The Evolving Metropolis
2019 IABSE Congress
New York City

IABSE 90 YEARS

Timber constructions as a main participant in the solution of housing problem

Ana C. COBAS

Doctor

UNNOBA

Junín, Argentina
cobasanaclara@yahoo.com.ar

Professor. Researcher on wood in LEMEJ-UNNOBA laboratory. Author of articles on wood for structural use. Forestry and genetic improvement research.

Renso A. CICHERO

Mechanical Engineer

UNNOBA

Junín, Argentina
rensocichero@unnoba.edu.ar

Professor in UNNOBA. Researcher. Participant in the characterization of wood for structural use providing from fast growing trees.

Miguel A. TORTORIELLO

Mechanical Engineer

UNNOBA

Pergamino, Argentina
miguel.tortoriello@nexo.unnoba.edu.ar

Subdirector of LEMEJ-UNNOBA laboratory. Professor of Materials and Structures. Researcher on wood for structural use. Organizer of CLEM+CIMAD 2017 Congress.

Luis J. LIMA

Construction, Hydraulic and Civil Engineer

UNNOBA

La Plata, Argentina
luislima@unnoba.edu.ar

Director of the Research Institute for Sustainable Development. Scientific director of LEMEJ-UNNOBA. Project and calculation of resistant structures for buildings, bridges.

Contact: cobasanaclara@yahoo.com.ar

1 Abstract

The development of timber constructions all around the world may be a very important component in a global policy of affordable housing. To realize this target timber constructions must have adequate security and acceptable durability. It means to have a well-founded Specific Structural Theory and sufficient data about deterioration process and rheological comportment. In this paper we analyze: a) the advantages and disadvantages of timber constructions; b) the main basic hypothesis to develop a theory concerning the "Strength of Wood Material Bodies" (a specific Strength of Materials referred to timber constructions); c) a more precise method to determine wood strength in any case; d) an adequate policy to assure desirable durability of timber constructions.

Keywords: wood advantages; timber constructions; security; strength of materials; durability.

2 Introduction

Timber constructions are a historical legacy in a lot of countries. In many of them, it is also an actual technology but founded in traditional knowledge. Only in some developed and developing countries timber constructions are designs with the support of a theory and the guidelines of a specific Code. In some of this last like in Argentina and other ones, Timber Codes give the strength of the material for a set of the most common woods generally employed. The large strength variability among the specimens of any tree family -and also in the different areas of the same tree- has two undesirable consequences in timber constructions: security decrease and costs increase.

This kind of problems are aggravated by the lack of a Specific Strength of Materials devoted to Timber Bodies, it means a "Strength of Timber Materials Bodies".

In reinforced concrete constructions one have had the same kind of problems in the origin of its utilization. So a good procedure guide may be to act with timber constructions as one have done in the case of that material. In other words, it seems to be advisable: 1) to determine in every construction the real strength of the specific employed wood; 2) to develop a "Specific Strength of Materials" referred to wood bodies. We will come back to these basic problems.

This theoretical work is justified by taking in mind the big advantages of wood in all the steps of timber constructions.

3 Advantages and disadvantages of wood as a construction material

The main advantages of wood all around the process of timber constructions -from the original tree to the final structure- are the following:

a) It is a renewable material that facilitates the natural forest preservation through the cultivation of artificial ones;
b) In artificial forests it is possible to have better timber elements with adequate specimens selection and pruning policy;
c) The cultivation of this kind of forests may be done in extended areas of actual world lands. Probably each country has the possibility to establish its own artificial forests policy;
d) As a consequence of the increase of forested areas, global world ecology may be increased;
e) In average from a tree one can have 50% of timber; the other 50% may be not lost. It can be transformed in profitable energy producing wood pallets;
f) It is easy to transform wood in timber also with elementary tools;
g) Timber constructions and many timber structures do not need high-specialized workers. Nevertheless it is always necessary to have a sufficient knowledge level to produce acceptable constructions and structures.

Main disadvantages of timber constructions are the following:

a) Very low fire resistance. It imposes a very exhaustive analysis and a strong and well-founded policy to act in these situations;
b) Wood is susceptible to biological attacks that will strongly reduce its durability. Actually, this problem solution has a lot of technological possibilities. The target is to select in any circumstance -geographic, climatologic, characteristics of structural use- the adequate solution.

