INVESTIGATION ON DRILLING OF THE PARTICLEBOARDS PRODUCED FROM FIBROUS CHIPS

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Abstract

The following paper presents the investigations of drilling of the panels produced from the fibrous chips from alternative raw materials: willow Salix Viminalis L. and Robinia Pseudoacacia L. The results show that there are bigger forces needed to drill the panels from robinia. Comparing the strength and forces parameters when drilling, the optimal are particleboards produced from willow fibrous chips.

Key words: *particleboard, fibrous chip, drilling, cutting moment, feed force*

INTRODUCTION

There are several reasons of trials to produce the strong and durable panels for furniture industry: transportation, handling and assembly costs, as well as raising raw materials and energy prices. The most popular, sandwich construction with paper based honey comb core layer, apart from many advantages, have the main disadvantage: the restriction to thickness reduction. One of the attempt to find the alternative material was to produce the sandwich-construction panel from HDF panels as the face layers and specially prepared particleboard with the density profile as the core layer (Michanicki 2005). The panels' density with 18 mm thickness can be reduced even to 240 kg/m^3. The reduction of the panels' density by use of the alternative raw materials was also investigated (Balducci et al. 2008). The raw materials were: hemp, kenaf, sunflower, maize, topinambur, miscanthus, rape, poplar and waste wood. These trials show that even with the panels' density decrease to 400 kg/m^3, there are possibilities to produce the panels, which meets the EN 312 requirements in terms of internal bond strength (i.e. panels made out from topinambur or poplar, with use of PMDI bonding agent). The bending strength of above mentioned panels is very low (2.4, 4.6 N/mm^2), but in case of special application (i.e. furniture doors) it must not be a disqualification feature. There were trials to produce the panels from fibrous chips (Anonym 1989). The main advantage of the panels produced from these chips was better machining parameters, as well as higher raw material's efficiency. The process of production has been successfully applied in German particleboard plant.

According to previous research (Kowaluk 2009 a, Kowaluk 2009 b), there are promising results of wood-based panels production with reduced density from alternative raw materials, such as fast growing willow *Salix Viminalis* and *Robinia Pseudoacacia*.

There is lack of information about the machining of the panels produced from such raw materials.

The goal of the research was to investigate the influence of the particleboards raw materials type on the forces during drilling of the panels produced from these raw materials. In the scope of the research the measurement of the cutting moment and feed force was performed.

MATERIAL AND METHODS

Tested materials

The following materials were used in investigations:

- commercially available 3 layer 16 mm thick particleboards, with the density 645 kg/m^3 *(hereinafter: **i**)*,
- 3 layer 16 mm thick particleboards with two densities (600 and 660 kg/m^3) produced in laboratory conditions from industrial particles *(hereinafter: **ip600** and **ip660**)*,
- 3 layer 16 mm thick particleboards with two densities (600 and 660 kg/m^3) produced in laboratory conditions from fibrous chips from willow *Salix Viminalis* L. *(hereinafter: **w600** and **w660**)*,
- 3 layer 16 mm thick particleboards with two densities (600 and 660 kg/m^3) produced in laboratory conditions from fibrous chips from robinia *Salix Viminalis* L. *(hereinafter: **r600** and **r660**)*.

The density profiles of the investigated panels were measured on x-ray based GreCon DA-X system. The results of the measurements are displayed on fig. **1**.The maximum variations of the produced panels average density from the assumed values were about 6 %. All the samples before the tests were stored in climatic chamber under parameters 20 ºC/65 % R.H.

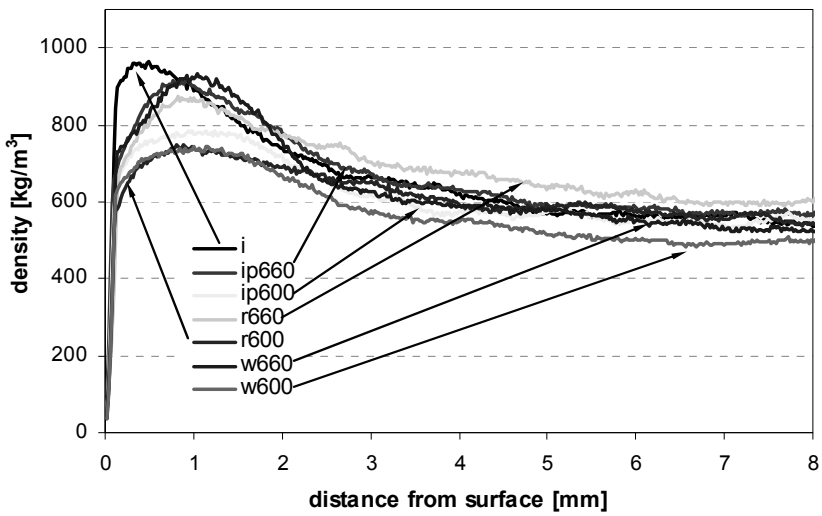

Fig. 1. The density profiles of investigated panels

Two different raw materials were used in these investigations to produce the fibrous chips:

- willow *Salix Viminalis* L., taken as about 2 m long 2 years old rods from plantation for energetic purposes,
- robinia *Robinia Pseudoacacia* L., taken as a 2 years old root offshoots.

