Faculty of Civil Engineering

WARSAW UNIVERSITY OF TECHNOLOGY

Building Materials

Laboratory exercises

Technical characteristics of wood

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1. The aim of the laboratory

The aim of this exercise is to carry out laboratory tests and calculations of chosen properties of wood indicated by the Tutor.

2. Background

2.1. Definitions

Wood – a natural composite material with a polymer matrix. The continuous polymer fibres are axially longitudinally oriented cells, which give material its specific anisotropic properties;

Sawn timber – timber product made by sawing round wood individually or in groups on sawing machines;

Untrimmed timber – wood material with two parallel surfaces processed; side edges rounded; obtained by slicing once;

Edged timber - material with all surfaces treated;

Building timber - floor coverings, facades, terraces, panelling, skirting boards and plinths, elements of balustrades, stairs or fences.

Structural timber - elements of load-bearing constructions, i.e. rafter framing, wooden houses, gazebos, sheds, bridges or terrace roofing. It comes in the form of scantlings, boards, logs, battens and counter-battens.

Sawn timber - Mostly made from ash, oak, pine and beech; moisture content of about 10%; furniture industry, window and door joinery.

Moisture content – the percent of water content of the material at the time of testing.

Flexural strength – the maximum value of the stress that the tested material can withstand during the bend test;

Compressive strength – the maximum value of the compressive stress that the tested material can withstand during the test;

Hardness – material resistance to local plastic deformations, applied on a small surface of the test sample as a result of pressing so called indenter, which is a harder material;

Density – mass of a unit of volume of dry material in a powdered state, i.e. of only the material, without pores.

Apparent (volume) density – mass of a unit of volume of dry material together with pores.

Weight absorption – is determined on the basis of the ratio of mass of absorbed water to the mass

of the sample in the dry state.

Volume absorption – is defined as the ratio of the mass of water contained in the material to the volume of the material.

Moisture content – the percent of water content of the material at the time of testing

2.2. Introduction

Next to stone, wood is the oldest material used in construction. The favourable technical properties of technical properties of wood make it possible to use this material and its waste in the construction industry. Wood consists of compounds containing carbon, oxygen, hydrogen and nitrogen. These compounds form two groups - the first is cellulose and related substances, and the second is starch, lignin, fats, protein and resin. Cellulose (the fibre) and lignin (the sapwood) account for the largest proportion of wood mass (about 85%). The basic tests of the mechanical properties of wood include:

- Tensile strength on and across fibres (EN 408+A1:2012 Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties)
- Compressive strength on and across fibres (*ISO 13061-5 Physical and mechanical properties of wood — Test methods for small clear wood specimens)*
- Shear strength along fibres ((ISO 13061-8 *Physical and mechanical properties of wood — Test methods for small clear specimens)*

3. Laboratory determinations

3.1. Wood moisture - the drier-weigher method

3.1.1. Materials and equipment

- 2 samples of the wood,
- Laboratory scale,
- Calliper or ruler.

3.1.2. Measurement

Take 2 samples of coniferous wood or hardwood (sample dimensions 2x2x2 or 2x2x3cm) and weigh them on a balance, determining their weight in moist state (m_w). After measuring, place them in an oven and dry at 103 ± 2˚C for at least 12 hours. After this time, remove from the oven and

place in a desiccator to cool. Weigh the cooled specimens to determine their weight in the completely dry state (m_s). Based on the measurements, calculate the relative and absolute moisture contents of the wood according to the formulae:

$$W_w = \frac{m_w - m_s}{m_w} * 100\% \qquad W_0 = \frac{m_w - m_s}{V} * 100\%$$

where:

m_w – mass of the wet sample [g],

m_s – mass of the dry sample [g],

V – volume of sample [cm^3].

NOTE: Each team will receive a sample with a different degree of wetness.

3.2. Determination of density of wood in absolutely dry condition and in moist condition - sterometric method

3.2.1. Materials and equipment

- 2 samples of the wood,
- Laboratory scale,
- Calliper or ruler.

3.2.2. Measurement

Determine the dimensions of the timber samples using a caliper before and after drying. On the basis of the results obtained and the mass measurement results from pt. 3.1, calculate the volume and density of the samples in the wet state and in the absolutely dry state using the formulae:

$$\varrho_w = \frac{m_w}{V_w} \qquad \varrho_0 = \frac{m_s}{V_s}$$

where:

m_w – mass of the wet sample [g],

m_s – mass of the dry sample [g],

V_w – volume of the wet sample [cm^3]

V_s - volume of the dry sample [cm^3]

3.3.Compressive strength

3.3.1. Materials and equipment

- 2 samples of wood,
- Calliper or ruler,
- Hydraulic press.

