Česká zemědělská univerzita v Praze

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Determining the effect of Populus tremula densification on the deformation tension characteristics under pressure perpendicular to the radial direction fibers

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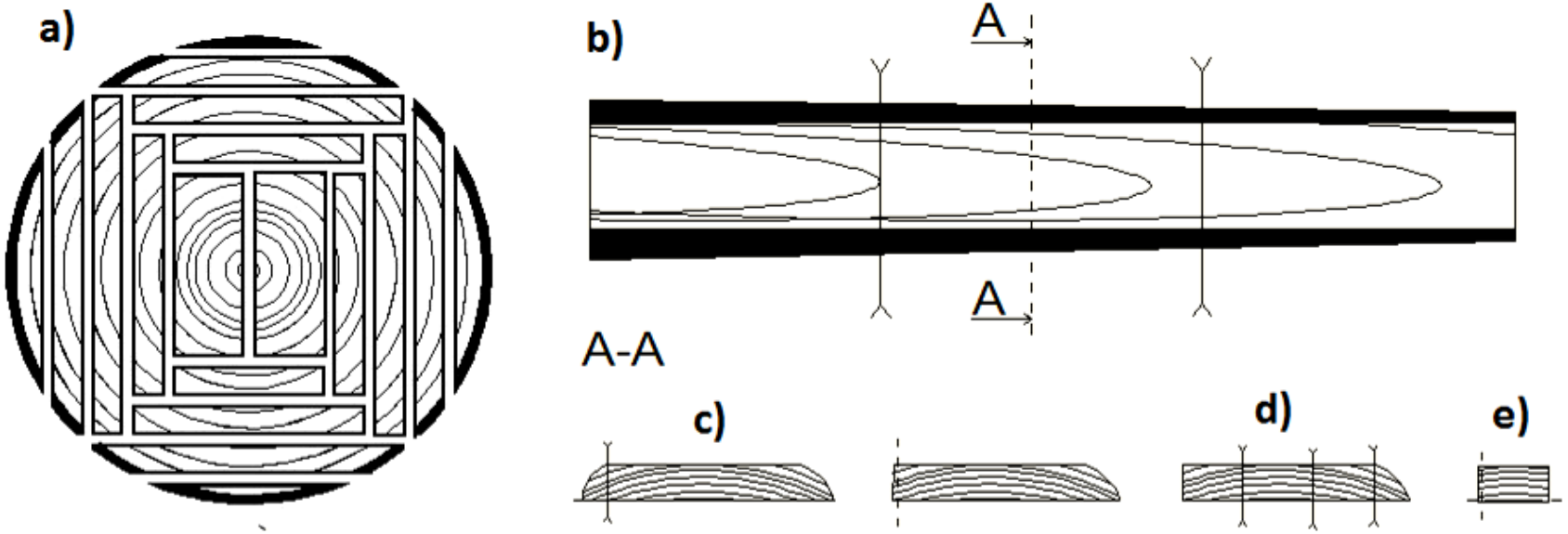
Introduction

- The creation of new types of materials is currently the problem with the much attention.
- One of the ways, as these materials to create, is the creating LVL materials.
- This problem requires an analysis and knowledge of the properties of the every single layer of material.
- Their appropriate combination can create materials of specific properties for their purpose of use.
- **Densification of the individual layers to LVL materials**

