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Properties of particleboard produced with use of hazelnut shells

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Abstract: *Properties of particleboard produced with use of hazelnut shells.* The aim of the work was to investigate the influence of addition of different amount of hazelnut shells particles to particleboards structure during its production, on selected parameters of produced composites. There is no significant influence of hazelnut particles content on bending strength and modulus of elasticity, but the significant decrease of water absorbance and swelling in thickness was observed with increase of hazelnut particles increase.

Key words: hazelnut shells, particleboard, mechanical parameters, water absorption, swelling in thickness

INTRODUCTION

According to Pirayesh et al. 2012, there are technological possibilities to produce the particleboards with the proper mechanical parameters and significantly improved panels' parameters when soaked in water, with use of walnut shells. The upper limit of the content of walnut particles should not exceed 20%, because the decrease of the mechanical parameters of the panels occurs over this value. The panels with correct mechanical parameters and lower water absorptivity can be produced also with 30% addition of almond shells (Pirayesh and Khazaeian 2012). Güler et al. 2008 investigated the utilization of peanut shells to particleboards production. According to these research, the particleboard with the density of 700 kg/m^3, which meet the requirements of the proper standards, can be produced with the peanut particles content less than 25% in the core layer.

RESEARCH OBJECTIVE

The aim of this work was to investigate the influence of addition of different amount of hazelnut shells particles to particleboard structure during its production, on selected parameters of produced composites.

MATERIAL AND METHODS

As thick as 12 mm, three layer panels, with the density of 800 kg/m^3, from industrial coniferous particles and urea-formaldehyde (UF) resin were produced. The content of hazelnut (*Corylus avellana* L.) shells particles in core layer (by weight) was 0, 5, 10, 30 and 50% (hereinafter: panel types). The share of face layers was 32%. The resination of all layers was 8%. As a hardener an aqueous solution of NH_4Cl was used, and the curing time of glue mass in 100°C was about 80 s. The fraction share of wood particles was like over 90% of particles in between 0.25 and 2 mm, when for hazelnut shells was like over 95% particles in between 0.63 and 4 mm. The moisture content of all used particles was about 3%. The pressing parameters were as follows: temperature 180ºC, time factor 15 s/mm, maximum unit pressure 2.5 MPa. The following parameters of produced panels were investigated: bending strength and modulus of elasticity during bending, internal bond, screw withdrawal resistance (SWR), as well as swelling in thickness and water absorption. The appropriate European standard procedures were applied (EN 310:1994, EN 319:1999, EN 320:2011, EN 317:1999). The density profiles were also measured with use GreCon Da-X, X-ray density profiler.

All samples were conditioned in 20°C/65% of R.H. to weight stabilization prior to testing.

RESEARCH RESULTS

The investigation of density profiles of produced panels with different content of hazelnut shells particles is presented on figure 1. Since the structure of the panels is symmetrical along the middle of thickness, only the half of the thickness is displayed. The figure shows that there is no significant difference between these profiles for panels with 5, 10 and 15% content of hazelnut particles. The reference panel 0 presents the highest densification of surface layers, when the core layer density in the middle of thickness is lowest. For the panels with the highest content of hazelnut particles, 30 and 50, the differences between the core and face densities decreases. The characteristic "U"-shape profile was observed for tested particleboards. The average density was quite regular, and the highest difference between assumed and received density was less than 2%. That means there should not be an influence of density variation on the measured properties of the panels.

