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WOOD DURABILITY BASED IN THE NEW BRAZILIAN TIMBER STRUCTURES CODE ABNT NBR 7190: 2022

Leandro Dussarrat Brito[1], Everaldo Pletz[2], Carlito Calil Junior[3].

ABSTRACT: The ABNT NBR 7190:1997 standard has recently undergone a revision process. Thus, this paper treats of the Chapter 12 wood durability of the standard revision project Brazilian, Design of Timber Structures code ABNT NBR 7190: 2022. Wood is an organic material and it must receive a prior analysis of the conditions in which it will be applied to identify the need for specific preservative treatment, seeking to obtain durability and resistance to wood biodeterioration agents, such as fungi, xylophagous insects and marine bores. Similar to Chapter 12 Wood durability of the ABNT NBR 7190: 2022 standard revision project, ABNT NBR 16143: 2013 complements regarding the wood preservation treatment, where it also establishes the system with six Use Categories for wood, with an emphasis on treatment preservative to increase the durability of construction systems. A very important aspect that must be considered is the elaboration of a project in which the durability is assured. Thus the purpose of the Use Categories System is to offer a simplified tool for decision making regarding the rational and intelligent use of wood, through a systemic approach to the producer and user, which ensures greater durability of constructions.

KEYWORDS: Brazilian Design of Timber Structures code, Timber structures, Wood durability.

1 INTRODUCTION

Wood is an organic material that can have biodeterioration.

To develop the design of a timber structure, it is necessary to ensure a minimum durability compatible with its purpose and with the investment to be made (ABNT NBR7190: 1997) [1].

Usually a good performance of the structural member is expected throughout its useful life. The key element to identify wood performance over time is durability (CALIL et al, 2006; CALIL JUNIOR & BRITO 2010) [2, 4].

Thus, durability is the capacity of a product to maintain its performance above pre-established minimum values in line with users under expected conditions of use (CALIL JUNIOR et al, 2006) [2].

2 BRIEF HISTORIC

The first Brazilian Code of Timber Structures was published in 1951 under the name of NB 11 - Design and Construction of Timber Structures [5], with a deterministic design method.

In February 1982 it was renamed ABNT NBR 7190:1982 without any modification.

As of 1992, a new study of this standard was started using the semi-probabilistic method of dimensioning in limit states.

As long as the research and scientific work evolved in the country, starting from the Technical Bulletin BT/PEF/9602/USP Fusco et al (1996)[6] updated the published standard revision project to version ABNT NBR 7190:1997 [1] with emphasis in the use of noble woods. In this version of the standard, topics on wood durability were introduced according to the Biodeterioration Risk Classes.

When developing the design of a timber structure, it is necessary to ensure a minimum durability compatible with its purpose and with the investment to be made.

The structural members of a timber construction can be exposed to different Risk Classes of biodeterioration depending of the biotic organisms present in the local and the environmental conditions that may favor the attack (FUSCO et al 1996)[6].

From the draft standard carried out by Fusco et al (1996) [6], Annex D of the ABNT NBR 7190: 1997 [1] was added, which is informative and deals with recommendations on the durability of wood.

In this Annex D of NBR 7190:1997 [1], five situations of Biodeterioration Risk Classes were presented to be considered in the design of timber structures (CALIL JUNIOR et al, 2003) [7].

Brazolin et al (2004) [8] proposed the elaboration of a standard of wood preservation to help producers and users of the civil construction sector to increase the durability of timber construction systems. In this work, a systematic approach was presented on the subject of biodeterioration and wood preservative treatment called the System of Risk Classes, which now has six situations of these classes (BRAZOLIN et al 2004) [8].

Calil Junior et al (2006) [2] presented six Risk Classes, when from Brito (2010) [3] it started to be called Use Classes. The term “risk” was replaced by “use” in order not to depreciate the use of wood.

[1]Leandro Dussarrat Brito, LaMEM/SET/EESC/USP University of São Paulo, Brazil, dussarrat@sc.usp.br
[2]Everaldo Pletz, Department of Structures, UEL State University of Londrina, Brazil, pletz@uel.br
[3]Carlito Calil Junior, LaMEM/SET/EESC/USP University of São Paulo, Brazil, calil@sc.usp.br

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In 2013, a new revision of NBR 7190 began, based on new research and work carried out by the CB-002 committee and in parallel with the revision project of this standard, ABNT NBR 16143:2013 Wood Preservation – Use Categories System [9] was prepared, when the term Use Categories was officially changed.
Thus, in the NBR 7190:2022 standard revision project, it now has the six Use Categories [10].
It is worth noting that the ABNT NBR 16143:2013 was prepared by the Brazilian Wood Committee (ABNT/CB-31), by the Wood Preservation Study Committee (CE-31: 000.15) [9].
While the revision of the ABNT NBR 7190-1:2022 standard was elaborated in the Brazilian Civil Construction Committee (ABNT/CB-002), by the Commission for the Study of Timber Structures (CE-002:126.010)[10].

