

## Key points

- I.S. EN 1995-1-1 along with the Irish national annex should be used for the general design of structural timber.
- European loading standards along with any Irish national annex should be used when designing to the Eurocodes.
- I.S. EN 1991-1-4 cover wind loads and has a large national annex.
- There are a number of non-contradictory complimentary information (NCCI) documents on design to Eurocode 5; these include S.R. 70 for roof trusses and S.R.71 for general structural timber.
- S.R. 71 contains load span tables for a range of different loadings.
- DoP and CE marks should be checked for information and the suitability of the product for the final end use.
- Preservative treatment certificates should comply with EN 15228. The link between the certificates and timber may need to be established.
- Most design information on fixings is contained in the DoP which is often on the box containing the fixings or on a website.
- Care should be taken that the fixings used (especially on site) match the assumptions made in design.
- EN 14081-1:2016 dealing with strength grading has not yet been included in the Official Journal of the European Union (OJEU). It is assumed that the standard will shortly be referenced in the OJEU.

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Forest Sector Development/COFORD Division,  
Department of Agriculture, Food and the Marine,  
Agriculture House 3 West, Kildare Street,  
Dublin 2, Ireland.

## Structural Timber – General Design Requirements

*Authors: Bill Robinson and Bob Davis*

### Introduction

This information sheet describes the general requirements in relation to the design of solid structural timber to I.S. EN 1995-1-1 (generally referred to as Eurocode 5 or EC5). The information sheet is part of a number of information sheets, some of which deal with different aspects of the same subject; their purpose is to give manufacturers, specifiers, designers, builders a broad understanding of what the basic requirements are for each subject. Some of the information sheets are aimed at a more general user and therefore may not be appropriate to some readers.

### Strength grading and design

All structural timber must undergo an assessment of their strength reducing defects usually carried out by a grading machine or trained visual strength graders. Strength grading must comply with EN 14081-1:2016; machine graded timber is usually graded directly into a strength class while visually graded timber is usually assigned a timber grade based on the visual grading standard (the relevant Irish standard is I.S. 127) the timber is then typically assigned a strength class using I.S. EN 1912. The design characteristics of timber strength classes commonly used in Ireland are given in I.S. EN 338.

I.S. EN 1995-1-1 deals with general rules for buildings; I.S. EN 1995-1-2 deals with structural fire design and I.S. EN 1995-2 deals with timber bridges. These are the only design standards valid for use in Ireland as the older design standards, such as I.S. 444 and BS 5268, have been withdrawn since 2010.

## Main standards related to timber design

- ICP 2:2002 Slating and tiling (currently under revision and to be published as S.R. 82)
- I.S. 127:2015 Structural timber – visual strength grading – Sawn softwoods with rectangular cross-section
- I.S. 440:2009:A1:2014 Timber Frame Construction, Dwellings and Other Buildings (currently under revision)
- SR 70:2015 Timber in construction – Eurocode 5 - Trussed rafters
- SR 71:2015 Timber in Construction – Span Tables and Guidelines
- I.S. EN 336:2013 Structural timber - Sizes, permitted deviations
- I.S. EN 338:2016 Structural timber - Strength classes
- I.S. EN 636:2012+A1:2015 Plywood – Specifications
- I.S. EN 845-1:2013 Specification for ancillary components for masonry - Part 1: Wall ties, tension straps, hangers and brackets
- I.S. EN 1912:2012 Structural Timber - Strength classes - Assignment of visual grades and species
- I.S. EN 1990:2002+A1:2005 Eurocode - Basis of structural design
- I.S. EN 1995-1-1:2004+A2:2014 Eurocode 5: Design of timber structures – Part 1-1: General - Common rules and rules for buildings
- I.S. EN 1995-1-2:2004 Eurocode 5: Design of timber structures – Part 1-2: General - Structural fire design
- I.S. EN 1995-2:2004 Eurocode 5: Design of timber structures – Bridges
- I.S. EN 12369-1:2001 Wood-based panels. Characteristic values for structural design. OSB, particleboards and fibreboards.
- I.S. EN 12369-2:2011 Wood-based panels. Characteristic values for structural design. Plywood
- I.S. EN 12369-3:2008 Wood-based panels. Characteristic values for structural design. Solid-wood panels
- I.S. EN 14080:2013 Timber structures - glued laminated and glued solid timber
- I.S. EN 14250:2010 Timber structures - product requirements for prefabricated structural members assembled with punched metal plates
- I.S. EN 14545:2008 Timber structures – Connectors – requirements
- I.S. EN 14592:2008+A1:2012 Timber structures – Dowel-type fasteners – Requirements (currently under revision)
- I.S. EN 15497:2014 - Structural finger jointed solid timber. Performance requirements and minimum production requirements

## Declaration of Performance (DoP) and CE marking

EN 14081-1:2016 “Timber structures — Strength graded structural timber with rectangular cross section — Part 1: General requirements” is the governing standard for timber strength grading and covers machine and visually graded timber; it is a harmonised standard and therefore requires the CE marking of timber. Before the CE mark can be applied the manufacturer must draw up a Declaration of Performance (DoP) which will give information on the timber’s properties usually by specifying the timber’s strength class and in some instances may actually give specific characteristic design values.

