
Training materials

Module D – Low carbon timber strategies for the regionalization of material flows and the implementation of Carbon Smart Communities

Sub-module D.2 – Requisites and properties of wood as a driver for LCT in construction sector

Contents of the presentation

- Wood properties and parameters
- Overview of timber requisites for construction sector
 - Standards for non structural applications
 - Standards for structural applications
- Other relevant standards for timber utilization
- Web resources

Premise

Wood is an extremely **variable and heterogeneous material**, both for its endogenous characteristics (wood species) and for other exogenous elements, in relation to its uses and the possible processing.

These characteristics of the material are reflected in the properties and typicality of the single assortment, increasing the **difficulties of standardization** in the design and installation process.

It is therefore necessary, for the professionals and for all the operators involved in the construction process with LCT, to **know the characteristics** of the wood and the **tools (including technical standards)** useful for the choice and use of the most correct material, semi-finished or finished product.

The properties of wood

HYGROSCOPICITY

The wood continues to constantly exchange moisture with the atmosphere, varying its size and physical-mechanical properties in relation to the humidity of the air, until it reaches a balance with it. While it is not sensitive to rapid changes in air humidity, wood is more sensitive to monthly and seasonal variations.

Degree and changes of humidity directly influence the risk of biological attacks and dimensional variation of the product, whose tendency also depends on the tree species

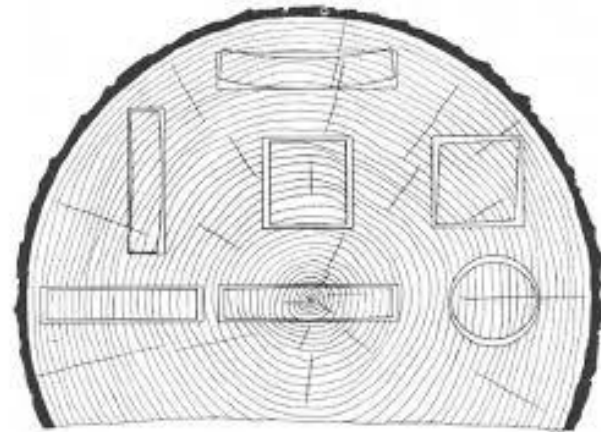
Class of service	Definition	Humidity of wood (average)
Class 1 – Indoor	T=20°, U>65%	< 12%
Class 2 - Outdoor (covered spaces)	T=20°, U>80%	12-20%
Class 3 - Outdoor	T and U > than the former	> 20%

Classes of service for wood (Eurocode 5)

The properties of wood

ANISOTROPY

The size of the dimensional variations of a wood assortment differs strongly in the three directions (longitudinal, transversal and tangential). A large roundwood or sawn log, drying, always tends to warp and crack. The extent of the deformation is greater the further you move away from the geometric axis of the trunk. The **dimensional stability** of the wood is defined as the ratio between the variations in the tangential direction and those in the radial direction.





The properties of wood

BIODEGRADABILITY and DURABILITY

Wood can be damaged by fungi and insects, which use the raw material for their nourishment. Knowing and preventing the **risk of biological attack** is certainly easier, as well as cheaper, than repairing damage.

To this end, the selection of the wood species is fundamental, as well as a correct design and maintenance of the product.

In some cases, depending on the natural durability of the tree species and the intended use for wood, it is necessary to use **preserving treatments** through the application of specific impregnating products.

Natural durability and potential of application of preservatives for the main tree species used for construction (EN 350-2)

Specie	Origine	Funghi da carie	Durabilità naturale					Impregnabilità	
			Insetti					a	d
			Hyl.	Hesp.	Anob.	Lyc.	Ter.		
Abete bianco	Europa	4	NR	R	NR	R	NR	2	2-3
Abete rosso	Europa	4	NR	R	NR	R	NR	3	3-4
Douglasia	Europa	3-4	NR	R	NR	R	NR	2-3	4
Larice	Europa	3-4	NR	R	NR	R	NR	2	4
Pino silvestre	Europa	3-4	NR	R	NR	R	NR	1	3-4
Castagno	Europa	2	R	NR	NR	NR	NR	2	4
Pioppo	Europa	5	R	NR	NR	R	NR	1	2
Querce	Europa	2-4	R	NR	NR	NR	NR	1	4