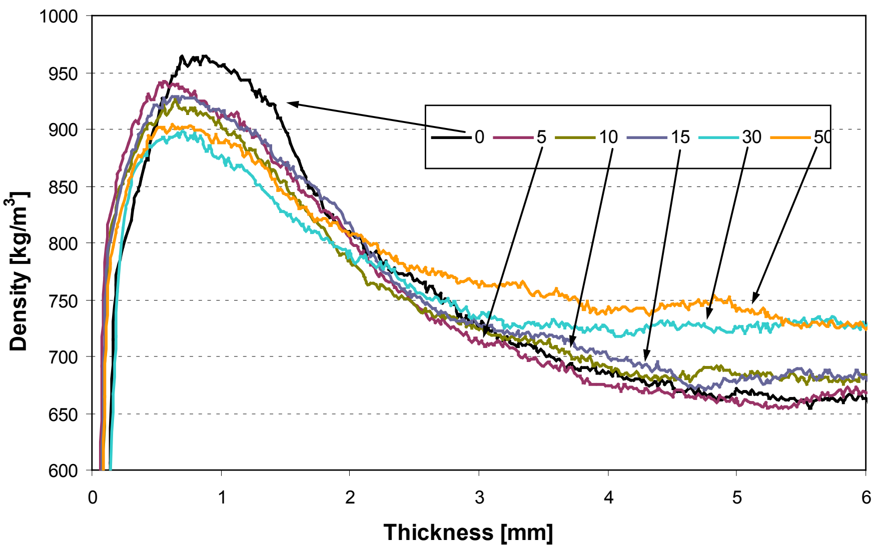

Figure 1. The density profiles of investigated panels

The figure 2a shows the values of the modulus of rupture and modulus of elasticity during bending of tested panels. As it can be seen, there is no significant difference between modulus of rupture of investigated panels, in the range of 0 – 50% content of hazelnut shells particles in core layer. The reason of this is the location of hazelnut particles – core layer. As it is well known from the mechanical point of view, the surface layers are mainly responsible for bending properties. The lowest value of modulus of rupture was about 14 N/mm^2 for panel 50, and the highest – over 16 N/mm^2 for panel 10. There is no statistically significant difference between modulus of rupture values. In case of modulus of elasticity in static bending, the statistically significant difference was observed only for panel 10, compare to the rest of the panels, where the highest value was noticed - 2903 N/mm^2. The remaining values were between 2137 N/mm^2 for panel 30 and 2469 N/mm^2 for panel 50. The investigated values of internal bond (figure 2b) shows, that, with exemption of panel 15, the internal bond of the panels produced with different content of hazelnut shells particles increases with hazelnut particles content increase. The lowest value of internal bond was for reference panel – 0 type, and it was 0.34 N/mm^2, when the highest value, 0.63 N/mm^2, for panel 50. The explanation of increasing internal bond with hazelnut particles content increase can be the structure of shells particles, which are more compact and homogenous, compare to wood particles. Since the glue demand for these particles is smaller, the higher real resination of wood particles can effect the increasing internal bond.

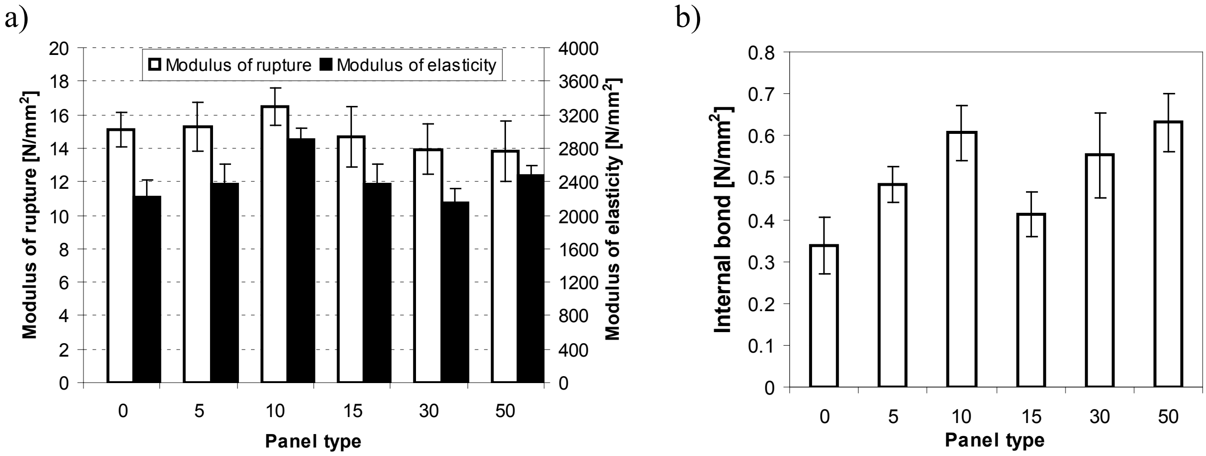

Figure 2. Selected mechanical properties of tested panels: modulus of elasticity in bending, modulus of rupture (a) and internal bond (b)

The results of investigation of influence of water on the properties of tested panels are displayed on figure 3a and figure 3b. According to figure 3a, where the swelling in thickness results are presented, the increase of hazelnut shells particles content in core layer of particleboard significantly reduces swelling. There is also clearly visible the reduction of intensiveness of swelling in time of soaking. The highest value of swelling after 2 h of soaking in water was less that 26% for panel 0, when this value increases to about 38% after 24 h of soaking, that gives 12% of increase. For panel 50 the difference of swelling in thickness after 2 and 24 h of soaking is about 8.6%. That blocking function is represented by less porous (less accessible for water) and more dense structure of hazelnut shells particles. The reduction of swelling in thickness after 2 h of soaking is from less that 26% for panel 0 to less than 13% for panel 50. For the same panels after 24 h of soaking the reduction of swelling was from less than 38% to about 21%.

