

An attempt to use fiber strands obtained from small-sized willow wood for production of particleboards

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Abstract: *An attempt to use fiber strands obtained from small-sized willow wood for production of particleboards.* The aim of this study was to determine the possibility of using willow wood particles in the form of fibre strands, obtained by crushing the shoots, for the manufacture of particleboards. As a part of this work oriented one- and three-layer particleboards with a density of 650 kg/m³ and a thickness of 16 mm were produced. Manufactured boards were tested for the density and density distribution, MOR, MOE, IB, swelling and water absorption after 2 and 24 hours soaking in water. It was stated that oriented one- and three-layer particleboards made from willow fibres are generally characterized by comparable strength properties (MOR, MOE, IB) when compared to typical particleboard and meet the strength requirements according to the standard PN-EN 312 with respect to particleboard type P2. At the same time boards have a comparable resistance to moisture after 24 hours soaking in water relative to traditional particleboards.

Keywords: fiber strands, small-sized willow wood, particleboards, properties of boards

INTRODUCTION

One of the main directions of research concerning the development of particleboards production is the search for new materials that could complement or replace "traditional" wood particles. Currently in Poland particleboards are produced in 45 % of industrial waste and 55 % of the wood from the forest, wherein trends show an increase in use of wood waste including sawdust (Nirdosha and Setunge 2006, Gamagea *et al.* 2009, Setunge *et al.* 2009, Borysiuk *et al.* 2010). Used wood can also be a potential source of raw material, including wood from recycled pallets and packaging (Ratajczak *et al.* 2003, Niecewicz and Danecki 2009). Particles of the above raw materials used in boards manufacturing are generally obtained by using knife ring flakers or hammer mills. Size and shape of particles significantly affect properties of particleboards (Moslemi 1974, Drouet 1992, Niemz 1993). Another potential possibility for grinding raw materials into particles is their distribution along the grain through crushing and tearing. This technology was developed for the production of Scrimber also appearing under the names Timtek or Scrimtek (Oniško 2001, Timtek 2001). Its advantage is high quantitative yield and the possibility of small diameter wood processing (a few - a several dozen mm) while obtaining sufficiently long fibres.

A part of this study was an attempt to determine suitability of particles obtained by crushing and longitudinal tearing of small-sized willow wood (shoots with diameters up to 20 mm) for particleboard production.

MATERIAL AND METHODS

In the study particleboards with thickness of 16 mm and density of 650 kg/ m³ were prepared, in the following variants of internal structure:

- one-layer oriented boards from willow particles – 1W
- three-layer oriented boards from willow particles (perpendicular orientation of particles in each layer, share of each layer: 25/50/25) – 3W

- one-layer particleboard from pine industrial chips - control variant - 1K.

Particles for the manufacture of boards were obtained from willow shoots about 1.0 ÷ 1.5 m long and 20 mm in diameter (Figure 1). Shoots were crushed between steel rollers, which caused the fragmentation along fibres. Exemplary particles derived from willow are shown in Figure 2. For the preparation of control boards industrial pine chips were used (for the middle layer). The UF glue was applied, the amount of glue was 10 %. Parameters of boards pressing were as follows: maximal specific pressure 2,5 MPa, temperature 180°C, time of pressing 288 s. After manufacturing, boards were conditioned under laboratory conditions for seven days and then their properties were tested: density, according to EN 323, density distribution through GreCon device, MOR and MOE according to EN 310, IB in accordance to EN 319, swelling and water absorption after 2 and 24 according to EN 317.



