Česká zemědělská univerzita v Praze

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The effect of periodic stressing and material thickness on the bending strength of densified beech wood

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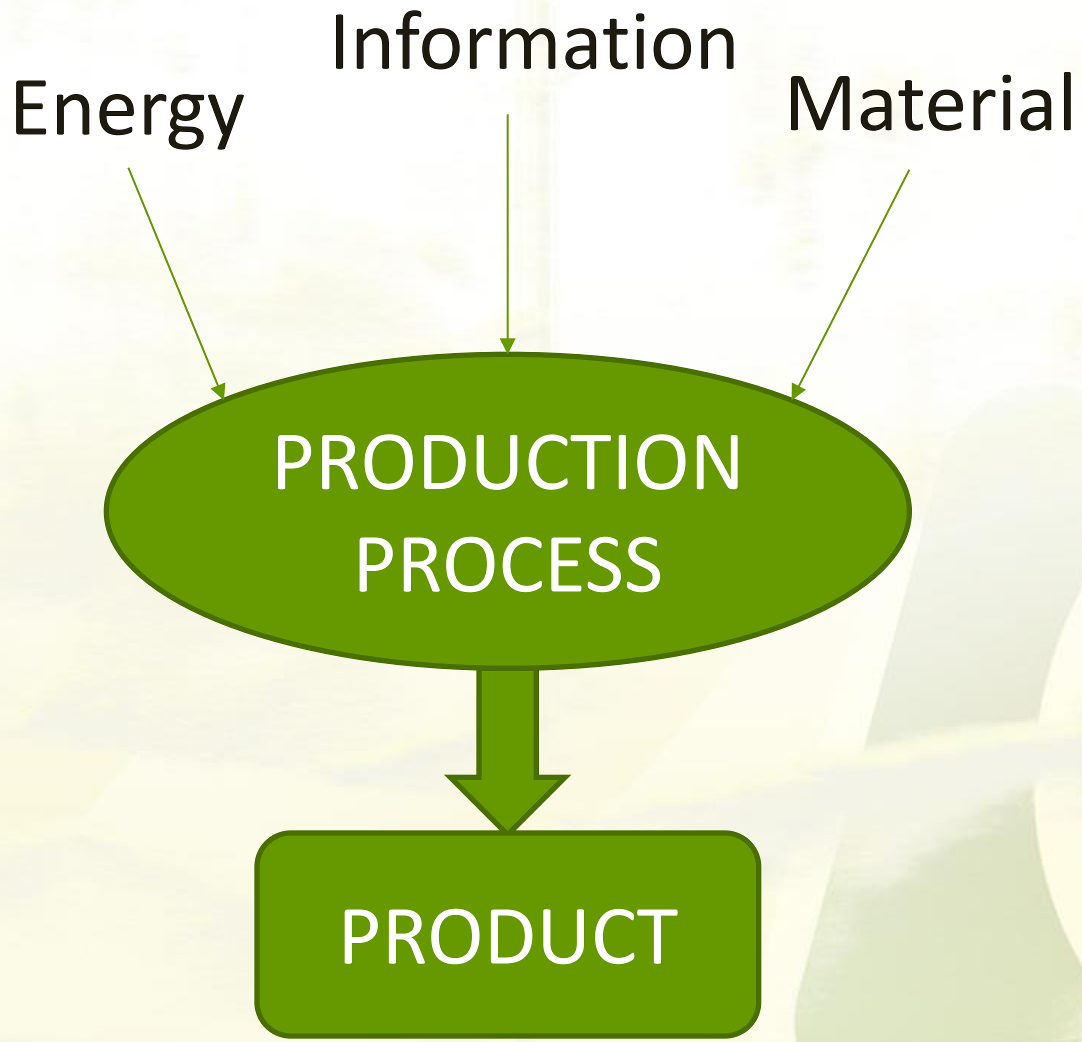
INTRODUCTION



MODIFICATION OF WOOD

Methods used for modification of wood:

- Chemical modification;
- Thermal modification;
- Mechanical modification or their combination.

DENSIFICATION OF WOOD

- ✓ The final product is characteristic by its enhanced physical-mechanical properties compared to the solid timber.