Preparation of the test pieces

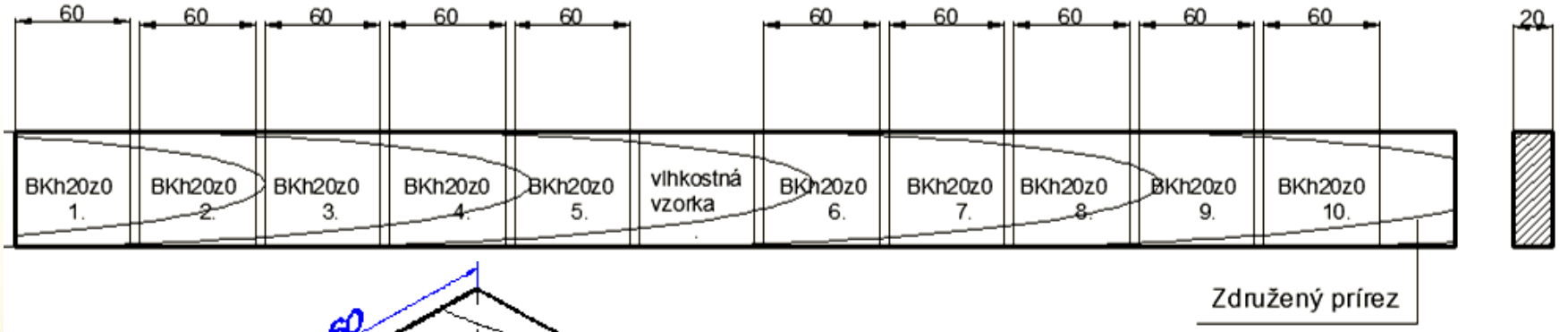
- Tangential lumber - circular cutting (fig. a)
- Moisture: 16% (± 2a%)
- shorten to desired rough dimensions (b)
- Clear (c)
- Cut (d)
- Level surfaces -> the cut pieces were treated by thicknesser (e)



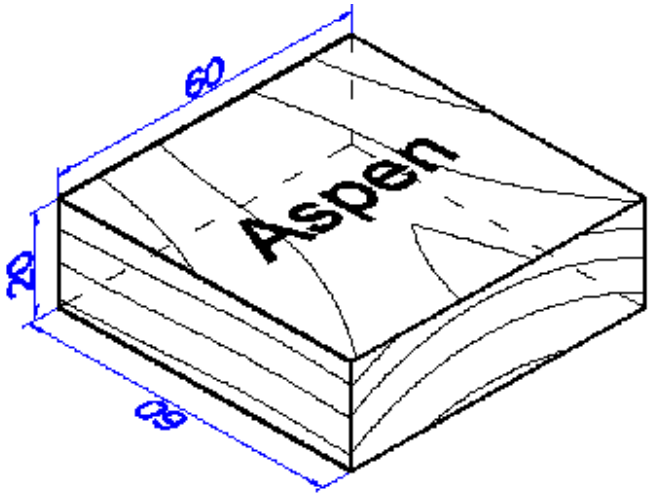
Preparation of the test pieces

- Individual cut pieces were shortened to the desired dimensions of test pieces (Fig. 1f).
- The dimensions of pieces for the pressure test are 20 x 60 x 60 mm (Fig. 1g).

f)



g)



Densification of cut pieces

- Densify to the desired thickness by uniform molding of wood crosswise the fibers at 16% moisture using a hydraulic press.
- To achieve the final thickness of 20 mm, it was necessary to account for the allowance before molding.
- The molded samples were compressed by 10% and 30% of their thickness, whereby we have to account for the elastic deformation of the material.

Densification of cut pieces

- Example:
  - During the densification, cut pieces of 22 mm thickness, which were molded to 20 mm, i.e. by 10%, were used.

- At higher levels of densification we reach higher wood density, but at the expense of damaged structure.

- Density is assessed according to formula:

$$\rho = \frac{m}{V}\left[kg/m^3\right]$$

m – weight [kg],
V – volume [m^3].

Conditioning

- The test material was conditioned in an environment of relative air humidity of **ϕ = (65 ± 5)%** and of temperature of **t = (20 ± 2) °C** to a state of equilibrium.

- These moisture content were assessed and match the **12%** equilibrium moisture of wood, at which the test was executed.

Tests on the tensile testing machine

- Assessed were the material of 20 mm thickness (ordinal number 1, 2, 3).
- 3 possible levels of densification
  - For each set of test pieces, 10 samples were used, which constitute 30 samples overall

O.No.	Wood species	Thickness (h) in mm	Densification	Index
1	PT	20	0%	OSh20z0
2	PT	20	10%	OSh20z10
3	PT	20	30%	OSh20z30

The test process

- **Width** and **length** of the conditioned test pieces in the axes of symmetry with **accuracy of 0,1 mm**.
- The test piece was inserted into the tensile testing machine between the plates in a way in which force was applied in the **radial direction**.

