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SIST EN 350-1:1995
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Trajnost lesa in lesnih izdelkov - Preskušanje in razvrstitev trajnosti lesa in lesnih izdelkov proti biološkim agensom

Durability of wood and wood-based products - Testing and classification of the durability to biological agents of wood and wood-based materials

Dauerhaftigkeit von Holz und Holzprodukten - Prüfung und Klassifikation der Dauerhaftigkeit von Holz und Holzprodukten gegen biologischen Angriff

Durabilité du bois et des matériaux dérivés du bois - Méthodes d'essai et de classification de la durabilité vis-à-vis des agents biologiques du bois et des matériaux dérivés du bois

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Durability of wood and wood-based products - Testing and classification of the durability to biological agents of wood and wood-based materials

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (EN 350:2016) has been prepared by Technical Committee CEN/TC 38 "Durability of wood and wood-based products", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2017, and conflicting national standards shall be withdrawn at the latest by February 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 350-1:1994 and EN 350-2:1994.

Wood durability is an important factor that influences the service life of a wood product. This standard provides input to service life prediction of wood and wood-based products. It's intended to give guidance on using wood products appropriate for different end-uses avoiding excessive requirements. It also ranks durability against wood-decay organisms of various wood species thereby allowing species of appropriate durability to be selected for a particular use. It will however be emphasized that the biological durability rating of wood species given in Annex B cannot be regarded as any guarantee of performance in service.

There are many other factors influencing service life of a wood product, such as the principles of good design, use conditions, climate, maintenance which should be taken into consideration.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard gives guidance on methods for determining and classifying the durability of wood and wood-based materials against biological wood-destroying agents.

The methods can be applied either to individual wood species, batches of wood and processed wood-based materials, including heat-treated, preservative-treated wood and modified wood. However, this standard is not intended to replace testing of the efficacy of biocides.

The wood-destroying agents considered in this standard are:

— wood-decay fungi (basidiomycete and soft-rot fungi);

— beetles capable of attacking dry wood;

— termites;

— marine organisms capable of attacking wood in service.

Data on the biological durability of selected wood species considered of economic importance in European countries are presented in Annex B (informative), which also provides information relating to their geographical origin, density, sapwood width and treatability.

NOTE Treatability, durability to disfiguring fungi, permeability to water and performance in use of wood and wood-based materials are also important issues. However, because standardized methods aiming to assess and classify these factors do not exist and/or have not been extensively experienced yet, preliminary guidance is given in Annex C (informative) for the classification of wood treatability with aqueous wood preservatives, Annex D (informative) for the classification of the permeability to water, Annex E (informative) for the durability to disfiguring fungi, and Annex F (informative) for the classification of performance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 20-1, *Wood preservatives - Determination of the protective effectiveness against Lyctus Brunneus (Stephens) - Part 1: Application by surface treatment (laboratory method)*

EN 46–1, *Wood preservatives - Determination of the preventive action against recently hatched larvae of Hylotrupes bajulus (Linnaeus) - Part 1: Application by surface treatment (laboratory method)*

EN 49-1, *Wood preservatives - Determination of the protective effectiveness against Anobium punctatum (De Geer) by egg-laying and larval survival - Part 1: Application by surface treatment (Laboratory method)*

EN 117, *Wood preservatives - Determination of toxic values against Reticulitermes species (European termites) (Laboratory method)*

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

EN 275, *Wood preservatives - Determination of the protective effectiveness against marine borers*

ENV 12038, *Durability of wood and wood-based products - Wood-based panels - Method of test for determining the resistance against wood-destroying basidiomycetes*

EN 13556, *Round and sawn timber - Nomenclature of timbers used in Europe*

CEN/TS 15083-1, *Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 1: Basidiomycetes*

CEN/TS 15083-2, *Durability of wood and wood-based products - Determination of the natural durability of solid wood against wood-destroying fungi, test methods - Part 2: Soft rotting micro-fungi*

EN 16449, *Wood and wood-based products - Calculation of the biogenic carbon content of wood and conversion to carbon dioxide*

ISO 13061-2, *Physical and mechanical properties of wood — Test methods for small clear wood specimens — Part 2: Determination of density for physical and mechanical tests*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
wood species
trade name according to EN 13556 which can on occasion include more than one botanical tree species

Note 1 to entry: E.g. European oak which comprises both *Quercus robur* and *Q. petraea.*

3.2
pilot name for a wood species
result of a consensual choice due to practical considerations retaining the usual name under which the wood is the most widely commercialised, adopted either by the main exporting country or by the main importing country

Note 1 to entry: Pilot names are established since 1954 in the nomenclature of the ATIBT.