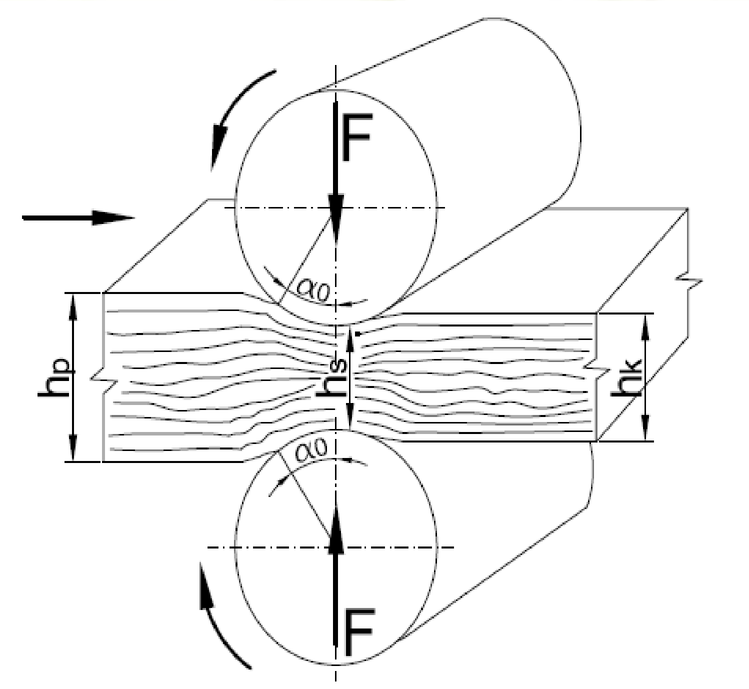


Fig. 1 Principle of wood densification by rolling

METHODS

➢ Material:

- Fagus Sylvatica (*Fagus sylvatica* L.). – densified beech wood pressing level of 30%.

➢ Selected characteristic:

- bending strength „σp“

➢ Effects of selected factors:

- Material thickness (4 mm, 6 mm, 10 mm a 18 mm)
- Number of cycles (0, 3 000, 6000 a 10 000)

• **The test pieces after densification had the dimensions of w=30 mm × t=2,8 mm, 4,2 mm, 7 mm a 12,6 mm × l=600 mm.**

METHODS

1.

Fig. 2 Densification of wood by rolling

2.