3 WOOD DURABILITY

The Chapter 12 of the new version of the ABNT NBR 7190:2022 treat with the theme "Durability of wood".
Among the various materials intended for civil construction, wood has exceptional qualities that elect it, in many respects, especially under the criterion of sustainability, as a high-performance building material (ABNT NBR 7190:2022).
However, wood is an organic material and must receive prior analysis of the conditions in which it will be applied, in order to identify the need for specific preservative treatment, seeking to obtain the best result in terms of durability and resistance to biodeteriorating agents of wood, such as fungis, xylophagous insects and marine borers (NBR 7190:2022).
The structural classification provides a connection between the timber structural members and their expected performance when they come into service (CALIL JUNIOR. et al, 2003; CALIL JUNIOR et al, 2006; CALIL JUNIOR & BRITO, 2010; CALIL JUNIOR et al, 2015) [2, 4, 7, 11].
Usually, good performance is expected over the entire useful life of the structural member (CALIL JUNIOR. et al, 2003; CALIL JUNIOR et al, 2006; CALIL JUNIOR & BRITO, 2010; CALIL JUNIOR et al, 2015) [2, 4, 7, 11].
The key element for this prediction is its durability, defined as the ability of a product to maintain its performance above pre-established minimum values, on consonance with users, under the intended conditions of use (CALIL JUNIOR. et al, 2003; CALIL JUNIOR et al, 2006; CALIL JUNIOR & BRITO, 2010); (CALIL JUNIOR et al, 2015) [2, 4, 7, 11].
A large number of biotic agents and abiotic agents have the potential to reduce wood performance over time (CALIL JUNIOR. et al, 2003; CALIL JUNIOR et al, 2006; CALIL JUNIOR & BRITO, 2010; CALIL JUNIOR et al, 2015) [2, 4, 7, 11].
The structural designer, however, can guarantee durability using a combination of three factors [2, 4, 7, 11]:

- Better design detailing;
- Preservative treatment;
- Inspection, maintenance and repairs.

An important aspect is to always record the works carried out for later verifications (CALIL JUNIOR. et al, 2006) [2].

4 WOOD PRESERVATION – USE CATEGORIES SYSTEM

According to the ABNT NBR 7190: 2022 wood preservation is the set of preventive and curative recommendations adopted to control biological agents (fungi, xylophagous insects and marine bores), physical and chemical that affect the properties of wood, adopted in the development and maintenance of wood components in the built environment.
Initially proposed by Brazolin et al (2004) [8] as Risk Category System, currently the normative term of ABNT NBR 7190:2022 becomes Use Category System.
The purpose of the Use Categories System is to offer a simplified tool for decision making regarding the rational and intelligent use of wood, through a systemic approach to the producer and user, which ensures greater durability of constructions.
The creation of the set of use categories was based on the principle of valuing the project as the first and most important preventive tool to be used with the objective of obtaining a wooden construction endowed with durability.
The system consists of establishing six Use Categories based on the conditions of exposure or use of the wood, on the expected performance of the component and on the possible biodeteriorators agents present (ABNT NBR 16143: 2013; ABNT NBR 7190: 2022) [9, 10].
In the design of timber structures, the following use categories should be considered [9, 10]:

- **Use Category 1:** Inside buildings, out of contact with the soil, foundations or masonry, protected from weathering, internal sources of moisture and local free from access by subterranean termites or arboreal.

- **Use Category 2:** Interior of buildings, in contact with the masonry, without contact with the soil or foundations, protected from the weather and indoor sources of moisture.

- **Use Category 3:** Interior of buildings, out of contact with the soil and protected from the weather, which can, occasionally be exposed to sources of moisture.

- **Use Category 4:** Outside use, out of contact with the soil and subject to the weathering.

- **Use Category 5:** Contact with soil, fresh water and other situations favorable to deterioration, such as setting in concrete and masonry.

- **Use Category 6:** Exposure to salt water or brackish.