3.3
set
clearly identifiable collection of units of wood or wood-based products, originating from a commercial supply of a defined origin (single or not) and likely comprising only some of the variability of the wood species or of the wood-based material

Note 1 to entry: E.g. wood species sourced from a restricted geographical area.

3.4
wood-based material
any processed matrix containing and/or made of a specific percentage of wood

Note 1 to entry: Wood-based materials are those derived from trees and include amongst others heat-treated wood and any other material modified by chemical, physico-chemical or physical process, glue-laminated wood, wood-based panels, wood polymer composites and treated with wood preservatives. This standard is not meant to test all ligno-cellulosic materials (e.g. bamboo, reed, straw, flax) as such and would require methodological adaptions to do so.

3.5
modified wood
wood that undergoes the action of a chemical, biological or physical agent, resulting in a permanent desired property enhancement

Note1 to entry: If the modification is intended for improved resistance to biological attack, then the mode of action is assumed to be non-biocidal.

3.6
durability to biological agents
inherent resistance of a wood species or a wood-based material against wood decay organisms

Note 1 to entry: This inherent resistance is due to the presence of natural components that can exhibit different levels of toxicity towards biological organisms and/or to anatomical particularities or a specific constitution of certain wood-based materials.

3.7
sapwood
outer zone of wood that, in the growing tree, contains living cells and conducts sap

Note 1 to entry: Depending on the species, age of the tree and the growing conditions the proportions of sapwood and heartwood can vary.

Note 2 to entry: Frequently paler than heartwood though not always distinguishable from heartwood in some wood species.

Note 3 to entry: Sapwood of all wood species is considered to be non-resistant against decay fungi unless other data are available. Sapwood can have different levels of resistance against wood boring insects (excluding termites).

3.8
heartwood
inner zone of wood that, in the growing tree, has ceased to contain living cells or to conduct sap

Note 1 to entry: Frequently darker than sapwood though not always distinguishable from sapwood in some wood species.

3.9
transition wood
wood in a zone between the sapwood and the heartwood

Note 1 to entry: The transition wood can be regarded as a region of the heartwood that has not fully matured. This is only distinguishable in very few wood species. In general, its biological durability, treatability and permeability to water is intermediate between that of sapwood and heartwood.

3.10
juvenile wood
set of few growth rings of woody tissue nearest the centre of the tree, often having abnormal properties

Note 1 to entry: Juvenile wood is a zone near to the pith, displaying marked ring to ring changes in its properties. There is no clear consensus as to where this zone ends. It is generally thought to end at 10 to 20 rings from the pith, but it depends on the wood species.

Note 2 to entry: The durability, permeability to water and treatability of juvenile wood can be different from that of mature heartwood.

3.11
permeability to water
ease with which water penetrates a wood-based matrix (wood of a particular species, wood-based material) and is released by evaporation

3.12
performance
ability of a wood species or a wood-based material to withstand deterioration over time

4 Sampling of wood and wood-based materials to be tested

4.1 Testing wood species

4.1.1 General

The origin of test specimens and the number of replicates is of great importance for the reliability of the test results.

The reliability of conclusions relating to the durability of a wood species increases with the number and diversity of growing sites from which trees are taken and the number of replicates from those trees. The recommendations given in 4.1.2 to 4.1.3 shall be regarded as minima.

NOTE Background information on sampling can be found in ISO 2859-2 and ISO 3129.

4.1.2 Sampling logs

A log shall be taken from at least 3 trees of the species under test, originating from 3 different sites representative of the diversity of the geographical regions or sites where the tree species grows. Samples should be taken from at least 5 planks, originating from at least 3 trees when only sawn wood is available (see Annex A).