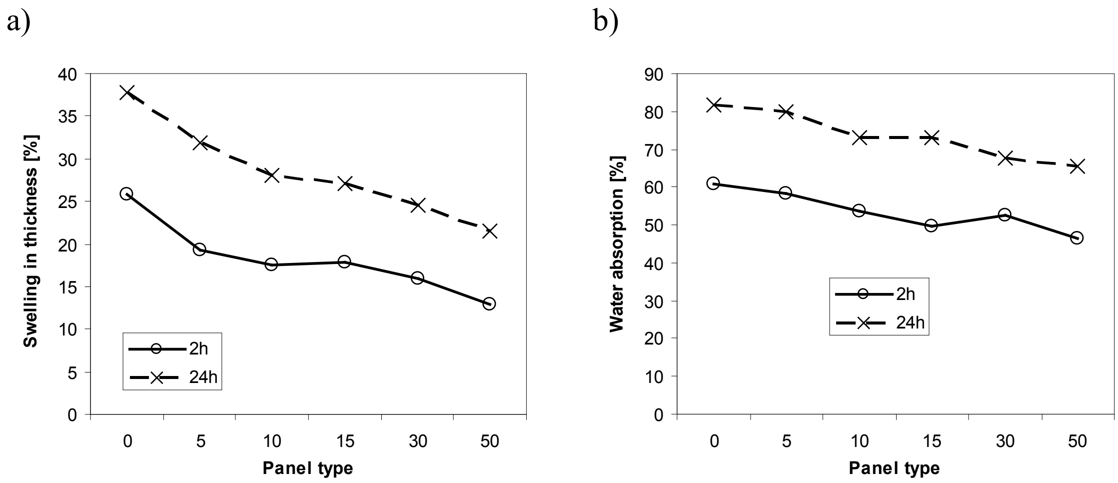

Figure 3. Swelling in thickness (a) and water absorption (b) of investigated panels

The similar blocking and reducing function of hazelnut shells particles can be noticed when analysing the results of water absorption of investigated panels (figure 3b). The strong dependence between hazelnut particles content and water absorption is marked, where the water absorption decreases with hazelnut particles content increase. These remarks are similar to conclusions of Pirayesh et al. 2012, where the walnut shells were used to particleboards production.

The investigation of screw withdrawal resistance shows no statistically significant influence of the hazelnut shells particles content of this feature. The lowest value of SWR was about 58 N/mm for panel 0, and the highest value was over 76 N/mm for panel 15.

CONCLUSIONS

On the basis of conducted investigations and result analysis the following conclusions and remarks can be drawn:

1) The highest/lowest density difference on the thickness of the panels produced with different content of hazelnut shells particles gets lower with hazelnut particles content increase.
2) There is no significant influence of the hazelnut particles content in core layer on modulus of rupture in the investigated content range (0 – 50%).
3) Except panel with 10% hazelnut particles content, there is no significant influence of the content of hazelnut particles on the modulus of elasticity.
4) The internal bond of the panels produced with use of hazelnut shells particles increases with these particles content increase.
5) The addition of hazelnut shells particles to the particleboard structure in the range of 0 – 50% significantly improves the properties of these panels when subjected to soaking. The swelling in thickness, as well as water absorption decreases with hazelnut particles content increase.

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Streszczenie: *Właściwości płyt wiórowych wytworzonych z użyciem łupin orzechów laskowych*. Celem badań była ocena wpływu różnego udziału cząstek łupin orzechów laskowych w strukturze płyt wiórowych na wybrane parametry wytworzonych kompozytów. Wykazano brak istotnego wpływu udziału tych cząstek na wytrzymałość na zginanie i moduł sprężystości. Stwierdzono natomiast znaczny spadek spęcznienia na grubość oraz nasiąkliwości płyt wraz ze wzrostem udziału cząstek orzechów laskowych w warstwie wewnętrznej.

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