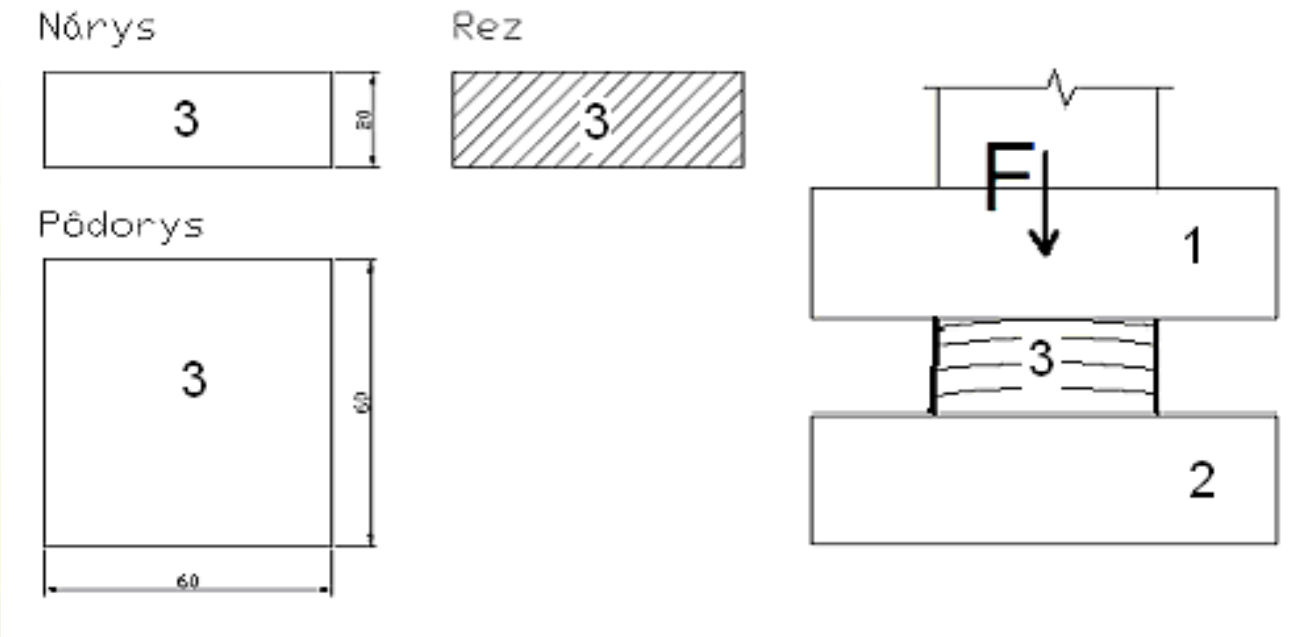


Fig.: Test piece for assessing the strength under pressure perpendicular to the fibers:
1 – pressure plate, 2 – fixed plate, 3 – test piece.

