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SCREW HOLDING PERFORMANCE OF PANELS MADE OF FIBROUS CHIPS

The aim of the research was to investigate the face screw withdrawal resistance of panels produced from fibrous chips of willow Salix Viminalis L. and black locust Robinia Pseudoacacia L. A series of laboratory 3-layer panels were produced from fibrous chips as well as from industrial particles. The results were compared to commercial industrial panel performance. The investigation shows that the panels from black locust have lower screw withdrawal resistance in comparison with the industrial panel. In the case of higher density willow panel the screw withdrawal resistance was better than that of the industrial panel.

Keywords: particleboard, fibrous chips, screw, withdrawal resistance, SWR, willow, black locust

Introduction

A lot of research on screw, nail and other joints withdrawal resistance from wood has been conducted [Eckelman 1975; Aytekin 2008; Taj et al. 2009]. Some of it aim to find the correlation between chosen features of wood and the screw withdrawal resistance, and other to confirm the validity of those correlations and/or to apply them to other materials. According to Fakopp Enterprise the bending strength of wooden beams can be determined on the basis of the screw withdrawal force as well. The correlation coefficient between the screw withdrawal force and the bending strength (modulus of rupture – MOR) is 0.72, and between the screw withdrawal force and shear modulus it is 0.86.

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The literature on determination of the screw withdrawal resistance of particleboards is not so numerous. The fundamental work of Eckelman [1975] proposes the package of formulas on the basis of which the average screw holding strength of particleboard can be predicted.

Because particleboards made of fibrous chips are rather new and uncommon type of panels, standard mechanical features of those panels were investigated, as well as the influence of changes in panel production parameters on the final product properties [Kowaluk 2009; Kowaluk et al. 2010]. Thus far there have been no investigations on the screw withdrawal resistance of panels produced from fibrous chips.

The aim of the research was to investigate the face screw withdrawal resistance of panels produced from fibrous chips of willow *Salix Viminalis* L. and black locust *Robinia Pseudoacacia* L.

Materials and methods

The following materials were used in the investigations:

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

The parameters of the production of fibrous chips and panels as well as the density profiles and main strength features (bending strength, internal bond and modulus of elasticity) of the produced panels were set according to Kowaluk et al. [2010].

The direction of the screw axis/load was perpendicular to the panel's face layer. The main dimensions of the screw intended for wood and wood-based materials used in those investigations were as follows: thread part diameter 4 mm and thread part length 45 mm. The screws were driven through the panel. The tests were carried out on a testing machine registering the maximum force.

The ANOVA test was performed to investigate statistical significance of the differences of the results obtained. The assumed significance level was 0.05.

Results and discussion

As it is clearly visible in fig. 1, among the investigated panels made of fibrous chips w660 panel is characterised by the highest SWR. The resistance of w660 panel to screw withdrawal is higher than the SWR of the industrial ***i*** panel. The low value of the screw withdrawal resistance of r660 and r600 panels can be connected with the low values of the internal bond [Kowaluk et al. 2010] in those panels. This observation is in accordance with the observation of Semple and Smith [2006] who found a correlation ($r^2 > 0.7$) between the screw withdrawal resistance and the internal bond. In the case of panels produced from fibrous chips (i.e. r660, r600, w660 and w600) the dependence between the SWR and the panel density can be observed: the SWR increases as the panel density increases. That observation confirms the conclusion of Eckelman [1975] that the specific gravity of particleboards is a useful predictor of the joints holding. Another important observation should be pointed out, namely that the type of particles can influence the SWR. In the case of industrial particles (ip660 and ip600) the SWR is independent of the panel density, and there are important differences between the SWRs of panels produced in the same way from fibrous chips.