If high between-tree variation is expected (e.g. different botanic species), it's recommended to test a larger number of trees (e.g. 5 – 10).

NOTE 1 It can be useful to test in parallel material derived from wood species with known durability.

Each log shall be of sufficient size to permit the required number of test specimens to be obtained from it.

Each log shall be taken from the main trunk avoiding its extreme ends. Knots and other features which can influence durability shall be avoided.

Sampling shall consider sapwood, heartwood and juvenile wood separately. While testing heartwood, the region within at least 3 cm of the pith shall be excluded in order to avoid juvenile wood, which is often less resistant than the mature heartwood. For heartwood sampling, both the inner (closest to the pith) and the outer (closest to the sapwood and thus including transition wood) parts of the heartwood shall be incorporated.

NOTE 2 For some species, in order to better assess the variability, there can be a need to sample the transition wood and juvenile wood separately.

For logs of large diameter, a larger number of samples shall be taken from the outer part (outer third of the heartwood radius which is closest to the sapwood).

For each part of the wood (heartwood, transition wood, sapwood, juvenile wood) to be tested, at least 30 test specimens shall be taken for each test variable (for example "test method" or "test organism"). A minimum of 6 specimens shall be taken from each log.

Depending on the selected test method, additional specimens might be required to determine the density of the wood species and the moisture content of the specimens. The sampling shall be done according to the relevant standards (ISO 13061-2 for density and ISO 13061-1 for moisture content).

NOTE 3 A scheme of a suitable preparation and distribution of the specimens for testing is showed in Annex A.

4.1.3 Sampling sawn timber

Wood placed on the market is mostly available as sawn timber and hence it is difficult to identify pieces originating from specific trees. For this reason, it is preferred to sample as many pieces as possible so as to better estimate the overall durability. A minimum of 30 pieces originating from minimum 5 batches and providing 1 specimen per piece is required. The general considerations described in 4.1.2 related to sampling also apply for sawn wood.

4.2 Testing of sets of wood

Since timbers are mostly presented on the market as commercial supplies there is a need to assess their durability. A maximum of wood pieces shall be used for the realization of the test specimens (e.g. 2 replicate test specimens from each of 20 pieces are preferred to 10 specimens from each of 4 pieces). To give a good indication on the variability of the tested set of wood, it is recommended to test at least 30 specimens per variable (for example “test method” or “test organism”).

4.3 Testing of wood-based materials

The sampling should take into account the variability of the wood-based material to be tested.

For each variation in processing parameter (e.g. a change in temperature, particle size, wood species), a minimum of 30 specimens is required, derived from at least 3 produced items (e.g. boards) sampled at random from 3 different batches. A minimum of 5 specimens from each batch should be tested.

If the material contains both sapwood and heartwood, care has to be taken that both sapwood and heartwood are used to produce the test specimens.

5 General principles for testing and classification

5.1 General principles for testing wood specimens

When testing a wood species, an identification of the tree or the wood species shall be done. Wood species shall be specified according to EN 13556.

In order to get a homogeneous set of samples in terms of moisture content, the test specimens shall be conditioned prior to testing in a ventilated conditioning chamber at controlled temperature and relative humidity, until their weight and moisture content are stabilized.

The sample selection requirement for reference specimens shall follow the instructions of the relevant test method. If several wood species are tested at the same time, one set of reference specimens is sufficient.

Test timber used to determine the durability of a wood species should not be oven-dried at temperatures above 60 °C prior to the test.

If laboratory test vessels are used, reference specimens and test specimens shall be tested in separate vessels.

EN 73 or EN 84 are ageing procedures which might be required prior to biological testing.

The properties of the test specimen shall, as far as possible, be representative for the wood species being tested even if this does not follow the instruction given on sample selection in the relevant test

standard. However, the results still cannot be expected to take into account the full range of variation of properties within a species.

EXAMPLE 1: If the test method excludes the use of "wood of resinous appearance", but the species to be tested normally has a naturally resinous appearance, this exclusion is ignored.

EXAMPLE 2: If the test method requires a certain number of growth rings per centimetre, this restriction is ignored if growth rings do not exist or are too widely spaced. This is of importance for some tropical timbers, because it is sometimes impossible to see the growth rings; the rings can also correspond not to the annual growth but to the alternation of dry and wet seasons.

