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SMALL SCALE DEBARKING EXPERIMENT

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Strength, proportionality limit and relaxation time of beech wood debarking process are considered in the article as random variables. The direction of shear load and moisture content were significant, while time of felling during growing season were not significant factors.

Bark differs from wood in its structure and properties. This is the main reason for wood debarking at the beginning of many technologies. The wood-working companies try to debark wood as easy as possible. The consumption of energy and adhesion limit the process. Also the proportionality limit and relaxation time determine the way of debarking. On the other hand bark should keep its position on living tree as much as possible, bark is safety tissue. Therefore foresters expect good adhesion of bark on wood during thinning of forests. The wood debarking process occurs mainly in cambium and also in phloem. The strength of cambium can be overcome in different directions. The most common shear strengths covered in debarking process are in longitudinal and tangential directions and it is believed that these two directions are main directions of strength. Cambium is formed by living cells and its products are sapwood and phloem (Čunderlík and Vilkovský 2015). Both of them are involved in water transport processes in living tree and they are saturated with water. After felling, water evaporates and it is possible that weaker bonds between secondary water molecules are replaced by stronger ones between primary molecules and –OH groups in cambium cell walls. The season from March to October is recommended for beech felling in Slovakia, or otherwise it is recommended its fast processing for three weeks at most (Regináč et al. 1991).

The aim is evaluation of direction, moisture content and felling season impact on strength, proportionality limit and relaxation time during beech debarking process realized on small specimens.

Small scale experiment was designed to find the proportionality limit and strength during debarking. The disk samples were cut form breast height of three trunks in the beginning of April and July. The trunk diameter was more than 30cm. The specimens' dimensions were 3cm in longitudinal 3cm in radial and 9cm in radial directions. The specimen's were free of defects. The area was divided to two symmetric parts to obtain pair specimens for moisture content experiment. Thus loaded area was 1.5x3cm^2. It is supposed that first level of moisture content was near the saturation, while second level was obtained after three months of conditioning in conditioning chamber with temperature of 20°C and relative humidity of 65%. The constant speed of loading jaws of 3mm/min was applied on beech specimens with bark in the area of cambium. The force was parallel in plane. The half of the specimen number was loaded in longitudinal direction the other half in tangential one. The specimen response on shear loading was recorded in time every second until strength was overcome. The total number of specimens was 60 as we expected random character of quantities. The data was processed in MS Excel. The course of loading should be divided into two parts, during the first part Hook's law is obeyed and during the second one the evaluation procedure resides in solution of partial differential equation:

$$0 = \frac{\eta}{G}\frac{\partial^2 \tau}{\partial t^2} + \frac{\partial \tau}{\partial t}$$

where τ is shear stress, t is time of loading, the ratio $\frac{G}{\eta}$ is relaxation time.

The time of reaching the proportionality limit tu divided the solution into two parts:

$$\tau = \frac{G}{\eta}(\tau_p - \tau_u)t \qquad t \leq t_u$$

$$\tau = \tau_p - (\tau_p - \tau_u)e^{-\frac{G}{\eta}(t-t_0)} \qquad t \geq t_u$$

where index p relates to strength, u to proportional limit.

The function has first derivative in proportionality limit time tu. The multiple using of procedure Solver in MS Excel enabled us to find the proportionality limit, relaxation time and time tu, while strength was computed according to its definition as the ratio of maximum force recorded during experiment to initial loaded area.

Time of failure shows random character and Weibull's distribution was applied to find time of failure with some probability. Also, the results proved the random character of strength, proportionality limit and relaxation time. The Kolmogorov-Smirnov test proved suitability of Normal and Weibull's distributions for strength, but Normal distribution was more close to experimental values. The results are embedded in tables 1, 2.

Table 1

The basic statistics of the strength, proportional limit, time to reach the proportional limit of beech debarking process from small scale experiment

		Longitudinal direction					Tangential direction				
		τp [MPa]	τu [MPa]	ratio [%]	tu[s]	G/η [s^{-1}]	τp [MPa]	τu [MPa]	ratio [%]	tu[s]	G/η [s^{-1}]
April (wet)	average	0,53	0,49	92	11,88	0,95	0,40	0,36	90	12,61	0,74
	var. coef. [%]	22	24			86	43	45			119
April (dry)	average	2,7					1,6				
	var. coef. [%]	17					14				
July (wet)	average	0,46	0,41	89	10,16	0,79	0,45	0,41	93	14,17	0,91
	var. coef. [%]	14	17			93	29	32			137

Table 2

The Weibull's distribution parameters of failure time

		Longitudinal direction	Tangential direction
April (wet)	shape	4,7	7,4
	scale [s]	14,8	15,8
April (dry)	shape	10,0	7,1
	scale [s]	22,3	20,8
July (wet)	shape	4,8	5,1
	scale [s]	14,1	17,9

There is significant difference between dry and wet conditions as was expected from literature (Chow and Obermajer 2004). The dry cambium is more stronger then wet cambium. The time of felling during vegetation period has no significant effect on strength. The proportional limit is closer to the strength than it was expected from wood loading observations (Babiak and Dubovský 2001). The relaxation time exhibits the largest variability, more than 30%. The graphs from averages are depicted in figure. The failure time is left to reach 50% probability according to Weibull's distribution.