Fig. 3 Cyclic machine

METHODS

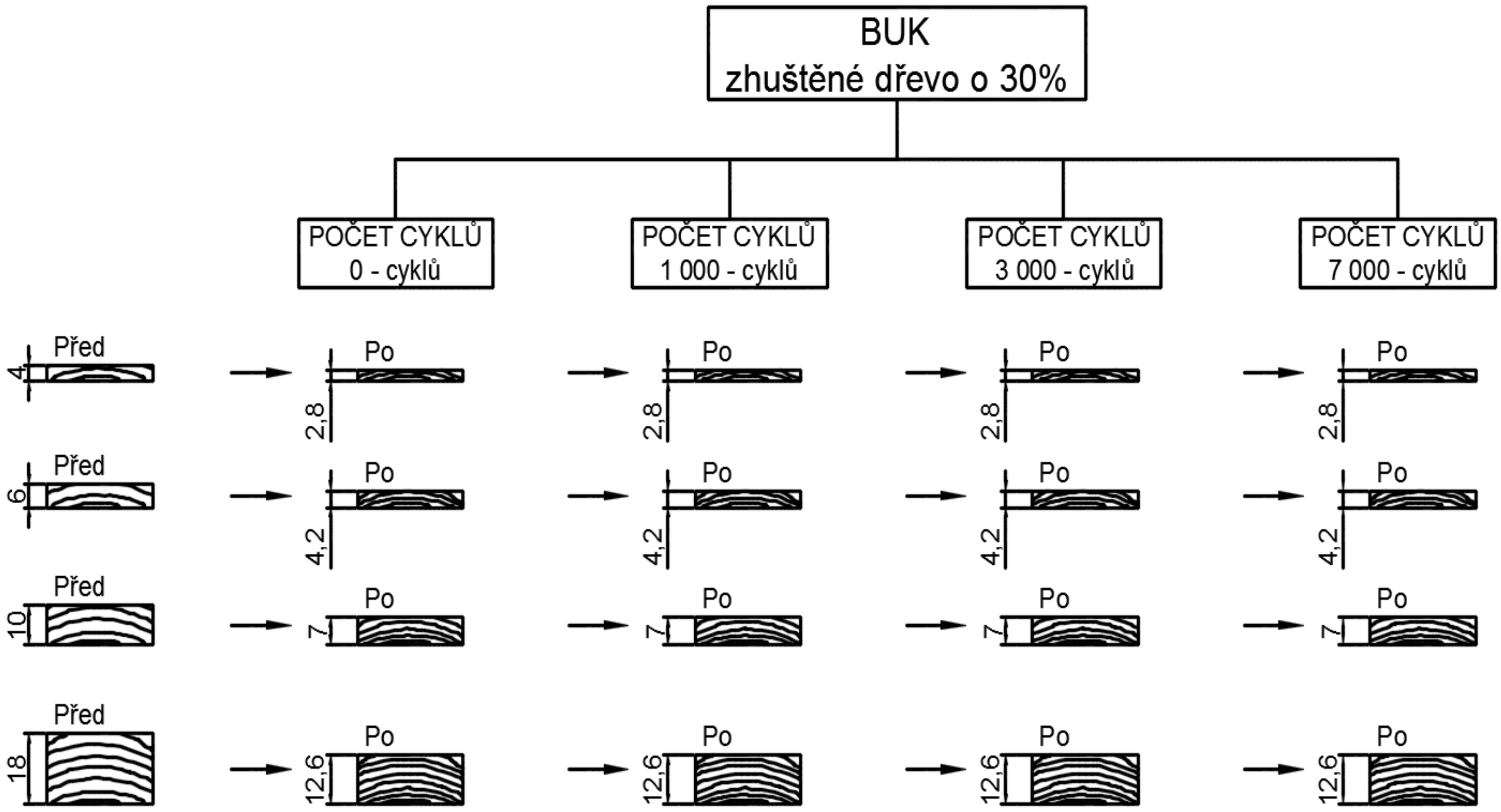


Fig. 4 Scheme of beech wood test pieces

Methods of determining the bending strength

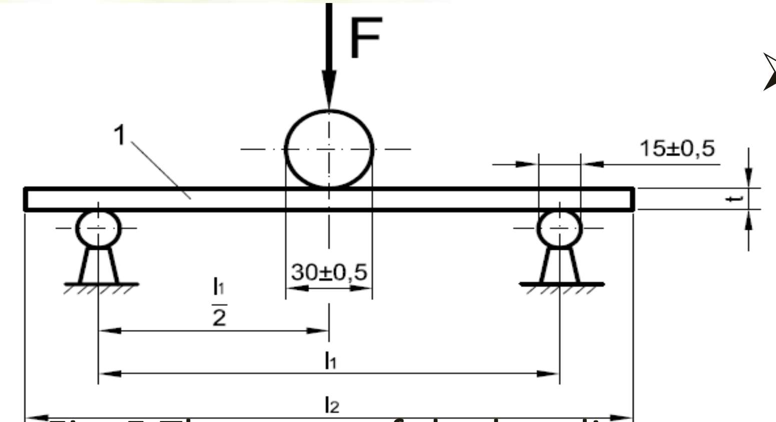


Fig. 5 The setup of the bending test

ČSN EN 310 (1995)

1 – test piece, F—load, t – test piece thickness, l_1=20×t, l_2=l_1±50 mm

- $$\sigma_{12} = \sigma_w [1 + \alpha (w - 12)] \quad \text{[MPa]}$$

Where:

σ_w – bending strength of wood at a humidity at the time of testing

σ_{12} – bending strength of wood at 12 % moisture content

w – the moisture content of a test piece at the time of testing

α – correctional humidity coefficient, which is 0,04 for all of the wood pulps

- **The bending strength at the three-point bend:**

$$\sigma_p = \frac{3 * F_{max} * l_1}{2 * b * t^2} \quad \text{[MPa]}$$

Where:

σ_p – bending strenght limit

F_{max} – is a force recorded at the breaking point of a test piece

l_1 – distance of the supports during the test

b – width of the test piece

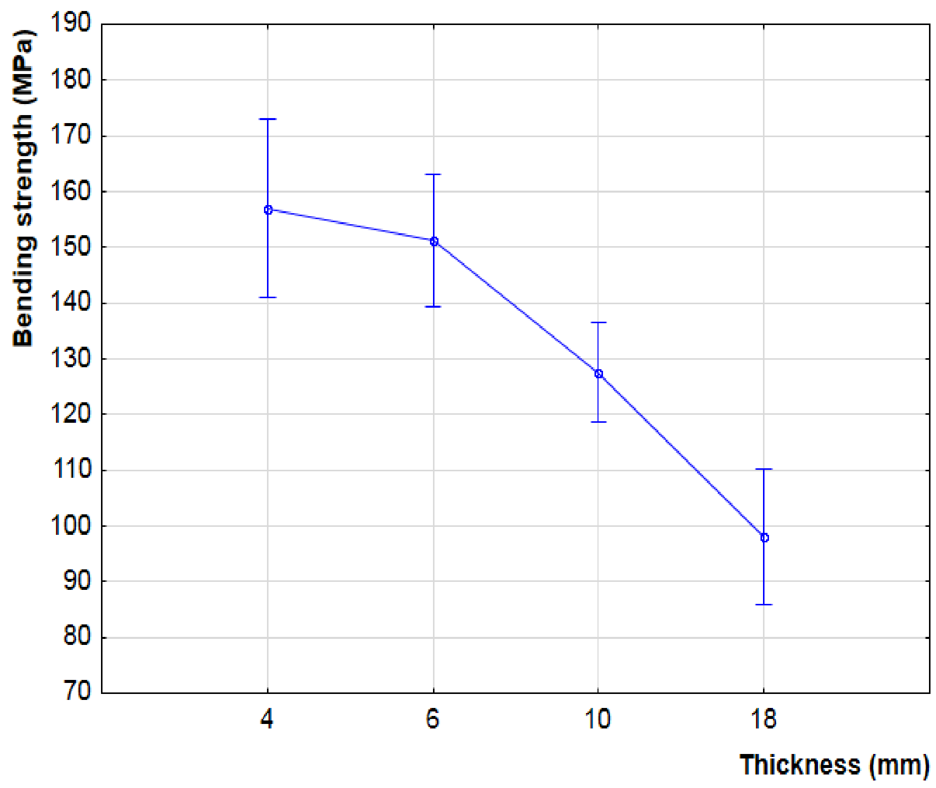
t – thickness of the test piece

RESULTS AND DISCUSION

Table 1. Basic table of the two-factorial analysis of variance, evaluating the effects of the individual factors on the change in bending strength of the densified beech wood

Observed factor	Summary of squares	Independence levels	Variance	Fischer's F-test	Significance level P
Abs. element	1394760	1	1394760	2380.026	0.000001
Number of cycles	1289	3	430	0.733	0.535423
Thickness	55219	3	18406	31.409	0.000001
Number of cycles*Thickness	17118	9	1902	3.246	0.002254
Error	43366	74	586		

RESULTS AND DISCUSION



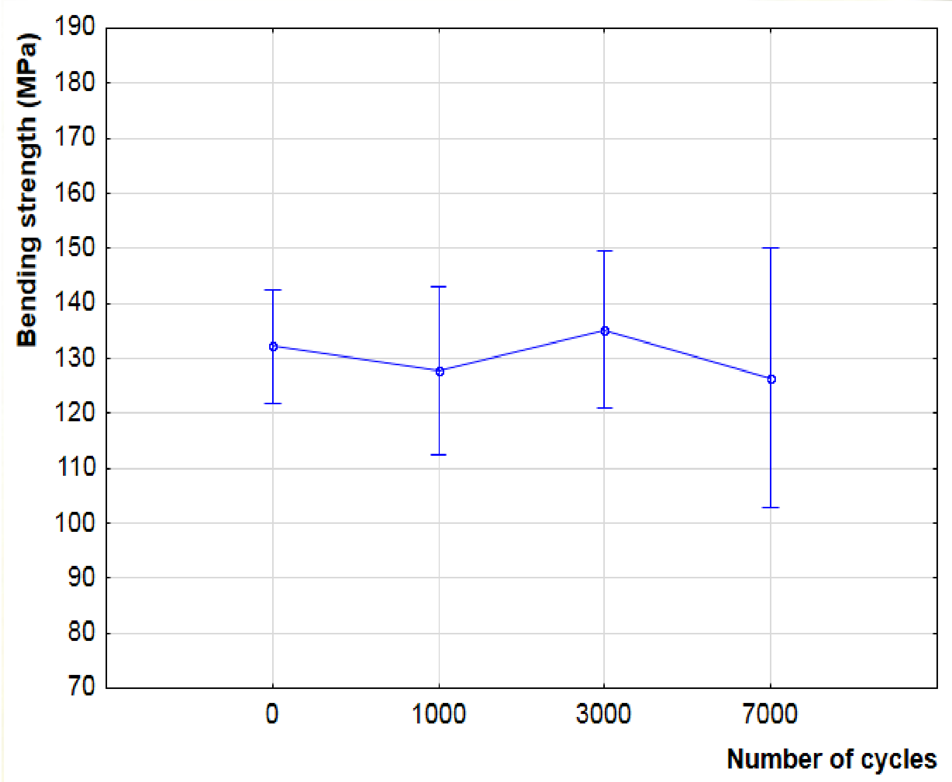


Fig. 6 Graph of the 95% intervals of reliability illustrating the effect of the material thickness on the values of average arithmetic bending strength of the densified beech wood

Fig. 7 Graph of the 95% intervals of reliability illustrating the effect of the number of cycles on the values of average arithmetic bending strength of the densified beech wood