5.2 General principles for the classification of durability

The durability of a wood species or a wood-based material to various wood destroying organisms is tested using methods described in relevant European Standards. The use of replicate specimens is a requirement in all test methods.

For wood species, durability classes refer only to heartwood. Sapwood is always regarded as not durable, unless test data provide different information.

Based on test results, the durability of a wood species or a wood-based material to the various wood-destroying organisms is classified within:

— a five grade scale for decay basidiomycete fungi and soft rotting micro-fungi

Table 1 — Durability classes (DC) of wood and wood-based materials to attack by decay fungi

Durability class	Description
DC 1	Very durable
DC 2	Durable
DC 3	Moderately durable
DC 4	Slightly durable
DC 5	Not durable

NOTE 1 This five-grade scale was initially designed in order to inform on the expected levels of performance of wood when used in contact with ground (service conditions as described for use class 4 in EN 335). Most of the data on biological durability against fungi, reported in Annex B, are derived from field tests, mainly performed according to the EN 252 standard. In other use classes, the service conditions can result in wood performance which differs from that implied by this classification.

— a two grade scale for beetles (*Hylotrupes bajulus*, *Anobium punctatum*, *Lyctus brunneus* and *Trichoferus holosericeus* Rossi (= *Trichoferus holosericeus cinereus*)

Table 2 — Durability classes (DC) of wood and wood-based materials to attack by wood-boring beetles

Durability class	Description
DC D	Durable
DC S	Not durable

Durability to *Hylotrupes bajulus* is only given for softwoods (see Annex B, Table B.1) as hardwoods are not attacked.

Durability to *Lyctus brunneus* is not mentioned in the list (see Annex B, Tables B.2 and B.3) as only the wood of starch-containing hardwood species with pores of suitable width is susceptible. For species with highly susceptible sapwood a specific note appears in the 'Remarks' column. Softwoods are not attacked.

Durability to *Trichoferus holosericeus*, which only attacks hardwoods in Southern Europe, is mentioned in the 'Remarks' column if a wood species is known as highly susceptible.

NOTE 2 The classification of a wood species or wood-based material as 'not durable' does not necessarily indicate that different products made with this material will be equally destroyed during their life in service. Susceptibility to insect attack may change over time through chemical changes in extractives, such as the fate of starch, which is the main source of food. Additionally, susceptibility of any commodity to biological attack may be influenced by other factors, such as its moisture content, design, maintenance and presence of surface coatings.

— a three-grades scale for termites

Table 3 — Durability classes (DC) of wood and wood-based materials to attack by termites

Durability class	Description
DC D	Durable
DC M	Moderately durable
DC S	Not durable

— a three-grades scale for marine organisms (or marine borers)

Table 4 — Durability classes (DC) of wood to attack by marine organisms

Durability class	Description
DC D	Durable
DC M	Moderately durable
DC S	Not durable

6 Test methods and classification system

NOTE Annex G provides a template form presenting the information which is required for adding new data to the standard.

6.1 Durability to wood-destroying fungi

6.1.1 General

Durability to a well-defined set of wood-destroying fungi can be assessed by performing laboratory tests (6.1.2.l and 6.1.2.2).

NOTE Field tests allow determining the durability of a wood species or a wood-based material in different end-uses (above-ground, in-ground) and expose it to a wider range of wood colonising and destroying organisms and long term conditioning through exposure to weather. Laboratory tests are more specific as they are performed under fully controlled conditions.

6.1.2 Testing durability against basidiomycete and soft-rot fungi

6.1.2.1 For solid wood and solid wood-based material

Durability against wood decay fungi based on a laboratory test shall be determined using CEN/TS 15083-1 for basidiomycetes and CEN/TS 15083-2 for soft rotting micro fungi.

The criteria for determining durability classes (DC), based on the CEN/TS 15083-1 are presented in Table 5.