Legenda:

Durabilità naturale, funghi da carie	1=molto durabile; 2=durabile; 3=moderatamente durabile; 4=poco durabile; 5=non durabile
Durabilità naturale, insetti	R=resistente; MR=moderatamente resistente; NR=non resistente
Tipologie di insetti	Hyl. = Hylotrupes; Hesp. = Hesperophanes Anob. = Anobidae; Lyc. = Lyctus; Ter. = Termiti
Classi di impregnabilità	1=impregnabile; 2=moderatamente impregnabile; 3=poco impregnabile; 4=non impregnabile a=alburno; d=durame

The properties of wood

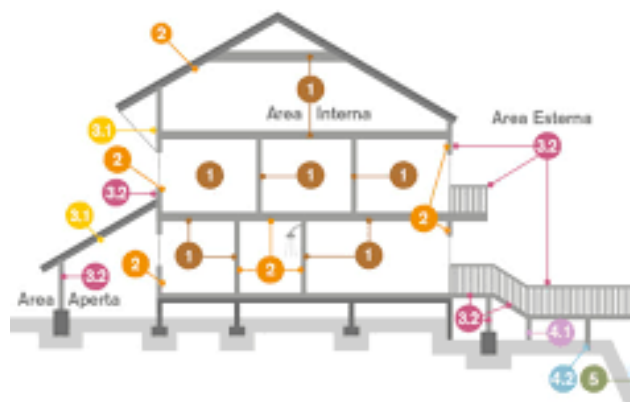
BIODEGRADABILITY and DURABILITY

The type of impregnation is dependent on the class of risk, strictly connected to the laying conditions of the wood.

5 classes of risks (1-5) are identified by EN 335 technical standard

Classe di impiego	Situazione generale di impiego
1	Fuori dal contatto con il terreno, al coperto (asciutto). U max < 20 %
2	Fuori dal contatto con il terreno, al coperto (rischio di inumidimento). U max occasionalmente > 20 %
3	Fuori dal contatto con il terreno, non riparato. U max frequentemente > 20 %
4	A contatto col terreno o con acqua dolce. U max sempre > 20 %
5	Come 4, In acqua di mare

Classi di rischio di attacco biologico secondo la normativa europea UNI EN 335-1



Source: www.amonncolor.com

The properties of wood

WOOD DEFECTS

Wood, being a natural material, can be affected by some **defects** that can reduce the **mechanical resistance** properties of the material. Defects are considered in the classification of the quality and possible destination of assortments.

Main possible defects:

- amplitude of the growth rings
- presence and type of nodes
- presence and position of the marrow
- inclination of the grain
- presence of cracks, pockets of resin



EN 1309-3 describes the methods to identify and quantify the defects, and is used, together with specific **quality standards for structural timber**, for the visual classification of assortments and the identification of the resistance of timber according to the **resistance classes of EN 338** both for deciduous and coniferous wood

