INFLUENCE OF THE RAW MATERIALS PARAMETERS ON THE PROPERTIES OF THE FIBROUS CHIPS AND PARTICLEBOARDS

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Abstract

The following paper presents the investigations of the particleboard's raw materials tensile strength influence on the mechanical features of the panels produced from them. The results have shown that the panels with higher bending strength and modulus of elasticity can be produced from the raw material with lower density and tensile strength.

Key words: *particleboard, fibrous chip, raw material, tensile strength*

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*.

As it is known, these wood species have significantly different density. It is also known, that many features of wood are strongly connected to density, e.g. tensile strength. Question is: are there any relations between the raw material's and particleboard's mechanical properties?

The goal of the research was to investigate the influence of the raw materials parameters on the properties of the fibrous chips and particleboards produced from them. In the scope of the research the measurement of tensile strength of willow and robinia was performed, as well as the bending strength and modulus of elasticity of panels produced from willow's and robinia's fibrous chips.

MATERIAL AND METHODS

For tensile strength measurement of the raw materials such as willow *Salix Viminalis* and robinia *Robinia Pseudoacacia*, the unique samples' geometry was developed (fig. 1a). In case of developed samples important is, that all essential elements of the sample, external and internal, including bark and pith, are present in the "cross section of destruction". The prepared samples before the tensile test are shown on fig. 1b.

The fibrous chips were produced from the investigated raw materials. The Pallmann chipper with defibrator equipment was used. The mass fraction share of produced fibrous chips was performed on the laboratory orbital-vertical sieving machine aided by vertical tap Retsch model AS 200 TAP. The results of the mass fraction share measurement are displayed on fig. 2.

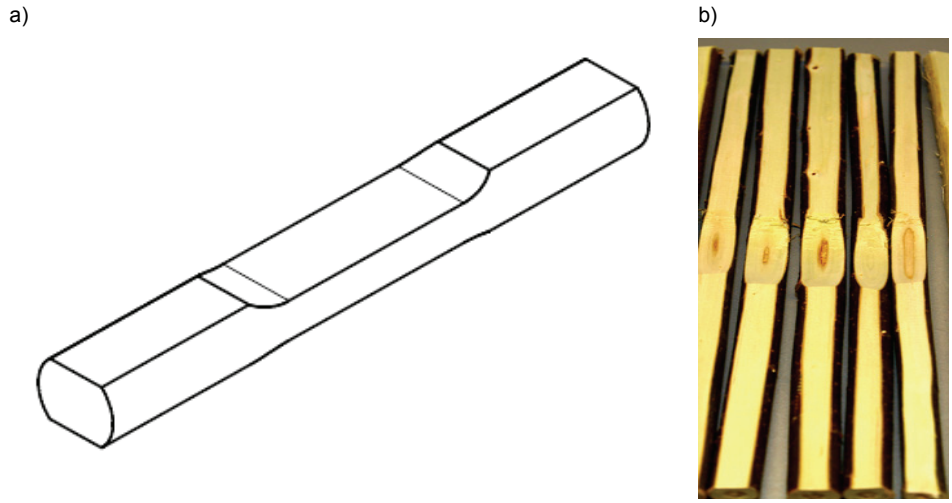

Fig. 1. The samples to measure the tensile strength of raw materials for fibrous chips production: assumed shape (a) and samples before test (b)

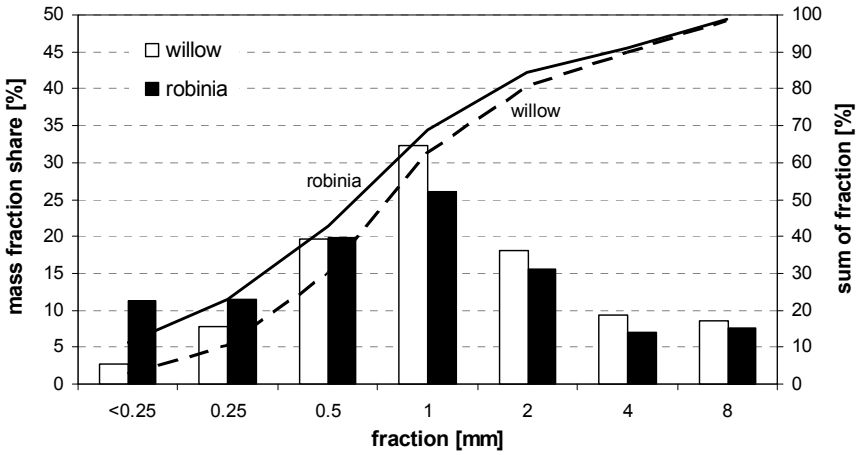

Fig. 2. The fraction share of the fibrous chips produced from investigated raw material

From the investigated fibrous chips the three-layer particleboards of the dimensions of 700x500 mm were produced under laboratory conditions. Important production parameters were: density (assumed) 600 kg/m^3, 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.

RESULTS AND DISCUSSION

According to fig. 3 the tensile strength of the investigated raw materials is strongly connected to the density. The tensile strength of pine (Krzysik 1974), which density is close to willow's density, is significantly higher. The reason can be the wood age: the origin of the samples of the pine wood could be the mature stem, and thanks to this, much more year rings could occur in the investigated sample. The samples of wood investigated in these research were taken from two-years old root offshoots.