Table 5 — Durability classes (DC) of wood to fungal attack (basidiomycete fungi)

Durability class	Description	Percentage mass loss (ML)
DC 1	Very durable	ML ≤ 5
DC 2	Durable	5 < ML ≤ 10
DC 3	Moderately durable	10 < ML ≤ 15
DC 4	Slightly durable	15 < ML ≤ 30
DC 5	Not durable	30 < ML
ML = highest of the median mass losses (in %) determined for test specimens exposed to each of the used test fungi		

The criteria for determining durability classes (DC), based on the CEN/TS 15083-2 are presented in Table 6. In this test, preliminary DC is based on the median of the mass loss for hardwoods or the MOE (apparent modulus of elasticity measured in 3 point bending according to EN 317) for softwoods.

Table 6 — Durability classes (DC) of wood to fungal attack (soft rot)

Durability class	Description	x value
DC 1	Very durable	x ≤ 0,10
DC 2	Durable	0,10 < x ≤ 0,20
DC 3	Moderately durable	0,20 < x ≤ 0,45
DC 4	Slightly durable	0,45 < x ≤ 0,80
DC 5	Not durable	x > 0,80
Hardwoods: x = median value of mass loss for timber test specimens / median value of mass loss for reference timber test specimens Softwoods: Calculate the "x value" for the test timber but using loss of MOE.		

Wood species known to be not durable should be used to test the virulence of fungi. Commonly, *Pinus sylvestris* sapwood is used for testing softwoods and *Fagus sylvatica* for testing hardwoods.

The validity criteria of the test are given in the corresponding test method.

The durability classification is based on the highest median mass loss determined for all the test specimens exposed to each of the test fungi.

Additional information about the spread of individual mass loss values should be provided. If individual mass loss values are distributed over two durability classes (x and y) with at least 40 % of values being in each of them, the retained durability class should not be based on the median mass loss but expressed as falling between "x – y ". High levels of variability should be clearly mentioned in the test report, e.g. by "v" as in the example presented in Table 7.

The spread of individual values can be expressed in test reports based on fitted probability density functions, as presented in Table 7.

Table 7 — Example of distribution of classes of mass loss values of the tested material in different durability classes based on fitted probability density functions

Wood species	Median mass loss (%)	% DC1	% DC2	% DC3	% DC4	% DC5	Durability class
A	2,2	83,0	15,6	1,3	0,1	0,0	1
B	7,3	27,2	46,4	21,8	4,6	0,0	2v
C	8,9	23,5	33,2	23,7	19,0	0,6	2v
D	28,2	0,0	0,0	13,4	46,6	40,0	4–5
"v" indicates that the species exhibits an unusually high level of variability							

6.1.2.2 For wood-based material other than solid wood

The test procedure described in ENV 12038 applies to wood-based products panels and the classification shall be undertaken according to Tables 5 and 6.

NOTE 1 CEN/TS 1099 specifies this method for testing biological durability of plywood.

NOTE 2 EN 15534–1 specifies this method for testing biological durability of wood polymer composites.

6.1.2.3 Durability of wood and wood-based materials used in-ground

The EN 252 standard provides a method which is suitable for assessing the durability of wood and wood-based materials in direct contact with the ground (use class 4). At least 30 stakes of the test wood species or wood-based material shall be used in place of the impregnated test stakes described in this standard. Stakes of *Pinus sylvestris* sapwood and *Fagus sylvatica* shall be used as references to measure microbiological activity of the field soil throughout the test. They shall be replaced as necessary when they fail.

It is recommended to perform the test in more than one field site.

NOTE The field conditions can vary between different test sites and comparing the results can consequently be difficult.

In the absence of a specific standard providing a test method allowing the determination of durability classes, the average life of wooden stakes used in-ground can be expressed relative to the life of the reference stakes as given in Table 8.

Table 8 — Durability classes (DC) to fungal attack for wood used in-ground determined using field tests based on EN 252

Durability class (DC)	Description	Results of field tests expressed as x values
DC 1	Very durable	$x > 5,0$
DC 2	Durable	$3,0 < x \leq 5,0$
DC 3	Moderately durable	$2,0 < x \leq 3,0$
DC 4	Slightly durable	$1,2 < x \leq 2,0$
DC 5	Not durable	$x \leq 1,2$
x value = average life of stakes / average life of the more durable set of reference stakes		