The fibrous chips were produced on Pallmann defibrator. The span between the hammer and milling disc was 1.2 mm. The raw material's moisture content was about 111 % for willow and 60 % for robinia. The mass fraction share of produced fibrous chips and industrial particles (for comparative purposes) was as in the fig. 2. The fraction of 2-8 mm was taken for core layer, and 0.5-1 mm for face layers.

From the investigated fibrous chips, as well as from industrial particles, the three-layer particleboards of the dimensions of 700x500 mm were produced under laboratory conditions. Important production parameters were: face layers share 32 %, industrial face layers' chips, face layers' resination 12 %, core layer resination 8 %, Silekol W1-C industrial UF resin, press factor 10 s/mm. The rest of production parameters were close to industrial. All the panels were both-side sanded on the industrial sanding machine to achieve the regular thickness.

All the produced panels, as well as the samples of the commercial particleboards, were tested in case of bending strength (PN-EN 310) (fig. 3).

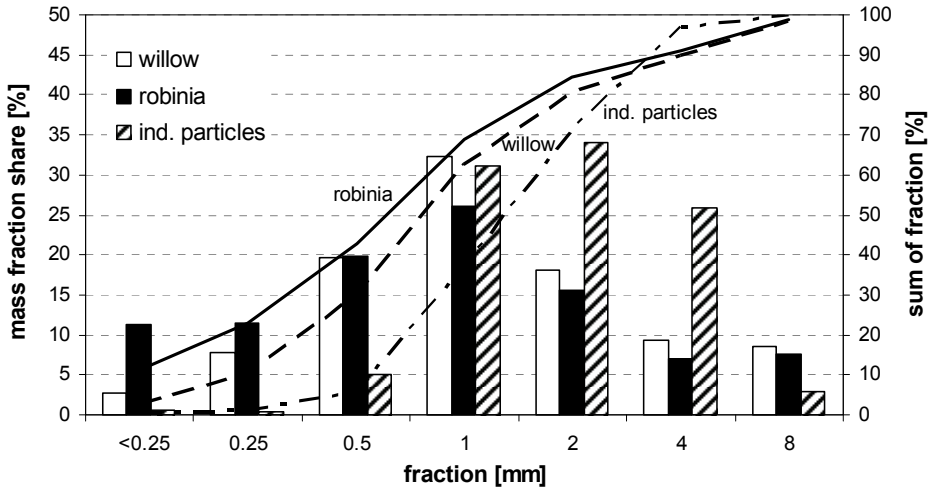

Fig. 2. The mass fraction share of produced fibrous chips

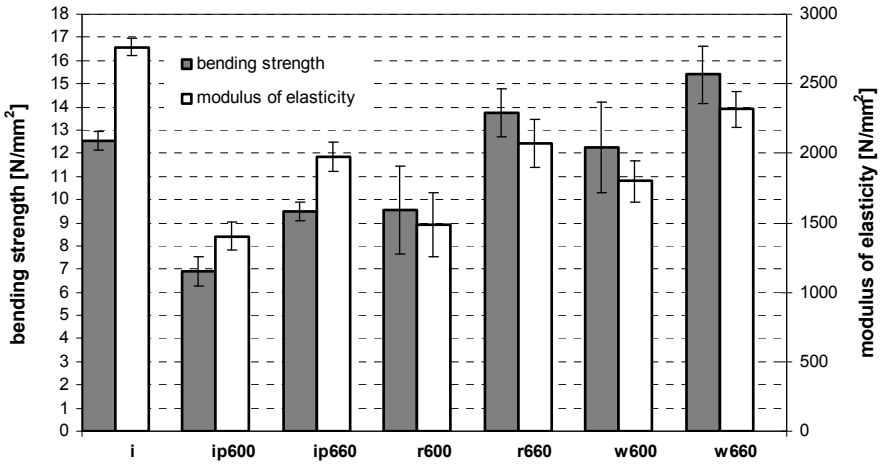

Fig. 3. The bending strength and modulus of elasticity of the investigated panels

Research stand

The machining was conducted on the stand described by Pohl and Biniek (2002). The signals from the gauges were registered by PC. The following drilling parameters were applied: drilling diameter 5 mm, feed rate per rotation 0.1 mm, rotation speed 615 rpm, depth of drilling – through, type of drill – spiral, equipped with a centering spike and pre-cutters, HSS, wear stage of cutting edges – sharp. Two parameters (feed force and cutting moment) were calculated basing on the measured signals with use of specially prepared LabView routine. The values of both: cutting moment and feed force were calculated as an average values for full depth of drilling.