4 Basic hypothesis of a possible "strength of wood material bodies"

The Basic Hypothesis of a possible Strength of Material referred to timber structures may be the following [1]. Timber bodies are:

1. Continuous
2. Heterogeneous
3. Anisotropic
4. Lineal elastic under service loads and plastic-elastic under ultimate loads.

5 How to establish the actual resistant capacity of wood

5.1 Problem

1. In order to obtain the resistant response of the bodies of different types of wood to each one of the solicitations to which they may be subjected in their structural work, a particular test of specific specimens is required for each possible situation and for each type of wood.
2. This would lead to a large number of different complex tests, a task that is practically impossible to perform for each particular construction, independently how important it may be.
3. It is even less practical for the project and building of medium and small constructions.
4. However, in order to provide security to the construction, in all cases it is necessary to

know with sufficient precision the responses of the structural elements.

5.2 Proposal

5. To refer the results of all |s on wood bodies obtained from specific specimens (item 1) to a single “Standard Specimen” which will be universally accepted.
6. This Standard Specimen must be geometrically simple, and with the smallest size possible, so that it can be representative and also tested with simple procedures.
7. Under this conditions, in each construction must be tested the minimum number of Standard Specimens required in order to obtain the properties of the specific wood utilized.
8. With these results, and based on the statement in item 5, the resistance mechanisms determined experimentally can be applied to the type of wood that will be employed.

5.3 Standard Specimen

We consider that of the laboratory tests that can be performed (traction, compression, bending and cutting), the most representative is the bending test.

Specimen characteristics:

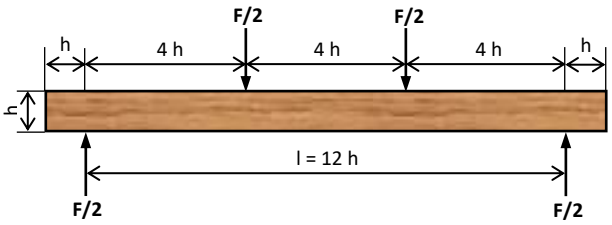
Size (h x h x l_{total}): 4x4 cm^2 section and 56 cm long.

Conditions: free of defects -without knots, holes due to biological attacks, marrow, fungus, fissures, Kino bags, resin or other substances, as these strongly modify their resistance.

Test characteristics proposed:

Distance between supports of the specimen l: 48 cm (value to be analyzed)

Load system: two (2) active loads applied perpendicularly to the direction of the fibers, in the thirds of the distance between supports (Figure 1). This allows the specimens to have the area of the central third subjected to pure bending -bending without cutting-, situation which minimizes the influence of punctual defects.



h: 4 cm; l: 480 cm

Figure 1. Standard Specimen proposed

6 Policy to assure good durability of timber constructions

Wood is a material of biological origin that consists of an arrangement of plant cells with walls composed of cellulose, hemicellulose and lignin in different proportions. Therefore, it is subject to degradation by various abiotic agents -light, temperature, humidity- and biotic -bacteria, insects, fungi-. The natural durability of the wood is its capacity to resist the attack of its agents of destruction -biotic and abiotic-, being the action of the fungi preponderant over that of the other agents, for being the main cause of the degradation of the material, therefore causing the reduction of the structural useful life.

The use of wood without the knowledge of its basic properties has led to selective exploitation that has gone to the detriment of species that have in common an adequate natural durability. This is important because it depends on the time in which the physical and mechanical properties of the wood remain in force, which characterizes them for a certain use. Likewise, the place where you will find the wood also influences the durability of it; it is not the same if the wood is in direct contact with the ground than if it is in indoors. In the first case, the microorganisms characteristic of the soil, the high percentage of humidity, among other factors favor the development of the xylophages fungi and a more rapid deterioration of the structure of the wood, while when it is inside for example of a house, it is more protected against the degradation of abiotic and biotic agents and this will influence the method and product of preservation of the material, as well as the characteristics of the species.

7 Conclusions

Beyond the years of durability that are indicated as a result of a laboratory or field test, the monitoring and control of the wood put into service is essential to achieve a longer life of the same. Preservation methods that are applied before the wood is utilized or once it is on the site, or both, can be considered; the difference will lie in the degree of protection granted to the material and that will result in a greater resistance to degradation.

8 References

[1] L. J. Lima, *La Madera como Material Estructural*. Junín: LEMEJ-UNNOBA; 2018.