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Effect of addition of waste pulp on selected mechanical properties of biplex board

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Abstract: *Effect of addition of waste pulp on selected mechanical properties of biplex board.* This work constitutes the fragment of the research on the issue of addition of waste pulp to a biplex board. For this purpose, examinations sheets of paper were produced in laboratory conditions with different second layer: Kraft type pulp, waste pulp type D (Kraft) and waste pulp type C (white pulp). Analyses showed significant influence of type of pulp used to prepare one of biplex layer on strength properties of final product. Findings were convergent with expectations. During tearing resistance test it was shown that this parameter is 41% lower for second layer prepared using waste pulp C type, and 19% for D type respectively.

Keywords: waste pulp, biplex board, mechanical properties

INTRODUCTION

The demand for paper is increasing on account of continued development of civilization.
As a result, nowadays, researchers seek for more efficient solutions of the recovery of paper and reprocessing. Current production technologies of waste pulp paper enable to obtain a paper product that is characterized by a comparable strength to the paper that has been manufactured from virgin pulp (Oldham 2006).

World paper production is constantly growing. Since the beginning of the twentieth century it steadily doubled in the 18 years periods (Wysocka-Robak et al. 2011). In 2009, the world consumption of cardboard amounted to 370.8 million tons, giving an average per capita of about 54.1 kg per year. The most paper and paperboard, of the total world paper usage, was used in Asia - 43.8%, followed by North America - 21.1%, and European countries belonging to CEPI - 21.9% (Fornalski 2011).

MATERIALS AND METHODS

Materials. The study was based on three kinds of laminated corrugated biplex board produced in the following combinations:

- paper made from Kraft type pulp + Kraft- type paper,
- paper made from Kraft type pulp + waste pulp paper Kraft - type D,
- paper made from Kraft type pulp + white waste pulp paper type C.

Cardboard was made in the laboratory using the Rapid – Köthen device. Weights were ground using a grinder Jokro. degree of beating of the masses determined by Schopper-Riegler apparatus. In the case of Kraft pulp reached 20 ± 2^{o}SR and recycled pulp ground to 30 ± 2^{o}SR. Obtained sheets of cardboard were prepared for further testing by cutting one sample sizes specified in the standards for individual determinations.

Methods. Prepared cardboard samples were referenced below:

- weight according to PN-EN ISO 536:2011,

- breaking length and extensibility according to PN-EN ISO 1924-2:2010,
- tearing resistance according to EN ISO 1974:2012,
- burst test according to PN-EN ISO 2758:2005,
- number of double folding according to ISO 5626:1995,
- air permeability according to PN-ISO 11004:1995,

RESEARCH RESULTS

The study applied two of the four types of waste pulp paper, according to the European nomenclature, namely type: C and D. The choice of masses was dictated by the fact that these two types are the most commonly recovered waste paper and re-processed; moreover they have the highest strength properties. Table 1 provides average results of obtained boards strength properties. It is observed that strength parameters decreased depending on pulp used to form second layer of biplex board.

Table 1 Comparison of average strength properties of biplex board.

Properties	**Research material**		
	Board: Kraft/Kraft	**Board: Kraft/waste pulp paper type C**	**Board: Kraft/waste pulp paper type D**
Breaking length [m]	3650	2905	3400
Extensibility [%]	2,63	1,16	1,50
Burst test [kPa]	1098	997	1020
Double folding	689	400	465
Tearing resistance [mN]	37	22	30
Air permeability [s]	59	47	52

Data collected in table 1 demonstrates biplex board type Kraft/Kraft, as one with the highest breaking length - 3650m, a little bit lower value – 3400m was shown for biplex type Kraft/waste pulp paper type Kraft D, the worst breaking length – 2905m was observed for biplex Kraft/waste pulp paper type C. Extensibility fluctuated from 2,63% up to 1,16%. Burst test achieved values : 1098kPa, 1020kPa and 997kPA for boards Kraft/Kraft, Kraft/waste pulp paper type Kraft D and Kraft/ waste pulp paper type C, respectively. The highest number of double folding (689) was observed for Kraft/Kraft, next 465 for Kraft/waste pulp paper type Kraft D and finally 400 for Kraft/ waste pulp paper type C. In case of tearing resistance the following values were observed: 37mN for Kraft/Kraft biplex, 30mN Kraft/waste pulp paper

type Kraft D and 22 mN Kraft/waste pulp paper type C. There were no significant differences observed for air permeability values. Figure 1 shows the percent change in strength properties contained in Table 1.