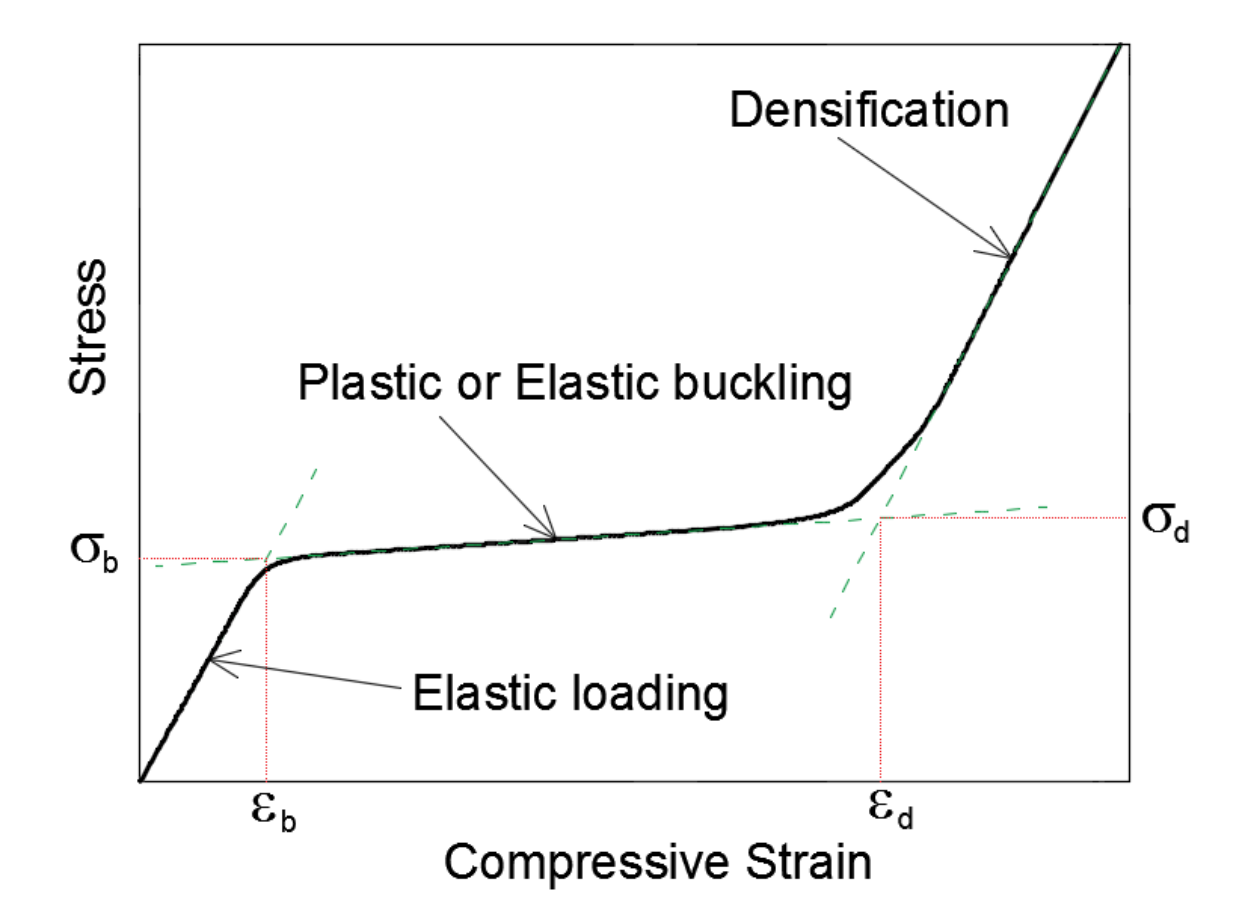
The test process

- The deformation was assessed using a **numerical indicator** with accuracy of 0,01 mm at the same intervals of load accession.
- The interval has to be at least **10 times** smaller than the load corressponding to the conventional fracture limit.
- The test carried on until **visible violation of the proportional limit**, which was assessed by numerical indicator.
- Measured data was processed using Microsoft Excel application, the **compressive-deformation graph** was created and from it the **proportional limit** was assessed.