Fig. 1 Willow shoots used to particles production

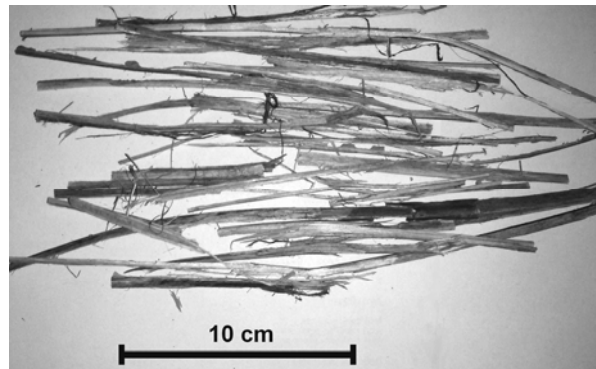


Fig. 2 Strands of fibres obtained from willow shoots

Determination of each tested properties was performed on 10 samples, selected against density ($\pm 5\%$ deviation of assumed average density). Statistic significance of differences was determined on the basis of T-Student test for the confidence level of 95%.

RESEARCH RESULTS

Test results of particleboards manufactured in this study are shown in Figure 3 and Tables 1 and 2.

Tab. 1 Compilation of mechanical tests results of manufactured boards

Variant	Density	MOR	MOE	IB
	kg/m ³	N/mm ²	N/mm ²	N/mm ²
1W	652	13.3 (2.6)	2664 (398)	0.59 (0.08)
3W	644	12.1 (3.2)	2389 (378)	0.60 (0.12)
1K	659	14.6 (1.6)	2181 (191)	0.63 (0.06)

*values in parentheses are standard deviations

Tab. 2 Compilation of physical tests results of manufactured boards

Variant	Thickness swelling		Absorbability	
	2 h	24 h	2 h	24 h
	%	%	%	%
1W	29 (4)	49 (6)	61 (7)	93 (4)
3W	27 (4)	50 (7)	61 (7)	94 (4)
1K	34 (4)	43 (5)	80 (5)	96 (9)

*values in parentheses are standard deviations

In general it can be stated that one- and three-layer particleboards manufactured from willow particles obtained by crushing the shoots between steel rollers are characterized by similar strength properties (MOR, MOE and IB) to a single-layer particleboards manufactured from chips for the inner layers. Statistically significant differences exist only in the case of MOE between variant 1W (single-layer boards from oriented willow particles) and 1K (control board). In case of variant 1W when compared to 1K, higher values of MOE (by 22%) directly result of oriented layout of particles in boards from willow raw material. In case of three-layer boards (variant 3W) only the outer layers, which represented 50% of the boards were oriented in the tested direction, the middle layer was oriented perpendicular to the tested direction. As a result, such a layout did not affect with a statistically significant change in the strength properties of boards in relation to the control boards. It should be noted that examined boards meet the strength requirements for boards of type P2 (according to EN 312). Use of willow particles resulted in an increase irregularities in density distribution on the cross section of manufactured boards for both one- and three-layer boards (Fig. 1).