The CE symbol should be on the timber and on the accompanying documentation.

EN 14081-1 and I.S. 127 have specific requirements for the marking to appear on the individual pieces of timber and for information to be provided in accompanying documentation; this is covered in a separate information Timber marking. All structural timber used in Ireland should be CE marked and have a DoP. If the visual grading standard of a member state allows package marking (as distinct from individually marking every piece of timber) then that timber should be acceptable for use provided the timber had a legitimate DoP and CE mark and that it was suitable for the specific end use.

The following are timber related products covered by harmonised standards and therefore a DoP and CE marking are required;

- Board materials are covered by EN 13986:2004+A1:2015
- Fixings are covered by EN 14592:2008+A1:2012 and connectors to EN 14545:2008
- Holding down straps, wall ties and similar products are covered by EN 845-1
- Finger jointing is covered by EN 15497:2014
- Prefabricated roof trusses are covered by EN 14250:2010
- Glulam is covered by EN 14080:2013

Other construction products may also be covered by a harmonised standard.

## Structural Design

This information sheet assumes that Eurocode 5 (EC5) will be the main standard used for the structural design of timber. The associated loading standards are given in EN 1991 “Actions on structures” with the more relevant parts for general design including:

- Part 1-1 – densities, self-weight and imposed loads
- Part 1-3 – snow loads
- Part 1-4 – wind loads

EN 1990 “Basis of structural design” include principles of limited state design and gives important requirements for design (not just timber design), partial safety factors, durability, and load combinations for limit state and serviceability (essentially deflection) amongst others.

Eurocode 5, EN 1990 and associated loading standards have National Annexes which give certain values and procedures to be used with the relevant standard, for example the Irish National Annex for I.S. EN 1991-1-4 (wind) is quite large and give pressure coefficients for buildings as well as a method for calculating wind pressures which are quite different to those given in the EN. Eurocode 5, like all the Eurocodes, is exactly the same across the EU but designers should use the National Annexes of the member state where the building is to be constructed.

In Ireland additional non-contradictory complimentary information (NCCI) on design to Eurocode 5 is contained in S.R. 70:2015 “Timber in construction – Eurocode 5 - Trussed rafters” and S.R. 71:2015 “Timber in Construction – Span Tables and Guidelines”. The UK has similar information in PD 6693-1:2012 “Recommendations for the design of timber structures to Eurocode 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings”. The use of these documents is voluntary but it is likely that they will effectively become mandatory through use and acceptance. It is up to the designer to ensure that any NCCI applies to their particular design situation.

National Annexes and NCCI are appropriate to the Member State where the timber structure or element is to be used. It would be inappropriate to use the National Annex or NCCI of one Member State in another Member State.

## S.R. 70:2015 Timber in construction – Eurocode 5 - Trussed rafters

This NCCI gives advice on timber roof trusses using punched metal plates. The contents include some additional information and advice on materials, design, limitations on roof truss spans and timber thickness, limitations on bay lengths and lengths of internal members (related to size), information exchange, handling and storage, site work including erection. There are also a number of sketches to demonstrate various aspects of truss use.

## S.R. 71:2015 Timber in Construction – Span Tables and Guidelines

This NCCI primarily gives load span tables for floor joists, ceiling joists, flat roofs, roof rafters and purlins. Advice is given on purlin supports and timber studding (but not timber frame). There is also a method to allow wind loads acting on a roof or building to be estimated.

The design criteria are given for the different members and there are examples on how to use the document and find the appropriate table. The load span tables take account the different Irish National Annexes and roof rafter design takes account of wind loads.

Fixings and holding down are not covered in S.R. 71 but attention is drawn to the need to check fixings especially for wind uplift on the roof. A major difference between designs to the Eurocodes and designs to the old permissible stress standards is the increased factor of safety for roof (wind) uplift.

S.R.71 assumes that timber is marked and does not apply to unmarked timber.