$$\sigma u = Fu / S \ [Mpa]$$

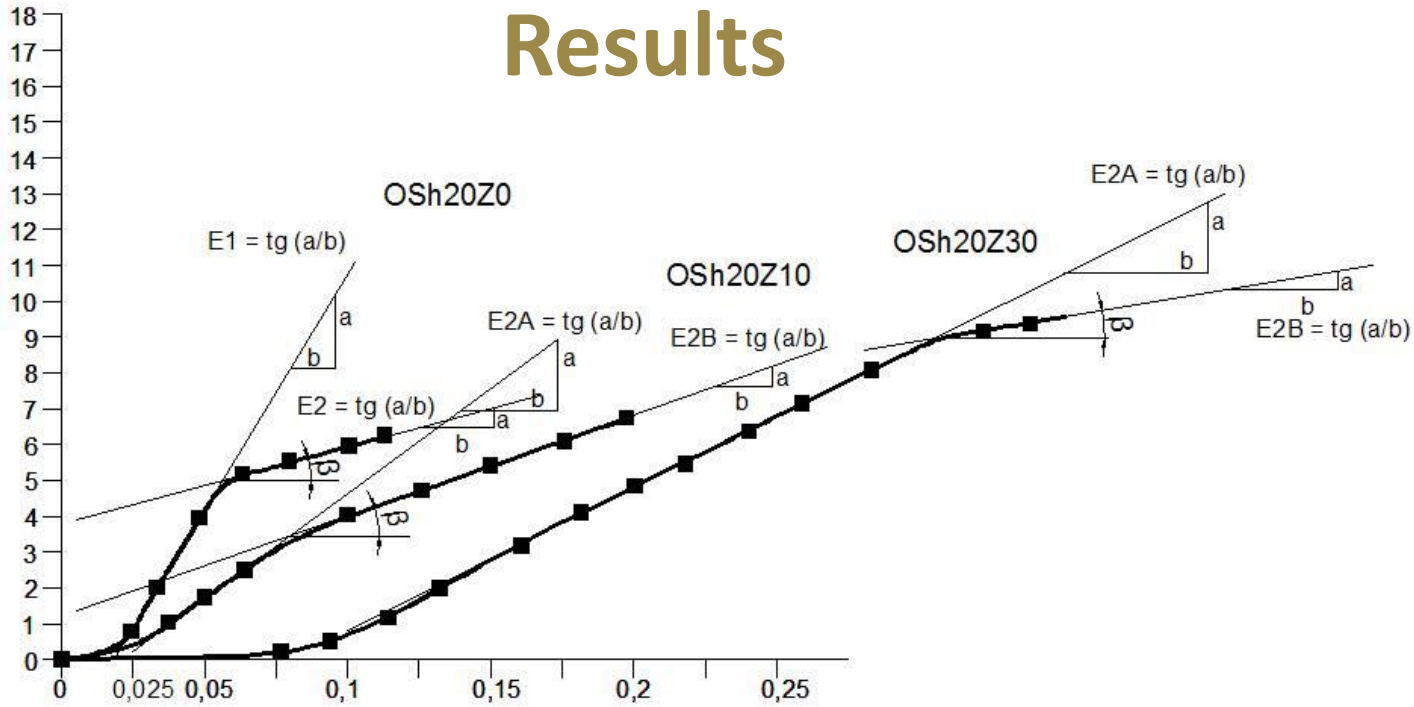
σu – proportional limit,
Fu – force at proportional limit in N,
S – loaded area of test piece in mm2.

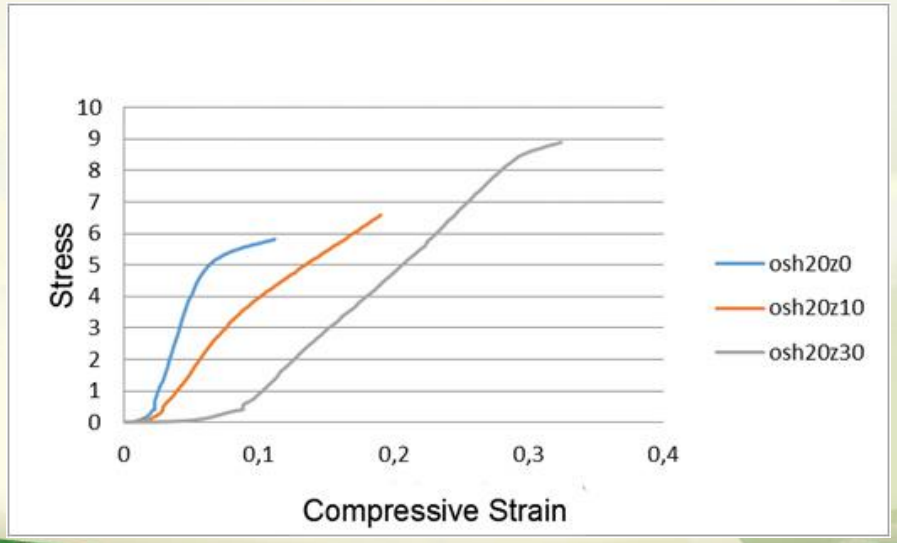
Results



Schematic view of a transverse compression stress-strain curve for wood. The dotted lines show the method used to extract initial modulus (E), stress and strain for the onset of buckling (σ_b and ε_b) and the stress and strain for the onset of densification (σd and εd).