Thus, in the current Brazilian standard ABNT NBR 7190: 2022, depending on the service condition in which the wood of the structure will be exposed, each corresponding

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use category is susceptible to attack by biodeteriorating organisms, as listed [9, 10]:

- **Use Category 1:** drywood termite, wood borer beetle;
- **Use Category 2:** drywood termite; wood borer beetle; subterranean termite, arboreal termite;
- **Use Category 3:** drywood termite; wood borer beetle; subterranean termite; arboreal termite; mold fungis; stain fungis; decay fungis;
- **Use Category 4:** drywood termite; wood borer beetle; subterranean termite; arboreal termite; mold fungis; stain fungis; decay fungis;
- **Use Category 5:** drywood termite; wood borer beetle; subterranean termite; arboreal termite; mold fungis; stain fungis; decay fungis;
- **Use Category 6:** marine borers; mold fungis; stain fungis; decay fungis.

The figure 1 illustrates some examples of biodeterioration risk situations for each corresponding use category, taking a residence as an example.

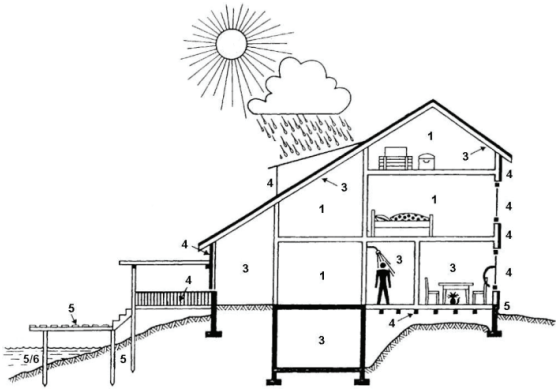
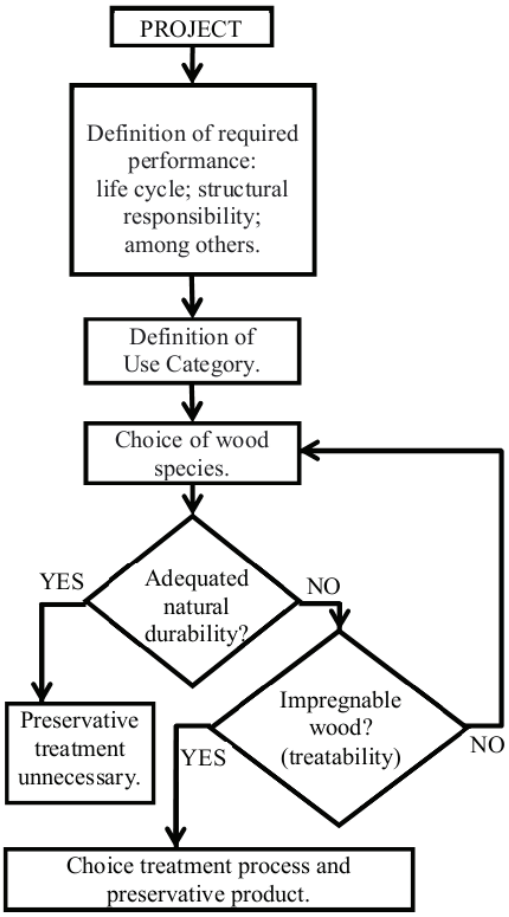


Figure 1: *Use Categories, depending on the situation of biodeterioration risk in a residence. Source: (BRITO (2010); CALIL & BRITO (2010); BRITO (2014)[3,4,12].*

Due to the chemical nature of the preservative products recommended for the treatment of wood, in the construction components of structures, which may be in direct contact with people or animals, it is recommended to use suitable finishes, such as "stains", varnishes and/or paints, to prevent migration and/or leaching of the preservative product. (CALIL JUNIOR. et al, 2006) [2].

5 APPLICATION OF THE USE CATEGORIES SYSTEM

The Use Category System defines recommendations that must be adopted during the design phase of a construction with wooden components, helping to choose the preservative treatment of wood - product and process (ABNT NBR 16143: 2013; ABNT NBR 7190: 2022) [9, 10]. This decision process is represented by the Flowchart 1 of the Figure 34 in ABNT NBR 7190: 2022 [10].