## I.S. 440:2009/A1:2014 Timber Frame Construction, Dwellings and Other Buildings

This standard refers to the Eurocodes for structural design including fire design. The standard also covers responsibilities, materials, manufacture, construction details and site work. Revision of the standard commenced in 2015 and should address the Construction Products Regulation for different products used in timber frame. The section on responsibilities will be updated to reflect the new certification requirements set out in SI 9:2014.

Work on a European standard on the manufacture of timber frame panels (FprEN 14732) had been undertaken, however it has proven difficult to get agreement on the standard and it is unlikely to be published in the near future.

## EN 336:2013 Structural timber – Sizes, permitted deviations

EN 336 refers to tolerances on the target sizes of structural timber and gives two tolerance classes, 1 and 2.

Target sizes are the sizes for which the tolerance would ideally be zero; therefore the average size of a timber member should be the target size. No dimension should be outside the specified target size plus tolerance.

The reference moisture content for measuring timber dimensions is 20% and the standard gives a method for relating dimensions to different moisture contents.

**Table 1: Tolerances for the two classes are as below**

Timber dimension	Tolerance Class 1	Tolerance Class 2
≤100mm	-1.0/+3.0mm	-1.0/+1.0mm
>100mm ≤300mm	-2.0/+4.0mm	-1.5/+1.5mm
>300mm	-3.0/+5.0mm	-2.0/+2.0mm

Tolerance class 1 is usually appropriate to sawn timber while tolerance class 2 is usually associated with factory produced components such as roof trusses and timber frame.

## Specifying timber

An example of specifying solid timber is listed in Table 2.

Unmarked structural timber should only appear on the Irish market if the timber has been visually graded to a standard of a member state that permits package marking and if the timber has a DoP and has been CE marked. With unmarked timber, the information that usually appears on the timber should appear on the package, normally on a label attached to the package. The label is an important link between the timber and accompanying documentation.

**Table 2: Example of specifying solid timber**

Specification clause	Comment
Target size 44 x 175	The target size is tied into the tolerance class
Tolerance class TC2	TC2 tolerances are -1/+1mm on the 44mm width and -1.5/+1.5mm on the 175 mm depth
Minimum strength class C16	Higher strength classes can be used but not lower. C14 can be specified but is usually not used for timber frame or roof trusses
Timber to be dry graded to I.S. EN 14081-1	The timber will have to be checked for warp etc. even if machine graded
Timber sections to be individually marked in accordance with Method A of Clause 7 of EN 14081-1	This requires marking to appear on each timber section. Inclusion of marking in the specification is an attempt to exclude unmarked timber
Marks on the timber shall be clear, legible and indelible	Although this is a requirement of the standards, it is given an emphasis here
DoP and CE marking to accompany all timber. Timber without a DoP and CE marking will not be accepted for use on site	A DoP can be generic and placed on a website; a paper copy has to be specifically requested. The CE mark should be supplied with the timber in accompanying documentation.

The accompanying documentation is very important for all timber, marked or unmarked and the CE mark is part of the accompanying information.

Sections 7.2 and 7.3 of I.S. EN 14081-1:2016 require an identification code linking the timber with the accompanying documentation and this code is important as it is the only direct link between the accompanying documentation and the timber. If the identification code is not on the timber then it must be on the label attached to the package or on the package in some other way. The chain of care of these documents is therefore important to ensure that they apply to the delivered timber. A work specification could state that each length of timber should be marked in accordance with Method A of I.S. EN 14081-1 (as outlined above) and this would help to ensure a link between the timber and documentation. Each piece of machine graded timber is required to be individually marked by Method A of I.S. EN 14081-1 and therefore the identification code should appear on the timber.

All construction products where there is a harmonised standard should have a DoP and be CE marked and a works specification should have a general requirement to this effect. If a designer is required to check that a product has the appropriate certification and is suitable for their end use then the DoP and the CE mark should be carefully reviewed. The DoP and CE mark do not necessarily cover the specific end use that the construction product might be used for.

## Site Fixings

When purchasing fixings a builder will need to check that their DoP (i.e. the declared essential characteristics) matches the minimum required by design. Alternatively the designer will need to know what fixings that are going to be used and this would generally be known in the case

of the manufacture of timber frame panels but not necessarily for any site work. Ensuring that site fixings match those required by design might prove problematic and the purchase of fixings will have to be undertaken with great care.

The DoP is often based on test results which might refer to a specific timber strength class; there is a need to ensure that the DoP matches the design requirements and the declared performances may need to be adjusted for the specific strength class and end use.

## Characteristic design values

The characteristic design values for solid timber are usually taken from EN 338; this standard has a number of strength class systems including the common 'C' class system.

Characteristic design values for sheathing and board materials can be taken from EN 12369 parts 1 to 3.

Characteristic design values for glulam can be taken from EN 14080:2013.