The data displayed on fig. 4 does not confirm the proportional regression between the raw material density and particleboards' bending strength and modulus of elasticity. As it is shown, the panels produced from willow, which density (and tensile strength) is lower than robinia, have the highest measured mechanical parameters. According to Barboutis and Philippou (2007), there is a strong correlation between the density of raw material and bending strength of particleboards produced from them. To achieve the proper mechanical parameters of the panels, the necessity of the proper compression ratio (board/wood density) appears: the species of wood of smaller density can give the opportunity to produce the panels with good mechanical parameters even with lower panel's density. To meet the requirements of high mechanical strength in case of panels produced from species with high wood density, the higher panel's density (compression ratio) is needed. In these research the compression ratio is 0.84 for robinia and 1.15 for willow, and, as it can be seen on fig. 4, the bending strength of robinia's panels is smaller than in case of particleboards produced from willow.

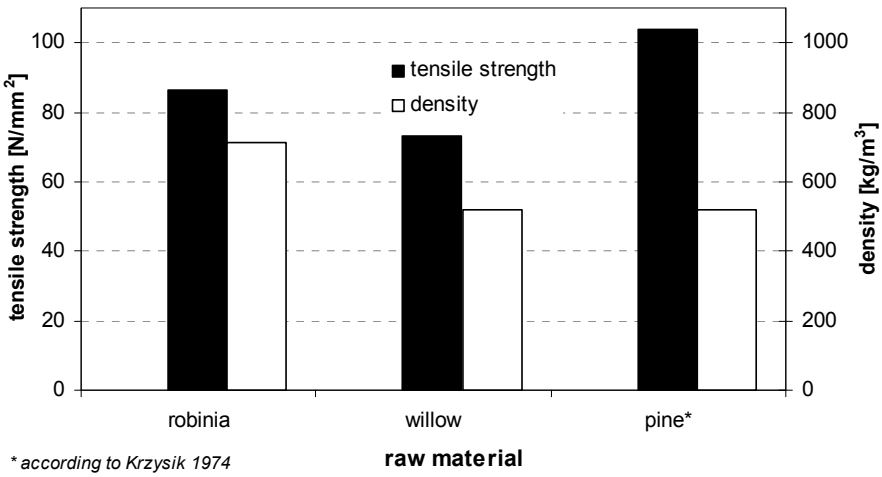

Fig. 3. The comparison of tensile strength and density of investigated raw materials

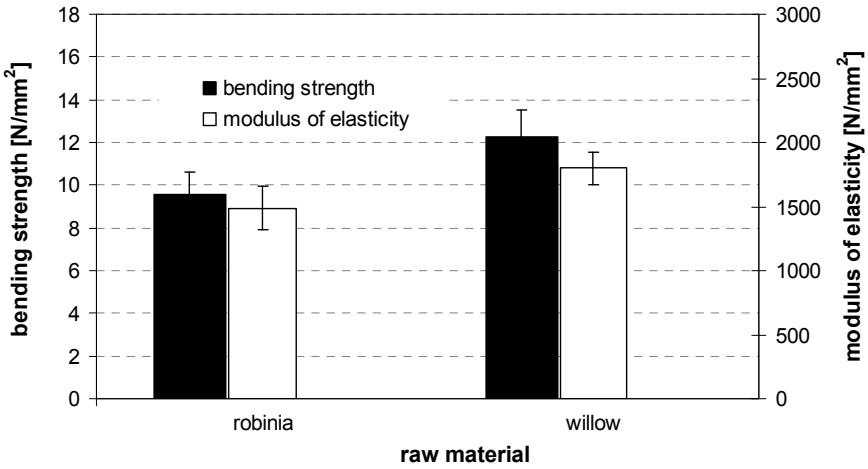

Fig. 4. The bending strength and modulus of elasticity of panels produced from fibrous chips

CONCLUSION

The investigation has shown, that in case of robinia, it is possible to produce the fibrous chips with higher share of smaller fractions (incl. dust), compare to willow. The tensile strength of robinia wood was higher than willow. Nevertheless, the panels produced from robinia's fibrous chips had lower tensile strength and modulus of elasticity in bending. The solution for achieving better bending strength of the panels produced from robinia can be higher panels' density.

REFERENCES

ANONYM (1989): Messerlose Faserspanaufbereitung. HK 11/89
BALDUCCI F., HARPER CH., MEINLSCHMIDT P., DIX B., SANASI A. (2008): Development of innovative particleboard panels. Drvna Industrija 59 (3): 131-136
BARBOUTIS J. A., PHILIPPOU J. L. (2007): Evergreen Mediterranean hardwoods as particleboard raw material. Building and Environment 42 (2007): 1183–1187
KOWALUK G. (2009 a): Influence of the density on the mechanical properties of the particleboards produced from fibrous chips. Ann. WULS-SGGW, For and Wood Technol. 68, 2009: 397-400
KOWALUK G. (2009 b): Influence of the method of milling on the geometry of fibrous chips and bending strength of produced particleboards. Proc. 3rd Int. Sc. Conf. WOODWORKING TECHNIQUES; Zalesina, Croatia; 02.-05.09.2009: 323-331
KRZYSIK F. (1974): Nauka o drewnie. PWN Warszawa [in polish]
MICHANICKI A. (2006): Development of a new light wood-based panel. 5th European Wood-based Panel Symposium, 4-6 October 2006, Hannover, Germany
PN-EN 310:1994 Wood-based panels – Determination of modulus of elasticity in bending and of bending strength

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