The properties of wood

Classi di resistenza secondo EN 338, per legno di conifere e di pioppo

Valori di resistenza modulo elastico e massa volumica		C14	C16	C18	C20	C22	C24	C27	C30	C35	C40	C45	C50
Resistenze [MPa]													
flessione	$f_{m,k}$	14	16	18	20	22	24	27	30	35	40	45	50
trazione parallela alla fibratura	$f_{t0,k}$	8	10	11	12	13	14	16	18	21	24	27	30
trazione perpendicolare alla fibratura	$f_{t90,k}$	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
compressione parallela alla fibratura	$f_{c0,k}$	16	17	18	19	20	21	22	23	25	26	27	29
compressione perpendicolare alla fibratura	$f_{c90,k}$	2	2,2	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9	3,1	3,2
taglio	$f_{v,k}$	3	3,2	3,4	3,6	3,8	4	4	4	4	4	4	4
Modulo elastico [GPa]													
modulo elastico medio parallelo alle fibre	$E_{0,mean}$	7	8	9	9,5	10	11	11,5	12	13	14	15	16
modulo elastico caratteristico parallelo alle fibre	$E_{0,05}$	4,7	5,4	6	6,4	6,7	7,4	7,7	8	8,7	9,4	10	10,7
modulo elastico medio perpendicolare alle fibre	$E_{90,mean}$	0,23	0,27	0,3	0,32	0,33	0,37	0,38	0,4	0,43	0,47	0,5	0,53
modulo di taglio medio	G_{mean}	0,44	0,5	0,56	0,59	0,63	0,69	0,72	0,75	0,81	0,88	0,94	1
Massa volumica [kg/m³]													
massa volumica caratteristica	ρ_k	290	310	320	330	340	350	370	380	400	420	440	460
massa volumica media	ρ_m	350	370	380	390	410	420	450	460	480	500	520	550

Timber requisites for construction sector

Terms and definition: the EN 884 standard

EN 884 provides to all operators involved in timber processing and trading a common basis of terms and definitions. It is subdivided in 12 thematic sections.

Section	Topics
1	General common terminology related to roundwood and sawnwood
2	Specific terms and definition for roundwood
3	Specific terms and definition for sawnwood
4	Terminology related to humidity
5	Terms related to measurement and dimensions of roundwood
6	Terms related to measurement and dimensions of sawnwood
7	Terms related to the anatomical structure of the wood
8	Terms related to the characteristics of round wood
9	Terms related to the characteristics of sawn wood
10	Terms related to color changes and fungal attack
11	Terms related to insect degradation
12	Additional terms and general indications



Timber requisites for construction sector

Main quality standards and requirements for LCT assortments

	Coniferous	Deciduous
Roundwood	EN 1927	EN 1316 (oak, beech, poplar)
Sawnwood for non structural applications	EN 1611	EN 975 (oak, beech, poplar)
Sawnwood for structural applications	EN 14081	EN 14081

Timber requisites for construction sector

Classification of the structural timber according to the resistance (EN 14081-1)

Wood becomes **timber** when it is classified according to resistance. The classification according to the resistance is the selection process through which each single saw can be inserted into a class, giving it specific strength values.