RESULTS AND DISCUSSION

The values of the cutting moments during drilling of the panels from different raw materials are displayed on fig. 4. The highest values of the cutting moment were noted for panels i and r660 (about 0.164 Nm). There is no difference between cutting moment when drilling of panels produced from industrial particles, ip600 and ip660. Important is, that these panels had the density different of 10 %. In case of these panels this difference of density is clearly visible on density profiles on

fig. **1**. When investigating the panels produced from fibrous chips (r and w), the influence of the density is better visible: the cutting moment increases with the density increase. The similar difference of the cutting moment when changing the density of the panels r and w, about 8 %, was noted. The cutting moment of the drilling of the panels from robinia is higher for about 31 % from cutting moment when drilling willow panels.

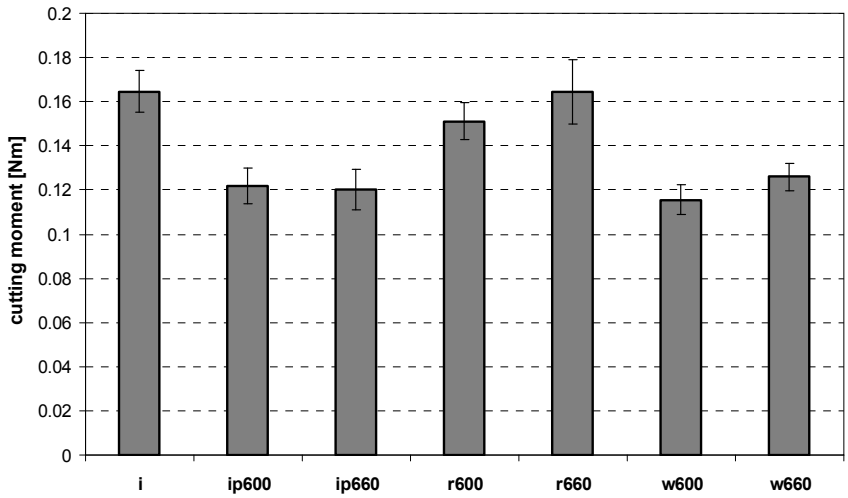

Fig. 4. The cutting moment when drilling of the investigated raw materials

The feed force when drilling of the panels produced from different raw materials is shown on fig. 5. The highest value of this force was observed for i panel, and the lowest for panels ip and w600. In case of the panels produced from fibrous chips, r and w, with the increase of the panels density the feed force increases. According to the comparison of the measured forces during drilling, to the mechanical parameters of the investigated panels (fig. 3), the most optimal panels are w660 and w600, because of the high bending strength and modulus of elasticity, with the low values of the forces during drilling.

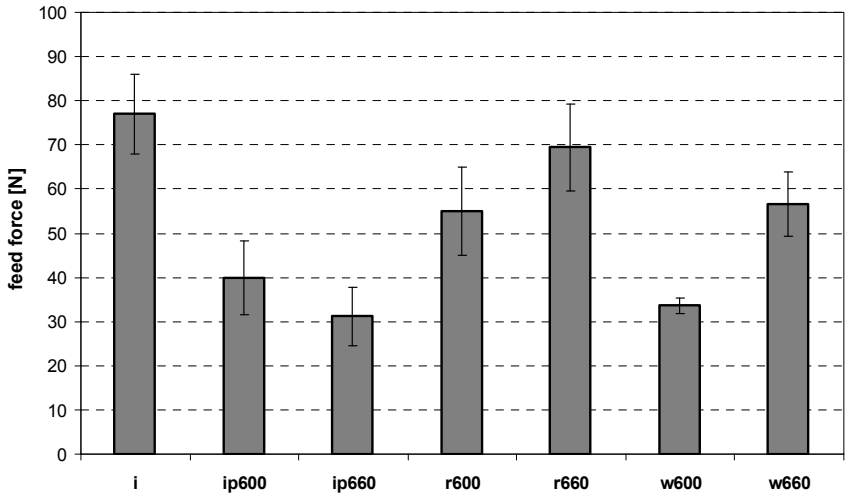

Fig. 5. The feed force when drilling of the investigated raw materials

CONCLUSION

According to the above mentioned results, it can be pointed out, that:

- there are different forces during drilling the industrial panels, particleboards produced from industrial particles and panels from fibrous chips,
- the panels produced from willow fibrous chips have the lower forces during drilling compare to the panels produced from robinia fibrous chips (with the comparable density),
- with the increase of the density of the panels the forces during drilling increases.

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