3.3.2. Measurement

During the test the specimen is compressed on a testing machine at a constant speed so that failure occurs 90±30 s after the loading begins. Fig. 1 shows the dimensions that need to be determined to obtain the contact area F when testing along and across wood fibres. Immediately after the test, the moisture content of the specimen W should be determined. It is common to convert the determination to a strength at a moisture content of W_{12}, so that comparisons can be made between the properties of different specimens. The following formulae are used:

$$R_c = \frac{P}{F} \qquad R_{c12} = R_c[1 + \alpha(W - W_{12})]$$

where:

P – destructive force [N]
F – contact area [mm^2]
W – specimen humidity [%]
W_{12} – specimen humidity 12%
α – coefficient of change of wood compressive strength along fibres , α = 0.04

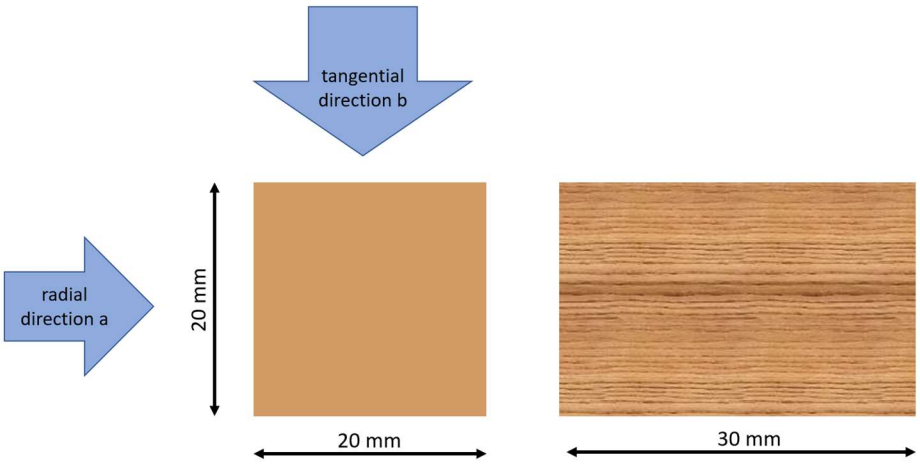

Fig.1. Shape and dimensions of the compression test specimen.

3.4. Detemination of hardness by Janka method

3.4.1. Materials and equipment

- Sample of wood material,
- Metal ball,
- Hydraulic press,
- Calliper or ruler.

3.4.2. Measurement

The test shall be performed on specimens in the form of 50x50x70 mm cuboid. The duration of one indentation shall be 2 minutes. The test shall be carried out on an accurately smoothened cross-section of the specimen. 4 indentations shall be made in such a way that their edges are 10 mm apart from each other and from the edge of the specimen. The loading rate shall be 3.2 - 4.8kN/min. The stress due to the pressing of the steel ball shall then be calculated from the formula:

$$T_{jw} = \frac{P_J}{A}$$

$$T_{jw,12} = T_{jw} * [1 + \alpha_c * (W - 12)]$$

where:

T_{jw} – Janka hardness [MPa],

P_J – maximum loading force [N],

A– cross-sectional area of Janki ball (A=1cm^2),

$T_{jw,12}$ – Janka hardness at 12% moisture content [MPa],

α_C – conversion factor α_C =0.03,

W– moisture [%].

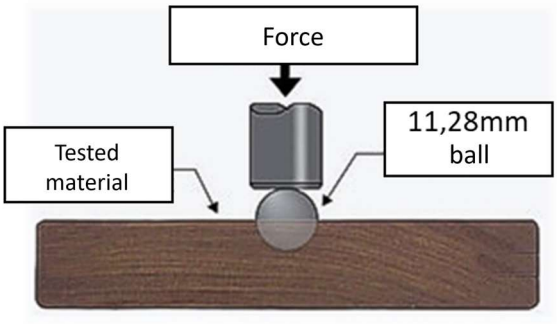

Fig.2. Determination of hardness by Janka method

4. Summary of the measurements

A summary of the measurements results and the calculations performed should be placed in Table 1, and then the results obtained should be compared with other teams results obtained for different moisture content of wood.

Tab.1. Results of measurements

No.	Determination		Unit	Calculations and results
1	Apparent density (ρ_p)	Moisture sample	g/cm^3	
		Dry sample		
2	Moisture content	Drier-weigher method	%	
		Conductivity method		
3	Compressive strength along fibres	Moisture sample	[MPa]	
		Dry sample		
4	Compressive strength across fibres	Moisture sample		
		Dry sample		
5	Hardness	Moisture sample	[MPa]	
		Dry sample		

5. The report on the laboratory task

The report on the laboratory task should contain:

I. Subject of the study
(basic information about the test material)

II. Test results
(results of measurements and calculations made in the laboratory classes)

III. Conclusions
(statements made on the basis of the obtained results and on the comparison of the obtained results and other teams results)

IV. Literature
(references to the literature used to prepare the report)

6. Literature

- Mamlouk M., Zaniewski J.: Materials for Civil and Construction Engineers
- EN 408+A1:2012 Timber structures - Structural timber and glued laminated timber - Determination of some physical and mechanical properties
- ISO 13061-5 Physical and mechanical properties of wood — Test methods for small clear wood specimens
- ISO 13061-8 Physical and mechanical properties of wood — Test methods for small clear specimens