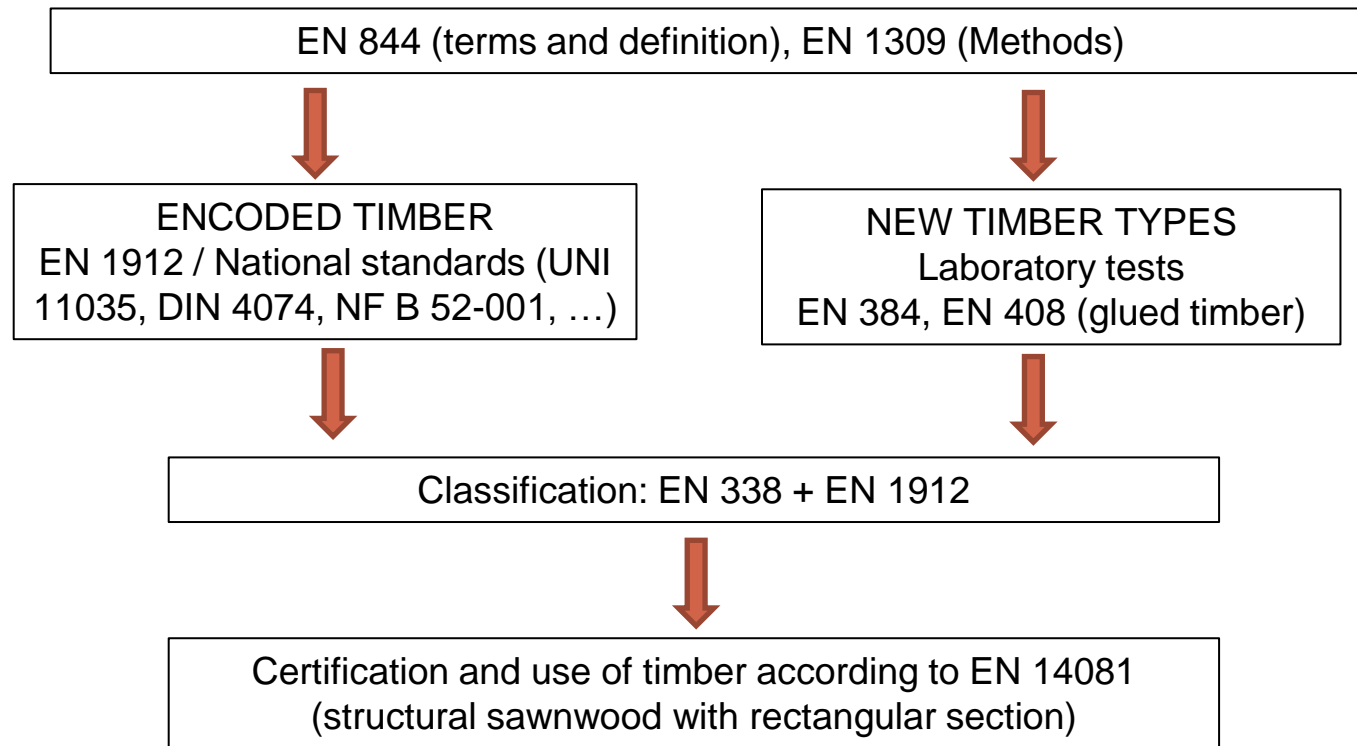
Actually, at EU level the harmonized standard is EN 14081-1, which refers to classification methods adopted at national level. Classification can be performed "on sight" or "by machine". In both cases, the aim is to assign to the single assortment a resistance class compared to those defined by the EN 338 standard.

At national level, specific technical standards are often applied for the visual classification of defects and the association to resistance classes which are specific for territorial contexts. These national standards are applicable for specific tree species and specific geographical origins. For example:

- DIN 4074 (Germany)
- UNI 11035-1/2 (Italy)
- NF B 52-001 (France)

Timber requisites for construction sector

Technical standards and process for classification of timber according to resistance



Timber requisites for construction sector




Technical standards for biological and climate protection of timber

When using timber, 5 main aspects must be considered to define necessities for protection:

1. The choice of the **tree species**: which are the «regionally» available tree species used? (see also EN 350-2 about natural durability)
2. What will be the final **position** (outdoor/indoor)?

Natural durability of tree species

3. Which is the required **dimensional stability** level?

	Application	Allowed dimensional deformation
	Windows and door frames	Minimal deformation allowed
	Outdoor applications where partial dimensional stability is required	Limited deformation allowed
	Outdoor applications where no dimensional stability is required	No limits to deformation

Timber requisites for construction sector

Technical standards for biological and climate protection of timber

4. What will be the **climatic solicitation** of timber?

The solicitation level of timber is determined by a combination of the constructive and climate situation (depending on orientation: N/S/E/W)

	Orientation N	Orientation E	Orientation S/W
Complete rain protection	LOW	LOW	MEDIUM
Partial rain protection	LOW	MEDIUM	HIGH
No rain protection	MEDIUM	HIGH	HIGH

Definition of the level of climate solicitation

Technical standards for biological and climate protection of timber

5. Is there any possibility of **biological attack** ?

Humidity conditions and solar lightning foster biological attack by **insects**, wood mushrooms and molds.

UV radiations are responsible of **wood graying**.

