report of project FAIR CT 95-0091. VTT Technical Research Centre of Finland. 1999.

Follett, P. Jayanetti, L. Timber poles construction. TRADA. Second Edition. 2000.

CE marking under the construction products directive. DETR. March 2001.

Life-sys wood: consistent life cycle analysis of wood product - Final consolidated report of project FAIR . TNO Building and Construction Research The Netherlands. 1999.

FT7-BHP01. Assessing environmental impact of innovative Glulam timber construction. Buro Happold. <http://www.pii.org.uk/fasttrack/>. 2002.

Softwood sizes. TRADA Wood Information Sheet 2/3-37. 2002.