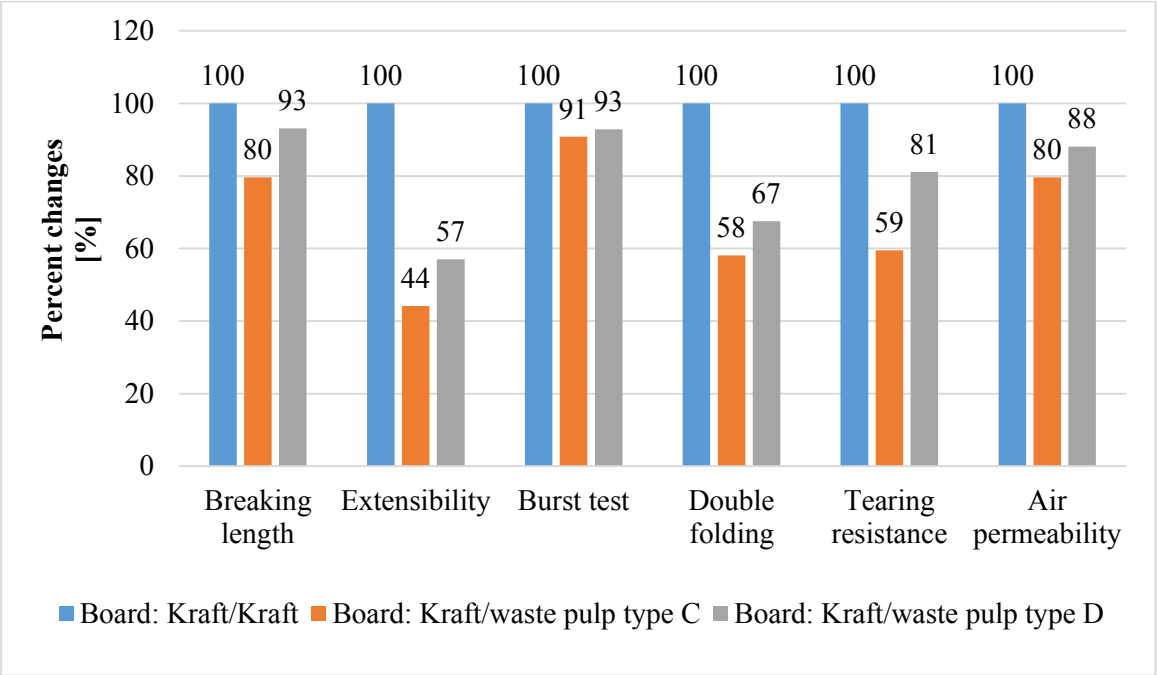

Figure 1 Percentage summary of the average results of board strength properties.

CONCLUSIONS

The results demonstrated significant influence of type of pulp used to prepare one of biplex layer on strength properties of final product. Among different alternatives to original Kraft type pulp the best strength parameters were observed for laboratory handsheets performed using waste pulp type D. These findings were convergent with expectations. During tearing resistance test it was shown that this parameter is 41% lower for second layer prepared using waste pulp C type, and 19% for D type respectively. Strength decreased insignificantly – 9% type C, 7% type D.

These preliminary findings prompt to expand research on the discussed issue.

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PN-EN ISO 536:2011: Paper and cardboard. Determination of basis weight.

PN-EN ISO 1924-2:2010: Paper and board. Determination of tensile properties -- Part 2: Constant rate of elongation method (20 mm/min).

EN ISO 1974:2012: Paper. Determination of tearing resistance. Elmendorf method.

PN-EN ISO 2758:2005: Paper. Determination of bursting strength.
ISO 5626:1995: Paper. Determination of folding endurance.
PN-ISO 11004:1995: Paper and board. Determination of air permeability. Low Range.

Streszczenie: *Wpływ dodatku masy makulaturowej na wybrane właściwości wytrzymałościowe tektury dwuwarstwowej.* Praca ta stanowi fragment badań dotyczących dodawania masy makulaturowej do tektury dwuwarstwowej. W tym celu badane arkusze papieru zostały wytworzone w warunkach laboratoryjnych z różnymi drugimi warstwami: z masy Kraft, z makulatury rodzaju D (Kraft) oraz z makulatury typu C (makulatura biurowa). Analizy wykazały znaczący wpływ rodzaju zastosowanej masy w jednej z warstw tektury dwuwarstwowej na właściwości wytrzymałościowe gotowego wytworu. Wyniki były zbieżne z oczekiwaniami. Podczas testu odporności na przedarcie wykazano, że ten parametr jest o 41% niższy dla tektury z drugą warstwą wykonaną z makulatury typu C i odpowiednio o 19% dla typu D.

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