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Analysis of core-side and core-core structural timber

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Abstract: *Analysis of core-side and core-core structural timber.* Quality of structural timber used in constructions is affected by quality of round wood as well as a grading method and processing technology. Softwood timber is mainly produced by slab cutting. A result of such technology is timber that is graded without taking into account an origin position in a prism ($core_{side}$, $core_{core}$). This effect was verified using bending tests. Several quality parameters were determined, namely: strength, modulus and density. Results showed that $core_{side}$ timber has average values of modulus of elasticity 30% higher than $core_{core}$ timber. The lowest increase of 6% has been observed for wood density. It can be concluded that grading process may take into account position of $core_{side}$ and $core_{core}$ timber.

Keywords: prism, core-side timber, core-core timber, quality, modulus of elasticity, modulus of rupture, wood density

INTRODUCTION

Designing of reliable and economical timber structures is conditioned by adhering to all the technical and technological specifications. Softwood timber of required physical and mechanical properties is mainly used in wooden structures [WEIDENHILLER, DENZLER 2009]. In Slovakia, the row material for timber comes from logs of III.A and III.B quality grades. This quality is visually evaluated according to STN 48 0055. Sawing scheme also affects a yield from logs. Optimal sawing is given by cutting technology (frame saw, bend saw) and the way of sawing.
Aim of this study is to evaluate effect of timber position within a log/slab on quality of structural timber [ROHANOVÁ, LAGAŇA, DUBOVSKÝ 2010].

MATERIAL AND METHODS

Spruce wood (*Picea abies*) was experimentally tested. Quality parameters of $core_{core}$ and $core_{side}$ timber were determined using a bending method according to STN EN 408. Tested material was taken from logs of III.A (6 pieces) and III.B (7 pieces) quality grades. From a log a slab was cut and it was further cut to 4 boards of dimensions 50x190x5000 *mm* (2 $core_{core\ (1/1)}$ and 2 $core_{side(1/2)}$) (fig. 1).

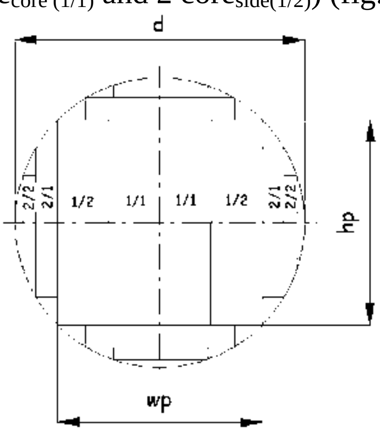

Fig. 1 Square slab sawing ($w_p = h_p$) (d – low face diameter, h_p – height of the prism, w_p – width of the prism, 1/1, 1/2 – core timber (sawn wood from the centre of a log), $core_{core}$ – $core_{1/1}$, $core_{side}$ – $core_{1/2}$, 2/1, 2/2 – slash grain wood (sawn timber from the side of a log)

Altogether, 52 boards were tested, from which

- 26 ks as $core_{side}$ or $core_{1/2}$,
- 26 ks as $core_{core}$ or $core_{1/1}$.

The samples were prepared in two steps:

1. Timber was sized to dimension of 40x180x5000 *mm*.
2. From each board, one tested sample of structural size 40x120x2360 *mm* was prepared.

Density samples were taken from three places of a board (from the middle of a board and 50 mm from both sides). Tested samples were conditioned at standard conditions (temperature 20±2°C and relative humidity 65±5 %) to constant moisture content (MC) 12 % [STN EN 338].

Bending tests were provided according to STN EN 408.

The following parameters were determined for each tested board ($core_{1/1}$, $core_{1/2}$):

1. Modulus of elasticity - ***E***
2. Modulus of rupture - ***σ***
3. Wood density - ***ρ***

All three parameters were recalculated to standard MC of 12% [Požgaj 1998].

RESULTS

Table 1: Descriptive statistic of basic quality parameters (wood density, modulus of elasticity and modulus of rupture) of $core_{1/1}$ and $core_{1/2}$ timber

Core timber	Statistical parameters	Quality parameters at MC 12%		
		Density ***ρ*** [kg.m^{-3}]	Modulus of elasticity ***E*** [MPa]	Modulus of rupture ***σ*** [MPa]
$core_{1/1}$ + $core_{1/2}$	***n***	**52**		
	mean	417	11514	42
	min	350	7107	16
	max	496	17318	63
	V%	8	18	28
$core_{1/1}$	***n***	**26**		
	mean	429	12410	47
	min	375	7107	16
	max	496	17318	63
	V%	8	18	22
$core_{1/2}$	***n***	**26**		
	mean	406	10618	36
	min	350	8181	17
	max	456	13761	56
	V%	8	15	27