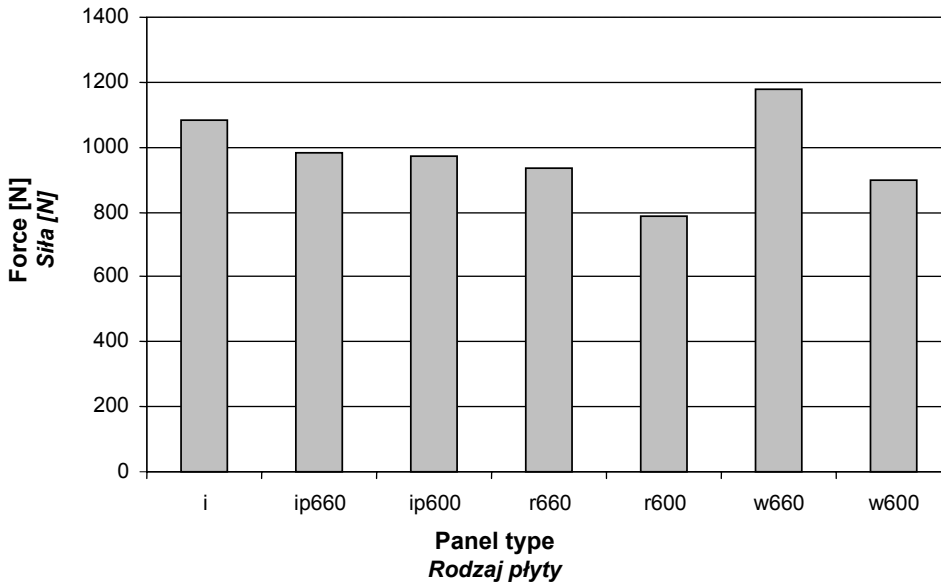

Fig. 1. The screw withdrawal resistance of the investigated panels
Rys. 1. Wytrzymałość badanych płyt na wyciąganie wkręta

Table 1. Statistical significance of the differences of the SWR mean values
Tabela 1. Statystyczna istotność różnic średnich wartości wytrzymałości na wyciąganie wkręta

w600	***0.00068***	0.08282	0.14130	0.50838	***0.02307***	***0.00101***
w660	0.28260	0.16202	0.06993	***0.00411***	***7.25E-06***	
r600	***0.00066***	***0.02194***	***0.01942***	***0.02996***		
r660	***0.00082***	0.05726	***0.04408***			
ip600	0.06190	0.82186				
ip660	0.10384					
	i	ip660	ip600	r660	r600	w660

In comparison with the results achieved by Joščák et al. [2009] concerning chipboards and joints for excenters, the investigated panels made of fibrous chips, even those panels of lower density, are characterised by comparable SWR.

According to table 1 significant differences of the mean values of the SWR obtained for the investigated panels can be observed between r600 and the rest of the panels, i and w600 and r660, ip600 and *r660*, w660 and r660, w600 and w660, and the strongest difference can be observed between w660 and r600.

Conclusions

On the basis of the above-mentioned results the following conclusions can be drawn and remarks made:

1. The screw withdrawal resistance of panels produced from fibrous chips of black locust *Robinia Pseudoacacia* L. is lower than in the case of the industrial panel, even when the density of the black locust panel is higher than that of the industrial panel.
2. There is a significant interrelation between the density of fibrous chip panel and the screw withdrawal resistance, i.e. the screw withdrawal resistance increases as the panel density increases.
3. There is no significant influence of the panel density on the screw withdrawal resistance in the case of panels produced from industrial particles.

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ZDOLNOŚĆ UTRZYMYWANIA WKRĘTA PŁYT WYTWORZONYCH Z WIÓRÓW WŁÓKNISTYCH

Streszczenie

Przedstawiono wyniki badań zdolności utrzymywania wkręta płyt wytworzonych z nietypowych cząstek drzewnych – wiórów włóknistych. W warunkach laboratoryjnych wykonano serię trójwarstwowych płyt o różnych gęstościach, z dwóch rodzajów wiórów włóknistych. Surowcem do produkcji wiórów włóknistych była wierzba *Salix Viminalis* L. oraz robinia *Robinia Pseudoacacia* L. Wykonano również płyty z wiórów przemysłowych. Wyniki zostały porównane z badaniami płyty przemysłowej. Badania wykazały niższą wytrzymałość na wyciąganie wkręta płyt wytworzonych z wiórów włóknistych z robinii, w porównaniu do płyty przemysłowej. Płyty o wyższej gęstości z wierzby charakteryzowała istotnie wyższa wytrzymałość na wyciąganie wkręta niż płyty komercyjne.

Słowa kluczowe: płyta wiórowa, wióry włókniste, wkręt, wytrzymałość na wyrywanie, wierzba, robinia