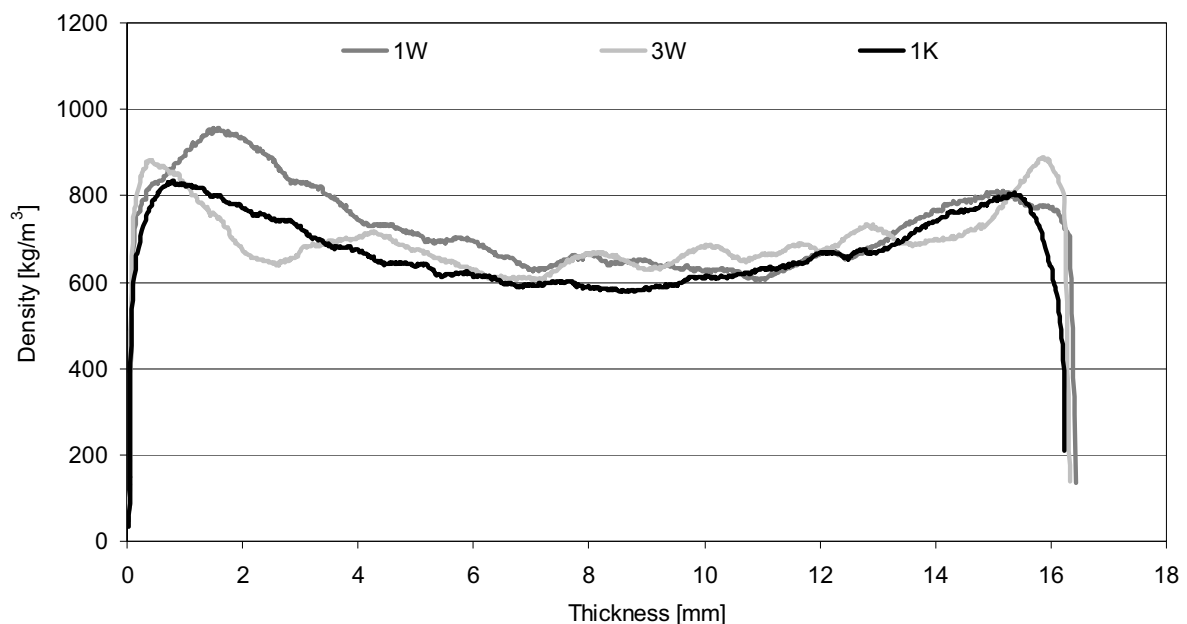


Fig. 3 Density distribution of tested particleboard

Particleboards manufactured from willow particles are characterized by lower values of swelling and water absorption by 18 % and 24 % respectively for short-term soaking in water (2 h) when compared to boards from industrial chips (Table 2). These differences were statistically significant. Differences between swelling and water absorption after 24 h of soaking in water were statistically insignificant in all variants. On this basis, it can be stated that better resistance to moisture characterizes boards from willow particles only after short-term exposure to its action. In the long term the new raw material does not significantly affect on changes in boards resistance to moisture.

CONCLUSIONS

Based on the research of one- and three-layer oriented particleboards, with a density of 650 kg/m^3 and a thickness of 16 mm, manufactured of willow wood particles, obtained by crushing, the following conclusions can be drawn:

1. particles obtained by crushing willow shoots (small-sized wood) can be used to manufacture oriented particleboards

2. one- and three-layer oriented particleboards manufactured from willow particles characterize in general by comparable strength properties (MOR, MOE, IB) when compared to typical particleboards
3. one- and three-layer oriented particleboards manufactured from willow particles characterize by lower swelling and water absorption after 2 hours of soaking in water and comparable resistance to moisture after 24 hours of soaking in water when compared to traditional particleboards
4. one- and three-layer oriented boards manufactured from willow particles characterize by more volatile density distribution than particleboards from industrial chips.

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Streszczenie: *Próba wykorzystania pasm włókien pozyskanych z małowymiarowego drewna wierzbowego do produkcji płyt wiórowych.* Celem pracy było określenie możliwości wykorzystania do wytwarzania płyt wiórowych cząstek z drewna wierzbowego w postaci pasm włókien, pozyskanych poprzez miażdżenie pędów. W ramach pracy wytworzono orientowane jedno- i trzywarstwowe płyty wiórowe o gęstości 650 kg/m³ i grubości 16 mm. Dla wytworzonych płyt zbadano gęstość i profil gęstości, MOR, MOE, IB, spęcznienie i nasiąkliwość po 2 i 24h moczenia w wodzie. Stwierdzono, że orientowane płyty wiórowe jedno- i trzywarstwowe wytworzone z cząstek wierzby charakteryzują się na ogół porównywalnymi właściwościami wytrzymałościowymi (MOR, MOE, IB) w stosunku do typowych płyt wiórowych i spełniają wymagania wytrzymałościowe według normy PN-EN 312 w odniesieniu do płyt wiórowych typu P2. Jednocześnie płyty te charakteryzują się porównywalną odpornością na działanie wilgoci po 24 h moczenia w wodzie w stosunku do tradycyjnych płyt wiórowych.

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