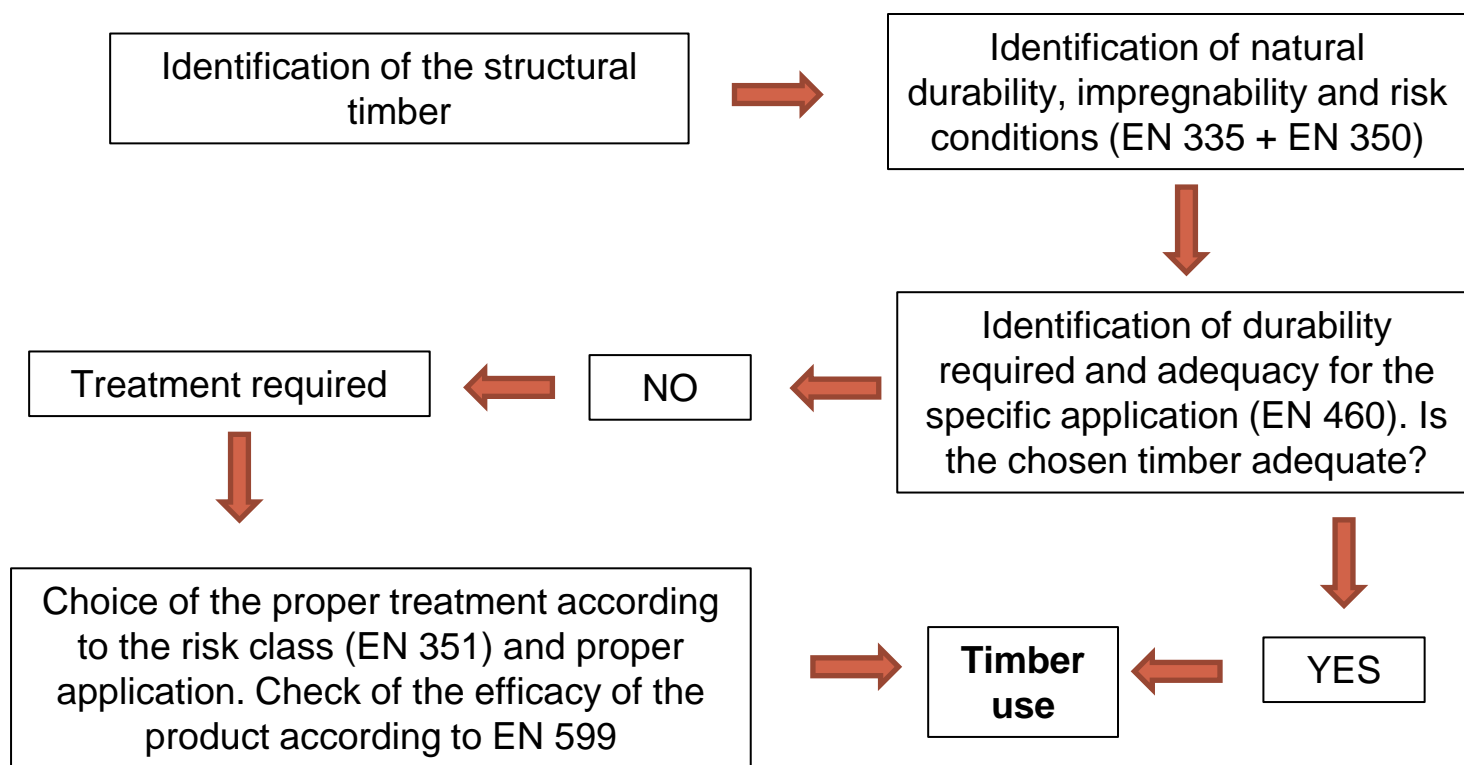
IR radiations foster **wood cracking** and resin leakage.

Humidity and steam are responsible of wood shrinkage and swelling.



Timber requisites for construction sector

Scheme of decision process for timber protection



Web resources

If you want to know more, the following resources are available:

- <https://www.iso.org/committee/54976/x/catalogue/>
(ISO Technical Committee for timber)
- <https://standards.cen.eu/dyn/www/f?p=204:105:0:.....>
(CEN, European Committee for Standardization – Timber Structures)
- <https://eurocodes.jrc.ec.europa.eu/showpage.php?id=135> (Eurocode 5 – Design of timber structures)