Flowchart 1: *Choice of treatment and wood species in the project. Fonte:* ***Figure 34 in ABNT NBR 7190:2022****.*

Thus, when using wood as an engineering material, the following steps must be considered mandatory (ABNT NBR 16143: 2013; ABNT NBR 7190: 2022) [9,10]:

a) Definition of the required performance level for the wooden component or structure, such as: useful life, structural responsibility and commercial and legal guarantees;

b) Evaluation of the biological risks to which the wood will be subjected during its useful life – attack by fungis, xylophagous insects and/or marine borers;

c) Definition of the wood species suitable for use and the need for preservative treatment considering: natural durability of the species, treatability, treatment process and available preservative products. The preservative

treatment is necessary if the chosen species is not naturally durable for the category of use considered and/or if the wood contains sapwood, a portion naturally susceptible to attack by xylophagous organisms;

d) Selection of the appropriate wood treatment process and preservative product.

6 USE CATEGORIES: TIMBER STRUCTURAL AND CONSTRUTIVE ELEMENTS

With a focus on preservative treatment to increase durability in the useful life of structural member and constructive wooden, ABNT NBR 16143:2013 Wood Preservation - Use Categories System [9] - complements the system of six use categories of the current version of ABNT NBR 7190: 2022 Projects of Wooden Structures [10].
Tables 1 to 4 list the possible applications of lumber wood, roundwood, glulam, and wood panels as engineering material, with the six use categories of probable, according to ABNT NBR 16143: 2013 [9].

Table 1: *Lumber wood. Fontes: BRASOLIN et. al (2004); ABNT NBR 16143:2013;* ***[8, 9]****.*

Application	**Probable Use Category**
Floor	2 e 3
Doors and Windows	2, 3 e 4
Floor beam	2 e 3
Door Jambs	2, 3, 4 e 5
Reel	1, 2, 3 e 4
Fences	4 e 5
Columns	2, 3, 4, 5 e 6
Handrail	2, 3 e 4
Crossarm	4
Bridge defense	5 e 6
Deck planks	3 e 4
Railway sleeper	5
Reusable wooden based packaging	1, 2, 3 e 4
Stairs	2, 3, 4 e 5
Piles	5
Roof structure	2, 3 e 4
Ceiling	2 e 3
Foundation	5 e 6
Railing	2, 3 e 4
Kerb	4 e 5
Door trim	2, 3 e 4
Window	1, 2, 3 e 4
Wainscoting	2 e 3
Strut	2 e 3
Furnitures	1, 2, 3 e 4
Ornaments	2, 3 e 4
Pergola	4 e 5
Playground	4 e 5
Bridge/ Footbridge	4, 5 e 6
Door	1,2 e 3
Wall	2, 3 e 4
Baseboard	2, 3 e 4
Window sill	2, 3 e 4
Fascia	4
Tiles shingles	4
Cooling tower	5
Beam	2, 3 e 4
Baldrame beam	5

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Table 2: *Roundwood. Fontes: BRASOLIN et. al (2004); ABNT NBR 16143:2013;* [8, 9].

Application	Probable Use Category
Fences	4 e 5
Columns	2, 3, 4 e 5
Crossarm	4
Bridge defense	5 e 6
Railway sleeper	5
Roof structure	2, 3 e 4
Foundation	5 e 6
Kerb	4 e 5
Fence posts	5
Furniture	1, 2, 3, 4 e 5
Playground	4 e 5
Bridge/ Footbridge	4, 5 e 6
Post (energy and telephony)	5
Wooden board bridge	4

Table 3: *Glulam. Fontes: BRASOLIN et. al (2004); ABNT NBR 16143:2013;* [8, 9].

Application	Probable Use Category
Arch	2, 3 e 5
Columns	2, 3, 4, 5 e 6
Bridge/ Footbridge	4, 5 e 6
Post (energy and telephony)	5
Beam	2, 3 e 4

Table 4: *Wood panels. Fontes: BRASOLIN et. al (2004); ABNT NBR 16143:2013;* [8, 9].

Application	Probable Use Category
Floor	2, 3, 4 e 5
Packaging (non-disposable)	1, 2, 3, e 4
Furnitures	1, 2, 3 e 4
Wall	2, 3 e 4
Tiles shingles	4
Roof (undercover)	2 e 3
Plywood box beam	2, 3 e 4

7 CONCLUSIONS

The Use Categories System defines the indications that must be taken in the design phase of a construction with wooden elements, thus helping to choose the most appropriate treatment for wood preservation.

Once the Use Categories are defined at the design step, the structural designer resorts to the ABNT NBR 16143:2013 standard and defines which will be the most appropriate preservative treatment to be used for each timber structural members.

The Annex D (informative) of ABNT NBR 7190:1997 dealt with recommendations on the durability of wood.

In the revised version of the ABNT NBR 7190:2022 standard, the content ceases to be informative and becomes normative and mandatory, available in Chapter 12 Durability of wood.

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