RESULTS AND DISCUSION

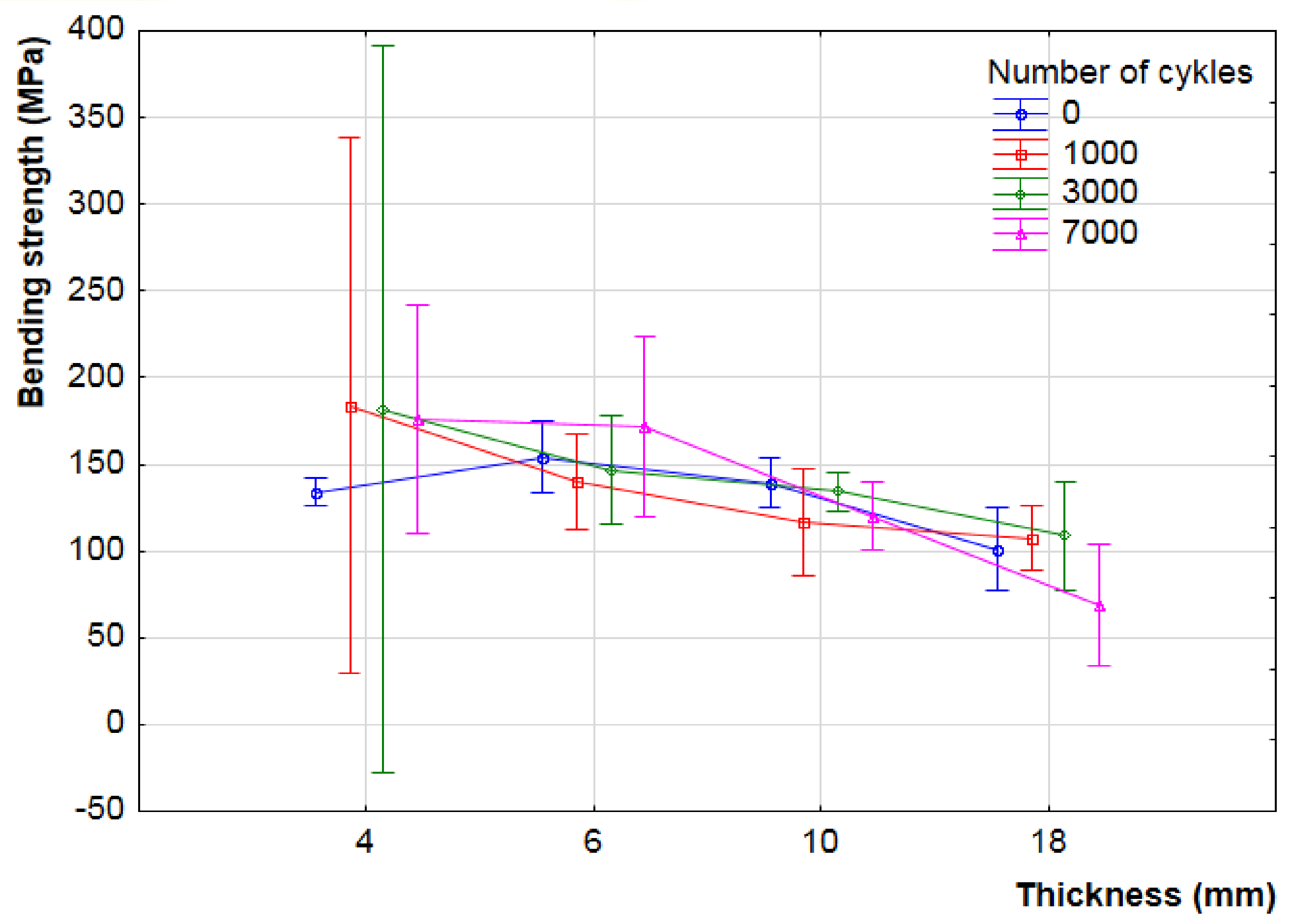


Fig. 8 Graph of the 95% intervals of reliability illustrating the effect of the interaction of material thickness and number of cycles on the values of average arithmetic bending strength of the densified beech wood

CONCLUSION

From the results listed in the paper ensues:

- Number of stress cycles proved to be a factor, which has no significant effect on the values of bending strength.

- In following works, it is necessary to focus on examination of the effect of greater number of stress cycles - 7000 and more.

- Recorded effect of decreasing bending strength with increasing material thickness concurs with the results in work of Milan Gaff et al., 2014, where he states, that even with preserved conditions of the slenderness ratio (20 x material thickness) the values of bending strength decrease as a consequence of greater increase of cross section module of the material compared to the increase in agential force, therefore the decrease in strength takes place.

Thank you for your attention!

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