Relatively, cambium shear strength in wet conditions is lower comparing to wood therefore debarking is an easier process. Also, the dependence of the strength on direction favors both procedures involved in wood debarking according to the place where they are applied. Debarking technology utilizes smaller shear strength in tangential direction if cambium is wet, while foresters utilize the larger shear strength in longitudinal direction during thinning or felling process. The results can be used to evaluate the minimum required energy consumption during debarking process. Further research is required on deformation measurements on narrow beech bark.

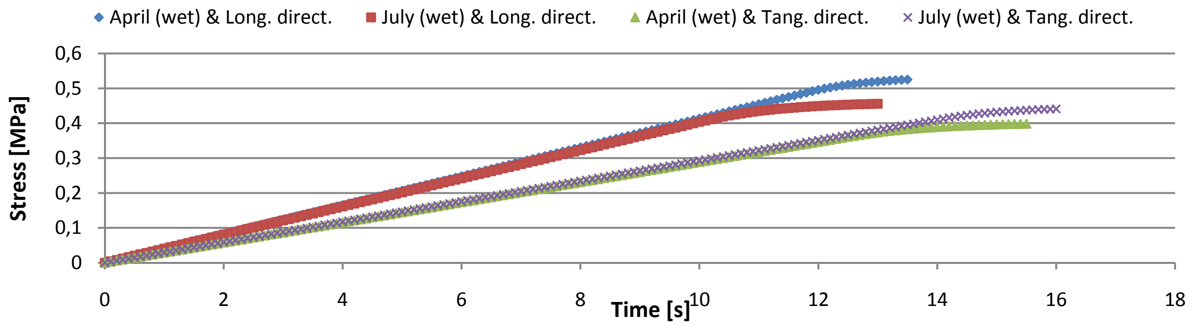

Fig. Stress development during small scale debarking experiment

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MIXED COOKING OF BAMBOO WITH HARDWOOD

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Abstract

Bamboo is the main fibrous raw material for pulping in Bangladesh. Recently *Trema orientalis* is found as the fastest growing wood suitable for pulping. But the basic wood density *of T. orientalis* is low, which consequently decreases digester yield. On the other hand basis wood density of bamboo is quite high. Optimum pulping conditions of these raw materials were similar. Therefore, mixed pulping of *T. orientalis* with bamboo can compensate digester yield. In this study, bamboo and *T. orientalis* chips mixtures were kraft cooked and resulting pulp and paper properties were investigated. Cooking was carried out for five different chip mixtures (0, 25, 50, 75, and 100%). Pulp yield was increased and kappa number decreased with increasing *T. orientalis* proportion in the fiber mixture. The tensile index of the produced was increased with increasing *T. orientalis* in the chip mixture. The maximum tensile-tear was obtained at 50:50 chips mixture. Bleaching was carried out by ECF sequences, and the bleached pulps were beaten in a PFI mill and tested for optical and physical properties. To reach 85% brightness, bamboo pulp needed 40 kg ClO_2/ton pulp, while mixed chips pulp (50:50) needed 35 kg ClO_2/ ton pulp. The chips mixture of bamboo and *T. orientalis* of 50:50 can be used in improving digester yield.

Keywords: Bamboo, *Trema orientalis*, Mixed cooking, Bleaching, Pulp yield, Kappa number.

УДК 630*812

ВНУТРИВИДОВОЕ БИОРАЗНООБРАЗИЕ КАК ФАКТОР УСТОЙЧИВОСТИ, КАЧЕСТВА И ФИТОСАНИТАРНОГО СОСТОЯНИЯ ДРЕВЕСНЫХ ЭКОСИСТЕМ

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В статье рассматриваются показатели качества древесины в характеристиках сучковатсоти и влияние внутривидового биоразнообразия посредством сравнения особей по формам кроны ели европейской.

В результате сохранения биологического разнообразия повышается устойчивость лесных экосистем, усиливаются средообразующие и защитные свойства лесов, повышается их генетико-биологическое разнообразие [1].

Одной из основных лесообразующих древесных пород в зоне в пределах Вологодской области является ель, из которой заготавливают основную часть деловой древесины. Постоянно увеличиваются площади вырубок и очень актуальным становится проблема интенсивного лесовыращивания высококачественных сортиментов [2–4].

Производство высококачественных лесоматериалов занимает одно из ведущих мест по объемам внутреннего валового продукта и экспорта в структуре экономики северо-запада России. Весомой составляющей их конкурентоспособности является высокое качество [5–8].

Качество круглых лесоматериалов обусловлено наличием и выраженностью пороков, основными из которых являются сучки. Сучки влияют на структуру, строение и фитосанитарное состояние древесины. Сучки – это неотъемлемая часть всех древесных стволов и получаемых из них сортиментов. Сортность 70% сосновых круглых лесоматериалов определяется их сучковатостью [4–7, 9].

В целях ускоренного лесовыращивания, улучшения состава и повышения устойчивости лесов, необходимо, наряду с проведением тех или иных мероприятий, глубже изучать и рационально использовать формовое разнообразие древесных пород. Морфологические различия важны тем, что они свя-