A manufacturer can provide design values (through the DoP and CE mark) for a specific timber product; the requirements for this are specified in EN 14081-1 and relate to testing of the timber/product to determine its strength properties.

## Structural fire design

I.S. EN 1995-1-2 should be used for structural fire design. Fire resistance requirements are still largely set out in Technical Guidance Document B (Fire Safety); the calculation of fire resistance is largely rooted in fire test performances and the Eurocodes refer to fire tests carried out to the EN 1364 series for non-load bearing elements and to the EN 1365 series for load bearing elements. These tests are slightly different to the BS 476 tests which were used in Ireland prior to the introduction of the Eurocodes. BS 476 information and tests should not be used for designs to EN 1995-1-1/2.

The approach to fire design in the Eurocode is similar to that used in BS 5268 Part 4 (now withdrawn) and relies on the charring rate of timber. The design loads are better defined in the Eurocode and the whole approach is probably more logical. The fire resistance of a floor or wall element is calculated from the contributions of each material used; plasterboard, flooring and insulation can contribute to the fire resistance of the timber and the overall element; again this is similar to the BS 5268 approach.

The contribution of linings such as plasterboard is often a major contribution to the fire resistance of a floor or wall

element. In taking such linings into account there is often an advantage to use the technical information supplied by the lining manufacturer. However, it is important to make sure that any information refers to tests to the appropriate EN rather than for example BS 476.

The term 'surface spread of flame' has been replaced by 'reaction to fire'; a similar concept of classifying the fire spread across the surface of a wall or ceiling. Technical Guidance Document B specifies the performance requirements but it should not be assumed that there is a direct relationship between the performance levels relating to surface spread of flame and reaction to fire.

I.S. 440 has specific construction details appropriate to fire safety. Fire resistance and reaction to fire are based on the European standards.

## Roof trusses

Roof trusses fall under the harmonised standard EN 14250 and are required to have a DoP and to be CE marked. The standard requires that the mechanical resistance be declared according to four possible methods. The method most common in Ireland is Method 3b where the manufacturer both fabricates and designs the truss. It is the opinion of WTI that roof trusses can only carry the CE mark when the design of the roof truss is to Eurocode 5 (I.S.EN 1995-1-1).

EN 14250 specifies a considerable amount of information to accompany roof trusses such as drawings, instructions, bracing, the design codes used for design (i.e. I.S. EN 1995-1-1) and calculation results (presumably a set of calculations or a summary of the calculations) amongst others.

The DoP may not specify the design code used and it is advisable to check that the trusses have been designed to the correct code and not to the withdrawn standards used before the introduction of the Eurocodes. See also the comments on S.R. 70 above.

## Timber Durability

Timber should have a natural durability or be treated with a preservative appropriate to their end use and/or the Use Class listed in the building specification. EN 335 parts 1 and 2 gives information on Use Classes while BS 8417 gives further advice on specific components and Use Classes using Service Factors.

BS 8417 also gives information on the recommended treatment of timber based on Use Classes. Further advice on preservative treatment can also be obtained from the Wood Protection Association (WPA).

EN 350 gives information on the natural durability of a range of timber species and their origin. The classification system of natural durability is based on heartwood in ground contact. However, unless information is available to the contrary, it is recommended that softwood timber should be considered to have a durability class of 5 (not durable in relation to fungi attack).

EN 15228 requires that specific information be provided with the treated timber; any treatment certificate should contain this information. Linking a treatment certificate to a specific batch of timber may prove difficult unless appropriate Factory Production Control systems are in place with the timber provider and timber treater. Basic information on durability and preservative treatment should be provided in the DoP and CE mark.

## General

I.S. EN 1995-1-1 is being revised and it is expected that there will be substantial changes to the standard when the revision is completed around 2020.

I.S. 440 is currently under revision and should be completed in 2017 or 2018,

Most standards are expected to be revised roughly every 5 years, therefore it is important to check a standard for any revisions or amendments.

The level of certification required in Ireland is high and the DoP and CE mark may assume a greater importance than in other jurisdictions.

Technical Guidance Document B (Fire Safety) is to be divided into two parts; volume 2 will deal with single family homes and should be published shortly; volume 1 dealing with other buildings should be published later, perhaps in 2017 or in 2018.

*This information sheet is for general guidance only and is based on information available at the time of writing; users should ensure that it is relevant to their specific circumstance. It may be advisable in certain cases to engage professional advice. While every effort has been made to ensure the information provided is accurate, WTI or the Department of Agriculture, Food and the Marine do not accept any responsibility or liability for errors of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information. Standards, regulations and information are subject to changes which may not be reflected in this information sheet.*