Results

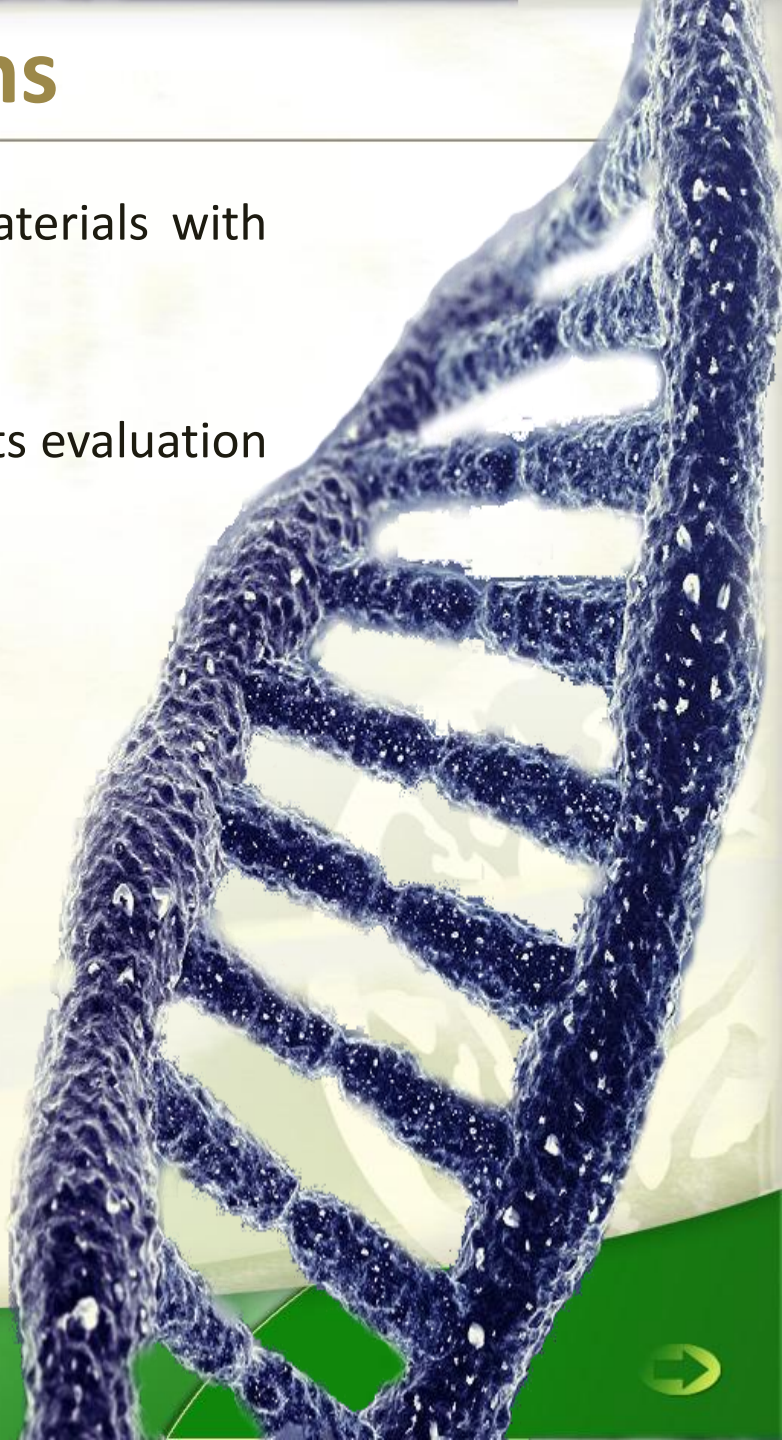




Tension-deformation graph for individual set of test pieces (Populus tremula L.)

Conclusions

- With using this analisys we can compare materials with diferent mechanical properties
- By the work was proposed change of standarts evaluation of modulus of elasticity and others
- On the base our knowledge we can build mathematical models of creation new composite materials with diferent properties for specified using in the praxes
- With this modification of cheap wood we can get material with properties which have the same properties like more expensive wood materials (beech, oak, …)



Thank you for your attention!