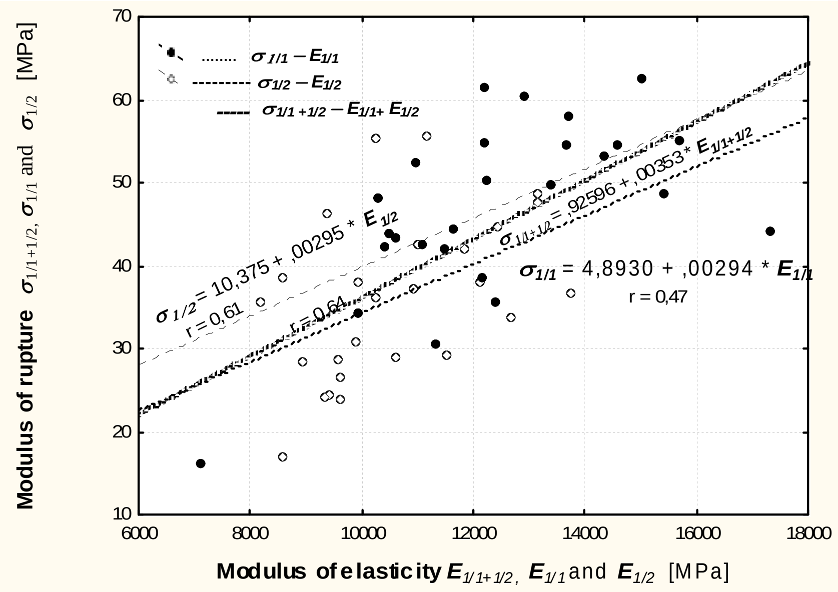

Fig. 2 *A change of bending modulus of rupture depended on the modulus of elasticity of spruce wood: modulus of rupture -* $\boldsymbol{\sigma_{1/1+1/2}}$ (altogether), $\boldsymbol{\sigma_{1/1}}$ (core$_{1/1}$) and $\boldsymbol{\sigma_{1/2}}$ (core$_{1/2}$), *modulus of elasticity -* $E_{1/1+1/2}$ (altogether), $\boldsymbol{E_{1/1}}$ (core$_{1/1}$) and $\boldsymbol{E_{1/2}}$ (core$_{1/2}$)

Relationship between modulus of elasticity and modulus of rupture ($\boldsymbol{E_{1/1+1/2}}$ a $\boldsymbol{\sigma_{1/1+1/2}}$) for all boards and individual sub samples core$_{1/2}$ ($\boldsymbol{E_{1/2}}$ a $\boldsymbol{\sigma_{1/2}}$) a core$_{1/1}$ ($\boldsymbol{E_{1/1}}$ a $\boldsymbol{\sigma_{,1/1}}$) are shown in Fig. 2. MOE increment of 1 MPa causes increase of 2.94 MPa in bending strength for both subsamples core$_{1/2}$ and core$_{1/1}$.

Comparison of core$_{1/1}$ a core$_{1/2}$ tested samples:

„tested samples core$_{1/2}$ have higher average values than core$_{1/1}$ samples“

- wood density $\boldsymbol{\rho_{1/2}}$ is 6 % higher,
- modulus of elasticity $\boldsymbol{E_{1/2}}$ is 17 % higher
- modulus of rupture $\boldsymbol{\sigma_{1/2}}$ is 30 % higher.

Fig. 3 Comparison of *modulus of rupture* between subsamples core$_{1/1}$ and core$_{1/2}$

Fig. 3 shows a 95% confidential limit of average values of determined quality parameter (σ). The results of Student t-test of core$_{1/1}$ and core$_{1/2}$ subsamples demonstrated that the difference of mean values of all determined quality parameters is significant at alpha level 0.05 (p-value for MOR is 0,0004), (p-value for wood density is 0,012, p-value for MOE is 0,001). It can be concluded that $core_{1/2}$ timber performs significantly better in all quality parameters: wood density, modulus of elasticity and modulus of rupture. A low quality juvenile wood influences quality of $core_{core}$ timber.

CONCLUSION

Reliability of structural wooden members depends on quality selection of timber. An effective evaluation can be achieved by selective grading of raw or processed material (log to structural timber). Because of the recent shortage of wood resources, the evaluation of quality at all processing stages is essential. Results of this study demonstrated quality parameters (wood density, modulus of elasticity and modulus of rupture) of core timber made by slag cutting. $Core_{side(1/2)}$ timber showed statistically higher mean values of all parameters than timber taken from the center part of a slag ($core_{core(1/1)}$ timber). This study substantiated the claim of grading structural timber into two groups $core_{side(1/2)}$ and $core_{core(1/1)}$, respectively, for achieving a better economic evaluation of wood material.

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Streszczenie: *Analiza tarcicy konstrukcyjnej z materiału głównego oraz bocznego.* Jakość tarcicy używanej w konstrukcjach zależy od jakości samego drewna, typu sortowania oraz technologii obróbki. Drewno iglaste jest sortowane bez brania pod uwagę pozycji konkretnej sztuki w pryzmie. Zależność tę sprawdzano poprzez test na zginanie badano wytrzymałość, współczynnik sprężystości oraz gęstość. Badania wykazały że tarcica boczna ma współczynnik sprężystości około 30% wyższy niż pozyskana z materiału głównego. Najmniejsze rozbieżności, rzędu 6% zaobserwowano w przypadku gęstości. Można wnioskować o wzbogacenie procesu sortowania o określenie czy tarcica pochodzi z materiału głównego czy bocznego.

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